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Abstract:

This master thesis in Lighting Design investigates designing with shadows in urban spaces, with the aim of attracting people and thereby increasing the use of the spaces. Epistemes, as a methodological framework have been used in two analyses and two design principles, to examine the perception of shadows within urban spaces. In order to design with shadows, an experiment and a test have been conducted, to investigate the perception and attraction of light and shadow settings, from different directions and angles on a staircase at Israels Plads, Copenhagen. Findings from the experiment and test are addressed in two design principles which introduce how to illuminate a staircase to entail an understandable structure of the staircase and steps as well as increasing the usability. Furthermore, the design principles present light and shadow settings that create an attractive space by the presence of shadows that cause people to stay at the space for a longer period of time. The two design principles are examples of designing with shadows and intended to be applied to other objects within urban spaces.

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DESIGNING WITH SHADOWS IN THE URBAN SPACE

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PREFACE

This master thesis in Lighting Design is made by Anna Petersen from February 2019 to May 2019 at Aalborg University, Copenhagen. The thesis deals with how shadows are perceived, and furthermore how the focus of designing with shadows increases the experience and attraction to the urban space. The focal point of the project is to investigate the phenomenon *shadow* by a methodological approach according to four epistemes - *morphology*, *praxeology*, *semiotics*, and *phenomenology* - which examine the way we *see*, *understand*, and *design* our surroundings.



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INTRODUCTION

01



The following chapter consists of an introduction to the thesis followed by a vision of the importance of incorporating light and shadows in the design to achieve more attractive urban spaces. Subsequently, the working methods are elaborated which leads to a description of how the thesis is structured.



Fig. 1.1 - Photograph of a shadow captured in a urban space

1.1 INTRODUCTION

The phenomenon *light* is an essential factor in people's life - we can not live without, and it is impossible to navigate in our environments in total darkness. With light the phenomenon *shadow* follows. The Japanese lighting designer Kaoru Mende states, that light is only perceived by the present of a shadow, and the shadow will not exists without the present of light (Mende, 2010). The shadow is an important factor for creating contrast, which entails that the human perception and understanding of a space increases. Contrasts occur by the presents of light and shadow, and the human eye and mind are especially drawn to contrasts. This is important for making a space more interesting to stay in. The British architect and urban designer Gordan Cullen (1961) claims that light and shadow are essential to draw human attention, and if the contrasts do not appear it will unsuspected slip past and become monotonous in humans minds.

Incorporating shadows in a design process will developing spaces that are designed *for* people. To design *for* people, a space has to be easy to understand and navigate within and be attractive as well. The focus of incorporating shadows in designs are especially seen in Japanese architecture. In Japan shadows is an important integrated part of a design process to get the relationship between human and nature closer. The Japanese author Junichiro Tanizaki and Kaoru Mende argue that the Western culture has to design based upon the nature's qualities, and thereby achieve designs that appeal to both the human eye and mind (Tanizaki, 2001) (Mende, 2010).

This thesis investigates how we *see*, *understand* and *feel* the perception of light and shadows within urban spaces. Here, the purpose is to incorporate the Japanese mindset into a design process. Thereby to create spaces in which experiences occur and where human and nature can meet and mutually affect each other positively. Humans perceptions and feelings of light and shadows are examined by a methodological approach of *epistemes*, which aims to interpret how people *see* a space, resulting in how we *understand* a space, and finally how the perception and experiences can increase *affiliation* and *attraction* to a specific urban space. This is elaborated in the thesis' chapters, which are structured as followed:

Continued in this chapter, the vision of this thesis will be described. Further the working method and the structure of the thesis are elaborated.

The following chapter *02 THEORY*, is containing definitions of shadows, and their natural movements. Followed by a description of the importance of designing with shadows in Japanese architecture.

Chapter *03 METHODOLOGY*, will explain the methods and methodology of four epistemes: *morphology*, *praxeology*, *semiotic*, and *phenomenology*, which is the framework for this thesis and the approach for the analyses and developed design principles.

Analyses of shadows in urban spaces are investigated in chapter *04 ANALYSIS*. This chapter examine two urban spaces: Piazza di Spagna in Rome and Israels Plads in Copenhagen. The analyses leads to the focus of further investigation of the perception of shadows on staircases.

The previous chapter leads to the problem statement, which is explained in chapter *05 PROBLEM STATEMENT*. To answer the problem statement, experiments and tests are performed to examine perception of shadows on a staircase at Israels Plads. The experiments and test are described in chapter *06 EXPERIMENTS & TESTS*.

In chapter *07 DISCUSSION*, the findings from experiments and results from tests will be compared and discussed. The discussion leads to development of two design principles of illumination on staircases. The two design principles are introduced in chapter *08 DESIGN PRINCIPLES*.

The final chapter *09 OUTRO*, contains a conclusion that sums up the findings and a reflection of the thesis' methodology.



Fig. 1.2 - A collage of light and shadows.
Photograph of the ceiling of Pantheon, Rome.

1.2 VISION

Occurrence and appearance of light and shadows in the urban space are essential to create spaces that appeal to the human eye and mind. Based on that the fascination of the Japanese lighting designer Kaoru Mende's focus of shadows in lighting design is the core on which the vision of this thesis is based. Especially the following statement emphasizes the importance of designing with shadows and why it can not be neglected in a design process:

"We go about our day looking at shadow not light. While mostly unconscious behavior and therefore nor something we are necessarily aware of, it is the shadow in our field of vision that our eyes follow. Though the world that we see is made up of layers of light and shadow, it is shadow not light that is usually the focus of our gaze." (Mende, 2010, p. 11, ll. 2-7).

According to Mende, the world we are staying and navigating in is a collage of light and shadows which creates patterns that we are naturally drawn to. Thereby, the vision of this thesis is as followed:

***Imagine if focusing on shadows in lighting design
could create more attractive spaces in an urban context.***

1.3 WORKING METHOD

This thesis is focusing on the fact, that it is essential to incorporate shadows in a design process. As stated by Mende, among others, humans are attracted to the contrasts which light and shadows create. To investigate the perception of shadows in urban spaces epistemes, as a methodology framework, are used for this thesis. The epistemes: *morphology*, *praxeology*, *semiotic*, and *phenomenology* all relate to the concept of *seeing*, *understanding*, and *designing*, which are elaborated in chapter 03. These epistemes investigate how humans experience spaces by seeing and feeling and are, therefore, used to examine shadows in the urban space. By working with this methodology, it has been determined that the four epistemes are used for both analysis and the design process.

A literature study has been made to collect and select theory of *shadows*; the presence of shadows in our world, and how shadows are shaped and perceived. In addition to this, the analysis is made by the observation method of two urban spaces to collect data of shadows within these urban spaces. The site analysis has been executed by the use of the methodology of epistemes, where the author of this thesis has used senses (seeing, hearing, touching, and feeling) to collect data of the presence of shadows in the urban space.

While analyzing the two urban spaces the focus of the thesis is narrowed down to examine, how to design with shadows on staircases in an urban space. Thereafter, based on the findings from the analysis, a problem statement has been conducted.

The design builds upon the methodology where experiments have been carried out, to investigate how shadows are casted on stairs according to different angles and directions. Further, the shadow observations from experiments are tested on test persons by the use of qualitative questionnaires.

1.4 STRUCTURE

In this section a description of the structure and process of the thesis will be presented, see fig. 1.3. The structure is build up according to Problem Based Learning (PBL), which approach is to acquire knowledge by working analytically, interdisciplinary, problem- and result oriented (Aalborg University learning model). Moreover, it is illustrated with numbers, to the right of the structure figure, which part of the figure corresponds to which chapter of the thesis.

The framework for the process is highlighted in the figure, which illustrates that the methodology is the framework of the project, where it is used to analyze two urban spaces and also that the design builds upon the same methodology. The methodology and methods are elaborated in chapter 03.

The two analyses (described in chapter 04) function as a part of the process to narrow down this thesis' focus. The focus area is defined in the problem statement in chapter 05. The focus area is further investigated by experiments and tested (described in chapter 06), and become the basis of the development of two design principles (introduced in chapter 08).

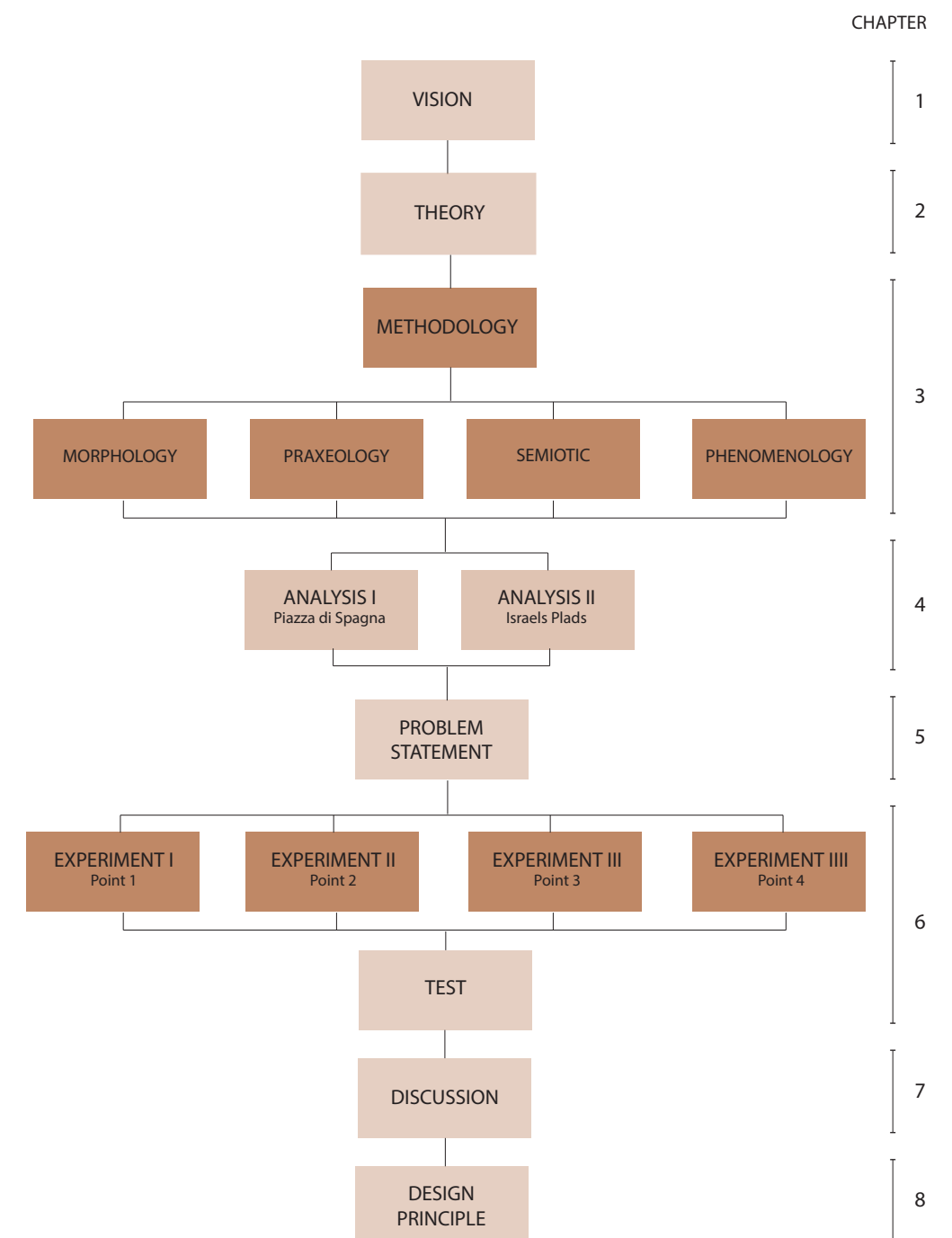




Fig. 1.3 - Illustrates the structure of the thesis. The methodology of four epistemes; morphology, praxeology, semiotic, and phenomenology, is the framework of the thesis, and is highlighted in the figure




THEORY

02



In this chapter the chosen theory is elaborated. The theory describes definitions of shadows by the Danish architect Sophus Frandsen (1984) and the British academic teacher and author Piotr Sadowski (2017). Moreover, the Earth's position in relation to the sun is described to examine the natural movement of light and thereby the occurring shadows. A description of the importance of designing with shadows in architecture is elaborated according to the Japanese lighting designer Kaoru Mende (2010) as well as the Japanese author Junichiro Tanizaki (2001). The examined theory in this chapter is further investigated in two analyses of urban spaces in chapter 04 and used to develop two design principles in chapter 08.



2.1 DEFINITION OF SHADOWS

2.1.1 A shadow

The phenomena *shadow* will in this section be defined according to theory by the Danish architect Sophus Frandsen (1984) and the British academic teacher and author of visual arts Piotr Sadowski (2017). Furthermore, the natural movement of shadows will be described.

A shadow is a dark area that occurs as a result of an object blocking a light beam. Shadows are ubiquitous and familiar side effects of both natural and artificial light, and the human perception of it. Without the darkness of a shadow to offset brightness not even the shadow or the light could appear as a sign in its own right and as an integral property of the visual world (Sadowski, 2017). The darkness of a shadow depends on shape and identity of the light source and on the shape of the object that intercepts the light beam. Furthermore, it depends on the color, texture, and shape of the surface upon which the light and shadow falls. Therefore, the factors - shape, color, texture etc. - determine that shadows, as optical effects, do not have an independent existence:

"... the light falling on an object from an angle of forty-five degrees produces on even ground an accurate dark silhouette of that object. When falling from other angles light create shadows that distort the shape of the object: a low-angle light, such as produced by the sun at dawn or sunset, casts shadows that are grotesquely elongated, while a high-angle, midday light produces a shortened squat version of the object." (Sadowski, 2017, p. 24, ll. 20-25).

Although shadows are visible and can be casted in many different shapes - long and thin, short and fat, dark and crisp, faint and hazy, graceful or clumsy, mysterious and sinister - they do not appear to be a part of the material world, because they lack solidity and substantiality. Even though shadows do not appear as a part of the material world they still have an impact of how people understand the world in which they are moving and interacting. In addition, shadows inform people about the solid object that produce them, even if the objects themselves are not visible (Sadowski, 2017).

2.1.2 The natural movement of light and shadows

This section is shortly describing the Earth's relation to the sun, and how shadows appear differently according to this relation.

Shadows appear on Earth and in our environment as an effect of the sun's light. The appearance of shadows are depending on Earth's position in relation to the sun. Fig. 2.1 illustrates the position of the Earth throughout a year. As well the change of shadows - their change in length, shape, and darkness, depends on to the Earth's orbital angle (Γ) which indicates the tilt of the Earth. Thereby, if the sun is positioned high at the sky, the shadow is short, but it grows longer as the sun moves closer to the horizon (Fajkus & Whitsett, 2018). The Earth's rotational axis is pointing in a constant direction during its orbit around the sun. Sunrise is always occurring on the site of the Earth that is rotating towards the sun and sunset is underway on the opposite site of the Earth. The line that separates day from night is called the terminator (Fajkus & Whitsett, 2018), and is illustrated in fig. 2.1.

The sun is essential for producing shadows, and the Norwegian architect Christian Norbert-Schulz claims that light and shadows are providing a way to design architecture, so that they defines place and environment as an important part of peoples' existence, and that the very basis of human identity is dependent on a notion of place (Norberg-Schulz, 1980).

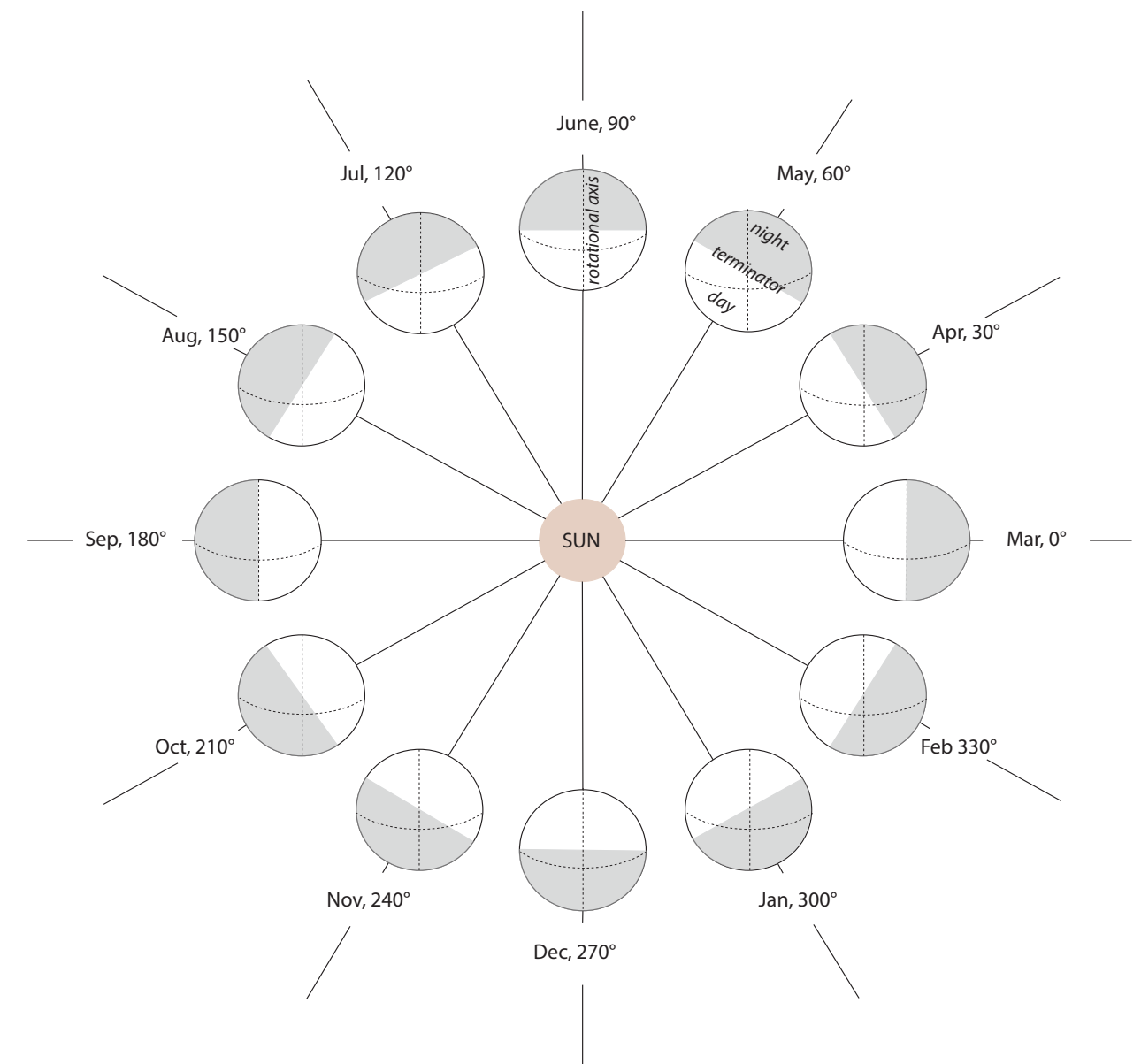


Fig. 2.1 - Illustrates the position of the Earth throughout the year. Numbers indicate the Earth's orbital angle (Γ).

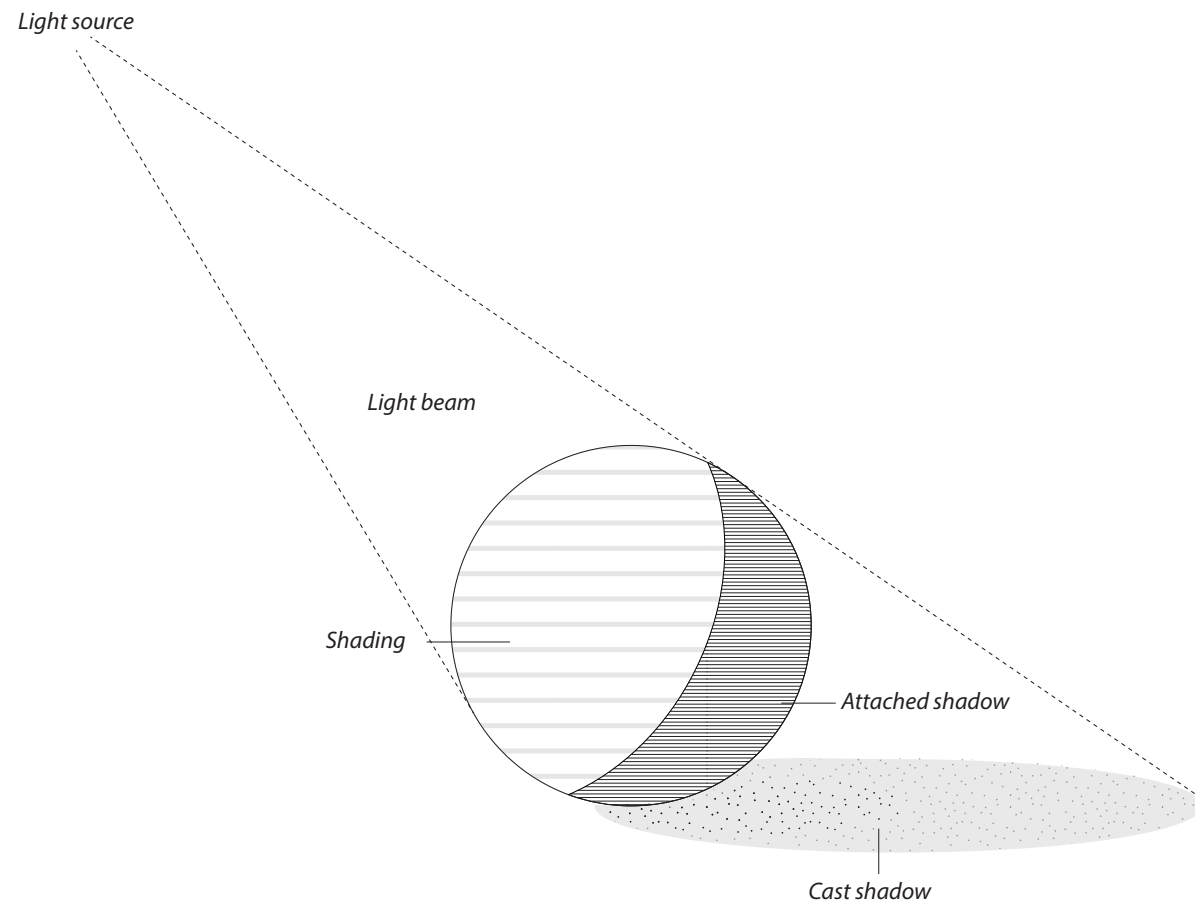


Fig. 2.2 - Illustrates Sadowski's (2017) three shadows on a sphere

2.1.3 Piotr Sadowski's three shadows

Sadowski (2017) defines three different kinds of shadows - *shading*, *attached shadow*, and *cast shadow* - which are illustrated in fig. 2.2 and 2.3.

The first type of shadow - *shading* - is a shadow that emphasizes the shape of an object and provide important clues about the texture of the object's surfaces:

"... *shading*, used to convey the sense of volume and roundness of solid objects represented on a flat surface. [...] *Shading* makes the surface of objects recede towards the contours, while highlights make objects protrude, creating for the viewer the illusion of relief and depth on an otherwise flat surface." (Sadowski, 2017, p. 30, ll. 16-19).

The *attached shadow* is the shadow that is defined as the dark silhouette on an object. The shadow is dark and therefore it does not show texture or surface detail:

"When shadows directly overlie the objects by whose shape, spatial orientation, and distance from the light source they are seated, we are talking about attached shadows." (Sadowski, 2017, p. 31, ll. 13-15).

The *cast shadow* is the dark area that appears of an object which blocks a light beam. Sadowski describes this type of shadow as a sign which maintain a physical connection to its object:

"Natural shadows also look insubstantial compared with the solid objects that cast them, while an artistically represented shadow has the same physical quality as the object - both are insubstantial and therefore potentially equivalent as pictorial motifs." (Sadowski, 2017, p. 34, ll. 10-13).

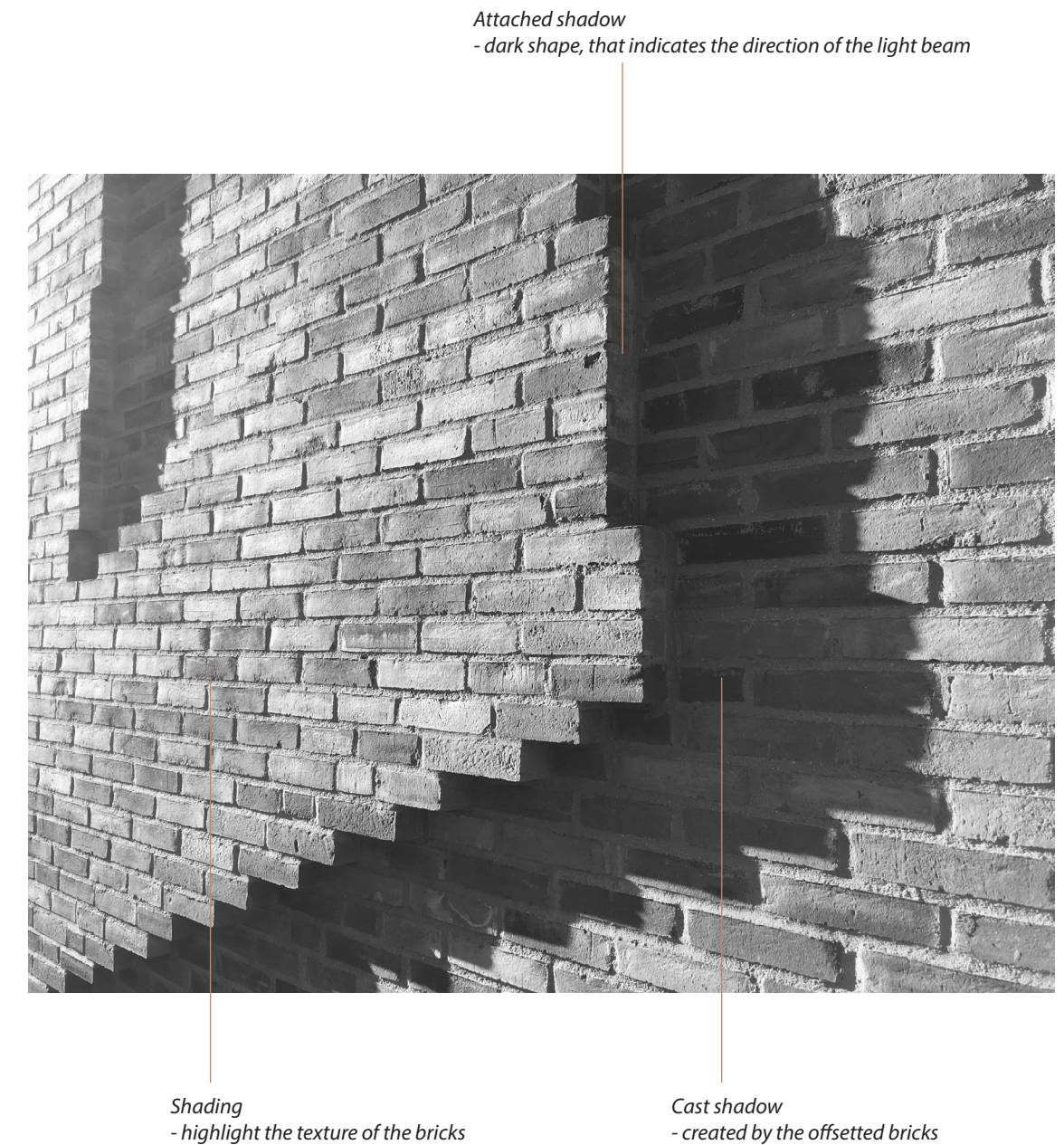


Fig. 2.3 - Example of the three shadows on a wall in the urban space



Fig. 2.4 - Example of Frandsen's four shadows

2.1.4 Sophus Frandsen's four shadows

Frandsen (1984) defines four types of shadows - *The big room shadow*, *The big object shadow*, *The small object shadow*, and *The detail shadow* - which are illustrated in fig. 2.4 and 2.5. The four shadows, which are created according to place and size, categorize how shadows occur in a side lit room, and with any modification can be adapted to conditions of spaces lit by artificial light. In principle, all four shadows will usually be experienced in spaces that are illuminated by the Danish architect Poul Henningsen's lamps, which are designed based on the theory of the fact that distinctions must be made between the different functions of the large and the small objects' shadows. When different sizes of shadows are considered and used in spaces, the space will appear as if it was only illuminated by daylight (Frandsen, 1984).

The concept of the four shadows is to divide shadows by size. The two big shadows (1 - *The big room shadow* and 2 - *The big object shadow*) are consequently related to the light in the space. These are the shadows we move through, step on, or sit upon. Similarly, the small shadows (3 - *The small object shadow*, and 4 - *The detail shadow*) are associated with the light on the objects. It is the shadows that we have between our hands and the ones we can touch. These are the shadows that surround us, and emphasize the details on objects (Frandsen, 1984).

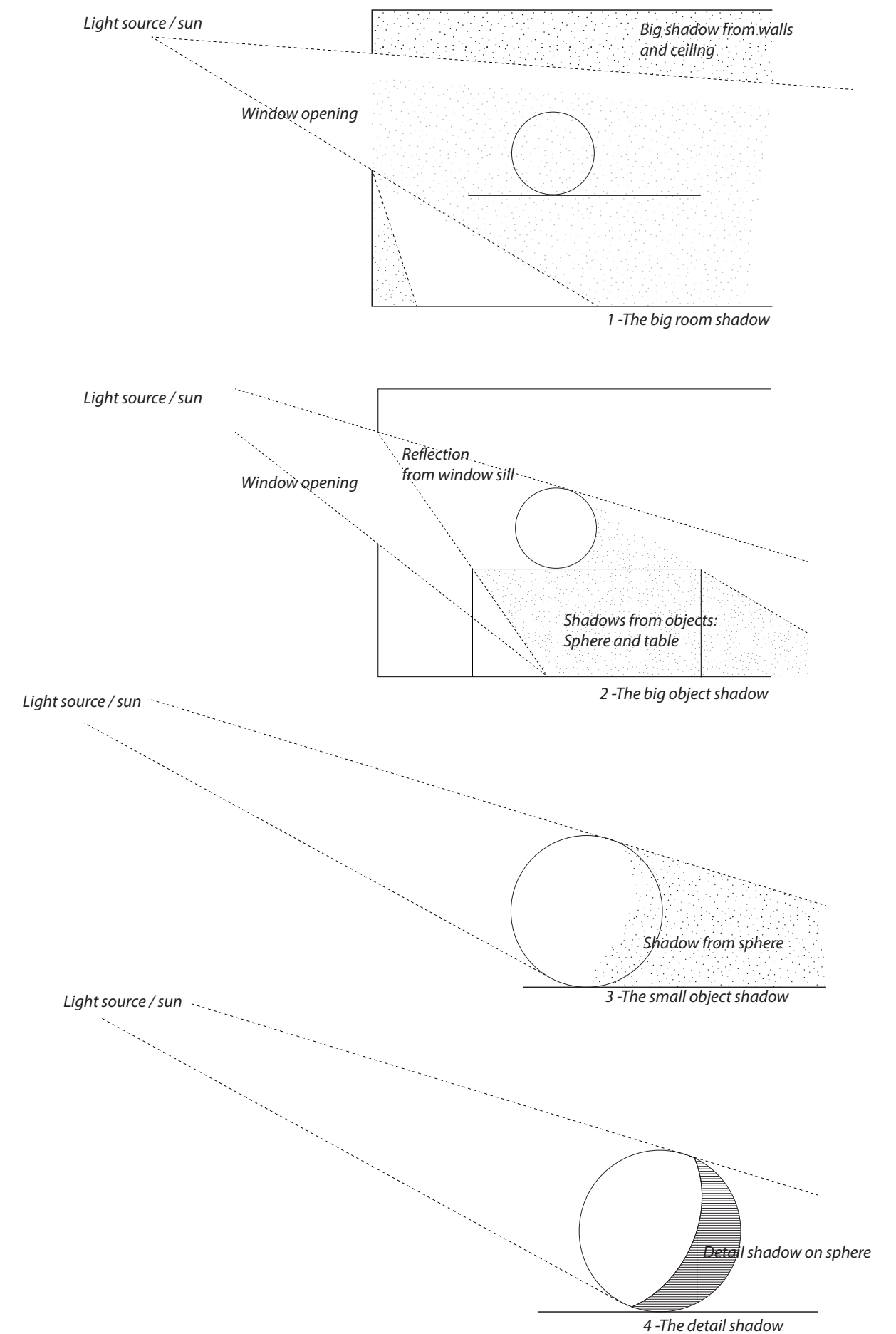


Fig. 2.5 - Illustrates Sophus Frandsen's (1984) four shadows

2.2 THE IMPORTANCE OF SHADOWS

This section will describe the importance of shadows' presence in order to create spaces for people. This is described according to the Japanese lighting designer Kaoru Mende (2010) and the Japanese author Junichiro Tanizaki (2001). The importance of shadows is especially seen in Japanese architecture and design, where it is common to incorporate natural elements into design, and thereby get a closer contact with nature. Japanese architects and designers, as Mende, use daylight and shadows to create contrast and movement in spaces, thereby involving the outer context (nature), in a design, which inform about the season, time of the day or weather conditions (Moore & Ørskov, 2011).

Shadows are a visual phenomena that the human eye is especially attracted to and find satisfying, as Mende (2010) states. The statement is, as well, mentioned in the vision for this thesis (section 1.2):

"We go about our day looking at shadow not light. While mostly unconscious behavior and therefore nor something we are necessarily aware of, it is the shadow in our field of vision that our eyes follow. Though the world that we see is made up of layers of light and shadow, it is shadow not light that is usually the focus of our gaze." (Mende, 2010, p. 11, ll. 2-7).

Mende shares his fascination of shadows with Tanizaki (2001). Tanizaki describes, in his essay *In Praise of Shadows*, shadows in Japanese architecture as something that are essential to "build up" spaces by using shadows as a factor in creating depth, beauty and mystery. Thereby he states, that shadows are essential to create aesthetic spaces: *"Were it not for shadows, there would be no beauty."* (Tanizaki, 2001, p. 41, ll. 18-19). Both, Mende and Tanizaki, believes that people are significantly more drawn to the patterns of light and shadow that objects create, than they are to the object itself. Shadows and darkness are therefore of great essence in lighting design in order to create satisfying spaces using minimal light, that can create subtle forms of shadows (Mende, 2010), and the use of various shadows to create countless dark layers which are decorating the space and bring depth to it. Different layers of darkness are carefully used in Japanese architecture. When focusing on darkness, by hiding parts of a space in shadows, it creates fluid patterns that conjure an inexpressible aura of depth and mystery of overtones (Tanizaki, 2001). Shadows are described as a phenomena that creates beauty, but also as something that appeal to what people find relaxing. This is because shadows in architecture create pauses to our eyes when they wander through a space. Tanizaki (2001) elaborates on these shadows by comparing them with soft voices in a conversation - in which he means, that people prefer things which do not obstruct the feeling of the atmosphere and on the other hand, contributes positively to people's impressions (Tanizaki, 2001). In the same way, the American architect Charles Moore explains shadows by comparing the feeling of shadows with the way musicians make their sounds to capture silence, or that architects develop complex shapes to envelope empty space (Moore, 2001). By that, the shape and patterns of shadows are important when attracting people and in drawing attention to these visual pauses, which occur in a space. Furthermore they are, as mentioned, also essential to what people find attractive.

In addition, it is important to point out that light and shadows are indistinguishable and that one of them does not exist without the other. Furthermore, it is important to emphasize, that each of the two phenomena - *light* and *shadow* - has considerable significance and thereby emitting widely different impressions within a space. The different impressions are depending on how they are used in a design. The following section describes how to design when focusing on shadows.



Fig. 2.6 - Photograph of an urban space made up of horizontal and vertical layers of light and shadow

2.3 DESIGNING WITH SHADOWS

2.3.1 Junichiro Tanizaki's beauty by shadows

A space which is dominated by shadows will create atmospheres, which Tanizaki (2001) describes as beauty. It is described how shadows are a central part of Japanese architecture and thinking, and Tanizaki describes the great difference between the design approach of shadows in Western and Japanese culture:

"And so it has come to be that the beauty of Japanese room depends on a variation of shadows heavy shadows against light shadows - it has nothing else. Westerners are amazed at the simplicity of Japanese rooms, perceiving in them no more than ashen walls bereft of ornament. Their reaction is understandable, but it betrays a failure to comprehend the mystery of shadows." (Tanizaki, 2001, p. 29, ll. 19-26).

Tanizaki believes, that Japanese's affiliation to design with shadows stems from the realities of life and our ancestors, who were forced to live in dark spaces and thereby came to discover beauty in shadows, which guided them to use shadows as an essential part of designing spaces with beauty as focal point. Thus, the central part of Japanese architecture is light, which creates a world of shadows, that form a space that has qualities of mystery and depth (Tanizaki, 2001). Shadows lead to a certain atmosphere in a space that makes people get the feeling of, that in a space which is laid in darkness, reigns complete and utter silence - an impenetrable calm. The impenetrable calm and dark areas within the space are where people find the beauty (Tanizaki, 2001). Beauty is not in the thing itself but in the patterns of shadows. Patterns of shadows are the phenomenon that darkness creates as a counter to point light. Tanizaki states that focusing on beauty is a way of thinking and thereby the impression of a space decorated with patterns of shadows are drawing peoples attention (Tanizaki, 2001).

2.3.2 Kaoru Mende's description of shadows

Likewise, Mende (2010) is fascinated by the focus of designing with shadows and describes the phenomenon as a region between light and darkness:

"...the quality inherent within rich gradation, the continuity that smoothly joins one place to another, the ephemeral nature of things manifested over time. Whether we look at the world in motion and through a shifting of vision or motionless and with a fixed field of vision, shadow twists and turns like a lead actor in a drama to smooth out the flow of time." (Mende, 2010, p. 12, ll. 47-54).

Thereby, Mende finds it crucial to include shadows in design and also states that the surroundings which people stay in must be in at least 70 percent shadow to really make an impression. To get this impression of a space Mende uses four keywords of describing shadows - *gradation*, *contrast*, *sparkling*, and *visualizing*. Mende uses his keywords as descriptive words for his work as a lighting designer.

First, the *gradation* is what Mende (2010) defines as the area between light and darkness. Gradation indicates how light gradually fades from indirect light to black. This transformation, from direct light to total darkness, is the essence of gradation. This essence is what he also calls the shadow, which lies in the infinit range between light and darkness. As Tanizaki (2001), Mende believes that there is a big difference in the way Western culture exploits light and shadow and how Japanese culture do it - namely, that shadows are of huge quality to a design. Hereby Mende states, that Western culture must be introduced to include shadows as a unique design quality. Furthermore he states, that shadow gradation is a particular product with which one gets a view of reality, which Japanese designers base their philosophy upon. He describes that light is only perceived by having a shadow, and the shadow does not exists without light (Mende, 2010).

The perception of shadows is described by *contrast*, which depends upon the change in light over time and on continuity through space. Contrast is a conceptual term which is the temporal-spatial variation between two or more things or two or more environments (Mende, 2010). According to Mende's keyword contrast, the British architect and urban designer Gordan Cullen (1961), also touches upon why

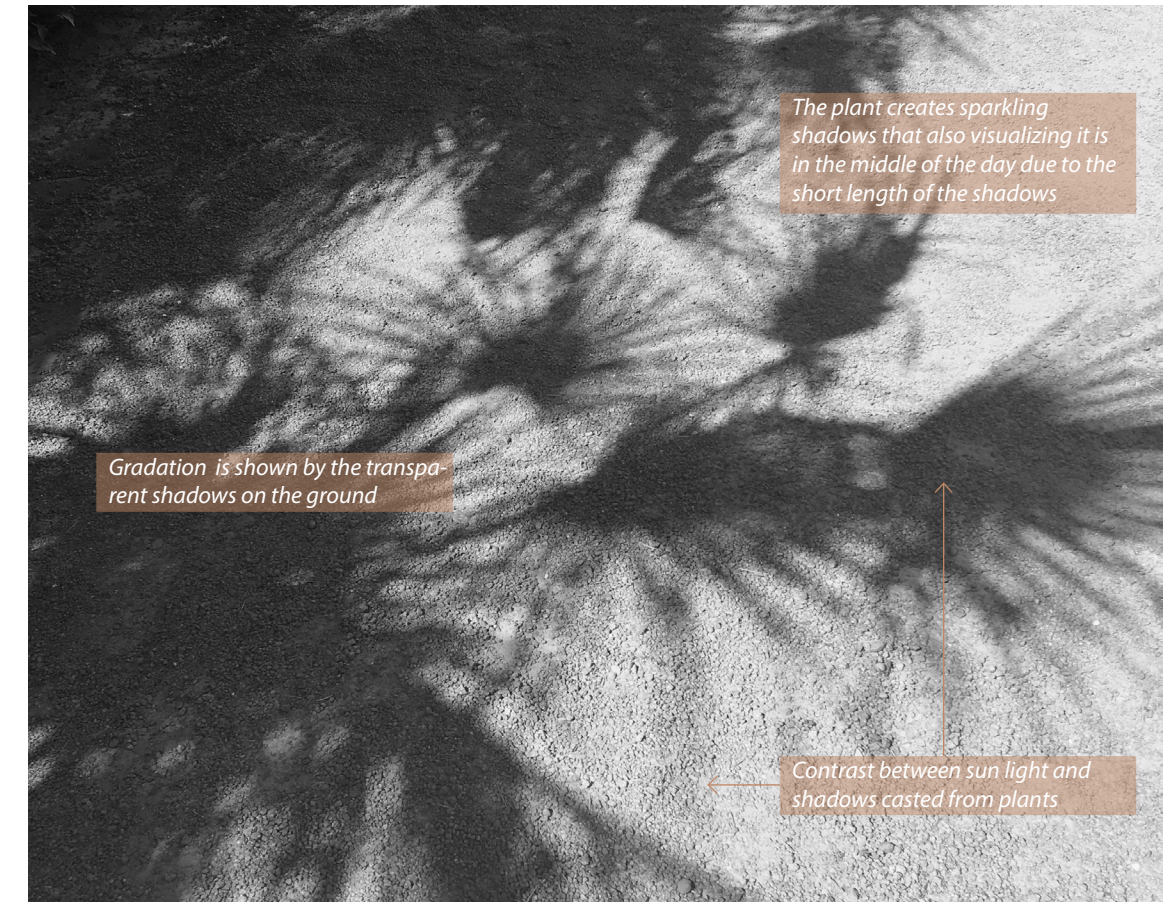


Fig. 2.7 - Example of Mende's shadows in an urban space

contrasts are important to create urban spaces that are interesting to stay in. Cullen (1961) states, that the human mind reacts to the difference between things. Contrast is the difference between things and is where a vivid feeling appears and thereby the perception of a urban space becomes more visible. Unless the contrast does not appear, the urban space will slip past us featureless and a it will become monotonous in our minds (Cullen, 1961).

The third keyword for describing shadows is named *sparkling*. Mende (2010) defines this as a relationship between light and darkness, as a pattern of flickering point of light that submerge against a background or in surroundings of well-coordinated shadows. The appearance of the relation between light and shadow has to bring forth an elegant and entertaining feeling for the viewers (Mende, 2010). According to this, the American lighting designer Richard Kelly (1952), is agreeing with the way of designing with contrasts resulting in stimulating humans' minds. Compared to the keyword sparkling, Kelly has defined an element called *Play of brilliants* and states that:

"Play of brilliants excites the optic nerves, and in turn stimulates the body and spirit, quickens the appetite, awakens curiosity, sharpens the wit. It is distracting or entertaining." (Kelly, 1952, p. 25, ll. 31-33).

According to the aforementioned, Mende's (2010) fourth keyword *visualizing*, is also appealing to human perception of light and darkness - in this case: day and night. Visualizing is describing that through the changeability of light humans do feel time, because of the way that sunlight casts gradually lengthening shadow and thereby reminds us of the passing time:

"In the same way, the shadow of a garden tree on shoji and light tinged with color remind of the passing season. Subtle shifting light and shadow regulates you daily biological rhythm and keeps us in sync with the passing seasons." (Mende, 2010, p. 133, ll. 9-11).



Fig. 2.8 - Example of the perception of light and shadows on steps of a staircase

2.4 VISUAL PERCEPTION

The human perception is depending on the eyes that see and interpret. Perception therefore depends on the viewer's ability to see. Being able to see is depending on a number of factors, as the American psychologist James J. Gibson writes:

"There are, as everybody knows, a number of conditions which have to be fulfilled before anyone can see: there must be light to see by; the eyes must be open; the eyes must focus and point properly; the sensitive film at the rear of each eyeball must react to light; the optic nerves must transmit impulses to the brain. Just so long as one of these conditions is not fulfilled, the seeing person is blind."
(Gibson, 1950, p. 1, ll. 1-11)

According to Gibson (1950), light is, in a way, the raw material of vision. It would be impossible to perceive an object in a space, if the human eye was not sensitive to the light that is reflected from the object. The perception and understanding of the objects that surround us are affected by light simulation by a properly functioning eye, and how the eye perceives the brightness and hue of the reflected light (Gibson, 1950).

When the human eye perceives the objects that surround us the visual world that human acts within is created. The human perception is not only useful, since it means we can act within spaces, it also evokes our memories and experiences, the emotions and feelings inside us, which have the power to disturb the mind when aroused (Cullen, 1961). When the human eye and mind get disturbed by the appearance of objects, it increases the affiliation to a certain space because, according to the Finnish architect Juhani Pallasmaa (2009), a space is structured by meanings and intentions reflected within the individual human. Either consciously or unconsciously a space is interpreted through human memory and experience:

"We do not live in an objective world of matter and facts, as commonplace naïve realism assumes. The characteristically human mode of existence takes place in worlds of possibilities, molded by our capacities of memory, fantasy, and imagination. We live in mental worlds, in which the material and the spiritual, as well as the experienced, remembered, and imagined fuse completely into each other."
(Pallasmaa, 2009, p. 223-224, ll. 11-3).

Humans, as sensory as well as conceptual creatures, have the ability to be emotionally attracted to objects and spaces solely by the perception of them. The Japanese professor of philosophy Yuriko Saito (2007) assumes, it is important, when architects and designers design, that they are forced to respect the users of a space. They have to be aware of the fact that the space can respond to the users bodily experiences (Saito, 2007).

2.4.1 The perception of shadows

Light is essential for humans to perceive spaces and objects within a space. The side effect of light is the shadow. These two phenomena, *light* and *shadow*, do not exist without each other's presence. The responsiveness to both light and shadow helps most living creatures - including humans, to get around in the world. In relation to the perception of shadows, it is interesting that they tend to simulate the imagination more, when they appear on their own than if they are perceived accompanied with their illuminated objects (Sadowski, 2017). The perception of shadows itself, has played an important role in the history of human interaction. By that, the human perception of shadows, that represent an object as a sign, is the most effective and adaptively important sense in humans. We can with our eyes acquire crucial knowledge and understanding of the physical properties of objects in our surroundings. It gives knowledge of; shape and size of objects, brightness, distance, movement, and spatial distribution:



"Shadows as side effects of light falling on opaque objects also play a role in our visual negotiation of the physical environment. [...] cast shadows indicate the direction of light falling on objects, as well as the fact that something is obstructing the light. Texture of objects is revealed by small shadows, and both the texture and the surface and the direction of illuminance are indicated by the form and direction of shadows."
(Sadowski, 2017, p. 12, ll. 27-34)

A space is, therefore, structured by light and shadows. And because darkness and shadows attract attention they have an essential impact in how humans act within a space, due to shadows informing us about the solid object that produce them, even if we do not perceive the objects themselves.




METHODOLOGY

03



The following chapter will explain the methodologies which have been used to analyze existing urban spaces and afterwards to develop design principles. The framework of the project is based on the *methodology of epistemes* (elaborated in section 3.1) and the method *Descriptive Observations* by the American anthropologist James P. Spradley (elaborated in section 3.2). The methodology is composed by the epistemes and four of the nine dimensions in *Descriptive Observation* and will be merged, by the author of this thesis.



3.1 METHODOLOGY OF EPISTEMES

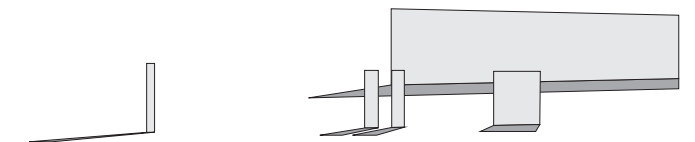
The method *Descriptive Observations* by the American anthropologist James P. Spradley (1980) is usually performed based on all his nine dimensions of everyday situations. In this thesis four out of the nine dimensions are selected due to their relation to the epistemes. Thereby, it has been determined that *Space* is equal to *Morphology*, *Activity* to *Praxeology*, *Object* to *Semiotics*, and *Feeling* to *Phenomenology*. This is illustrated in fig. 3.3, where it is also shown that the methodology is divided into quantitative and qualitative analysis approaches. To investigate two urban spaces different methods have been used within the quantitative and qualitative approaches - *observations, tracing, mapping, photography, serial vision*.

The different methodologies, which will be presented in this section, all relates to the concept of *seeing, understanding, and designing* a space - so called epistemes. The French philosopher Michel Foucault describes epistemes as frames of values and thoughts that influence the way we think and how knowledge is interpreted. Knowledge is collected using the senses, which is a necessary condition for recognizing objects themselves (Foucault, 1966). Foucault's concept of epistemes are used in this project as a bridge between the analysis (the way we see and understand) and for the design principles (the projection of the analysis to design). The focus of this thesis will be the four epistemes: *morphology, praxeology, semiotics, and phenomenology*, which will be elaborated on the next page. These mentioned epistemes are simultaneous and complementary, where each of them enables us to discover aspects of a urban space (Braae & Riesto, 2016). Each of the four epistemes relates to either qualitative or quantitative methods, which will be explained in section 3.2.

Before the different analysis methods will be presented, the four epistemes, *morphology, praxeology, semiotics, and phenomenology*, will be explained shortly according to the Danish landscape architect and professor Ellen Braae and the Swedish art historian Svava Riesto (2016) see fig. 3.1.

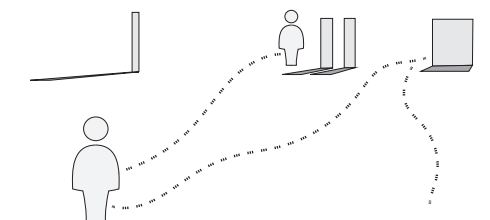
Morphology

Morphology means the study of forms and structures in a space. The forms and structures can be examined according to contextual relationships and to singular objects. Thereby, a morphological study describes how a space is structured according to the placement of objects within the specific space.



Praxeology

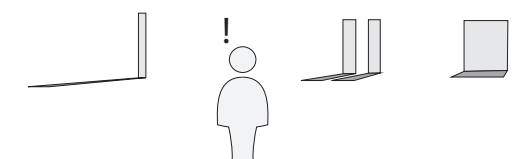
Praxeology is the study of human's action within a space. Praxeology is used to analyze the way humans do things in the urban space, or the way that they practice it. Studies of praxeology will therefore shed light on where people walk or stay.



Semiotics

Semiotic is the study of signs and the meaning of them. Signs are important for the layout of an urban space and will create meaning to the morphology of a space if the perceiver is able to "read" the signs of the objects.

In this project the semiotics of shadows will be examined according to the cast shadows of objects' morphology. Thus, the shadow will give information about the object's shape, solidity, transparency etc. and thereby how these shadow gives knowledge about how the urban space is structured.



Phenomenology

Phenomenology is the study of subjective experience, where all senses are used to examine a space - seeing, hearing, smelling, touching etc.. In this regard atmosphere is an aesthetic notion which is essential in phenomenology. Therefore, the atmospheres of spaces are central to understand the relationship between the characters of a space and conscious physical presence in space.

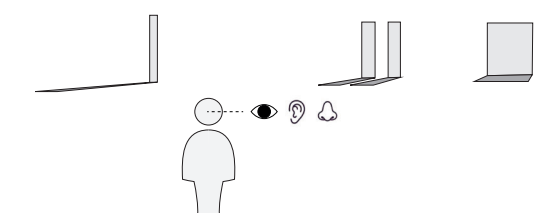


Fig. 3.1 - Describing and illustrating four epistemes (Braae & Riesto, 2016)

3.2 METHODOLOGY & METHODS

This section is structured so that the methods will be presented in the same order as they are used in the analysis. As mentioned above, the framework of the analysis is within the four epistemes: *morphology*, *praxeology*, *semiotics*, and *phenomenology*, and are divided into qualitative and quantitative analysis.

Two urban spaces are analyzed according to the methodological framework. Afterwards, the findings are compared in order to investigate the differences or similarities between the two urban spaces. The spaces which are analyzed are: Piazza di Spanga (The Spanish Steps) in Rome, Italy, and Israels Plads, Copenhagen, Denmark. The analysis of these are elaborated in chapter 04.

The analysis of the spaces are divided into different analysis-levels to investigate the site from different angles. First, the spaces will be examined according to James P. Spradleys (1980) *Descriptive Observations*. This qualitative method is called *Grand Tour Observations*, and give a subjective analysis of a specific site where the observer will examine a social urban space. The intend of The *Grand Tour Observation* is to investigate a specific space without any particular questions in mind - just the very wide question: “What is going on here?” (Spradley, 1980, p. 73). To guide the observer within the “superficial” analysis the question “What is going on here?” will be asked according to nine major dimensions of everyday situations, see fig. 3.2, where all nine dimensions are not important for every social space.

1.

Space: the physical place or places
2.

Actor: the people involved
3.

Activity: a set of related acts people do
4.

Object: the physical objects that are present
5.

Act: single actions that people do
6.

Event: a set of related acts that people carry out
7.

Time: the sequencing that takes place over time
8.

Goal: the things people are trying to accomplish
9.

Feeling: the emotions felt and expressed

Fig. 3.2 - Shows nine major dimensions of everyday situations according to social spaces (Spradley, 1980)

Based on the first impressions of the urban space, the findings from *Grand Tour Observations* opens up the mind to get deeper into the the next levels of the analysis. The deeper analysis will investigate smaller aspects of the experiences while being in the space, as Spradley states: “Every grand-tour observation is like a large room with numerous doors into smaller rooms...” (Spradley, 1980, p. 79, ll. 6-8). Four out of nine dimensions are analyzed: *Space*, *Activity*, *Object*, and *Feeling*. These dimensions are selected by the author, based on their relation to the four epistemes. Afterwards the four dimension are analyzed by using quantitative and qualitative methods based on the four epistemes, which is illustrated in fig. 3.3. As seen in the illustration, the structure of the space (*space* and *morphology*) and the human activity within the space (*activity* and *praxeology*) are analyzed by quantitative methods developed by the Austrian landscape architects Hans Loidl and Stefan Bernard (2014), and the Danish urban planners Jan Gehl and Birgitte Svarre (2013). Besides that, the impressions and feelings of shadows in the spaces are analyzed by using qualitative methods by architect and urban designer Gordon Cullen (1961) and anthropologist Helen Close (2007).

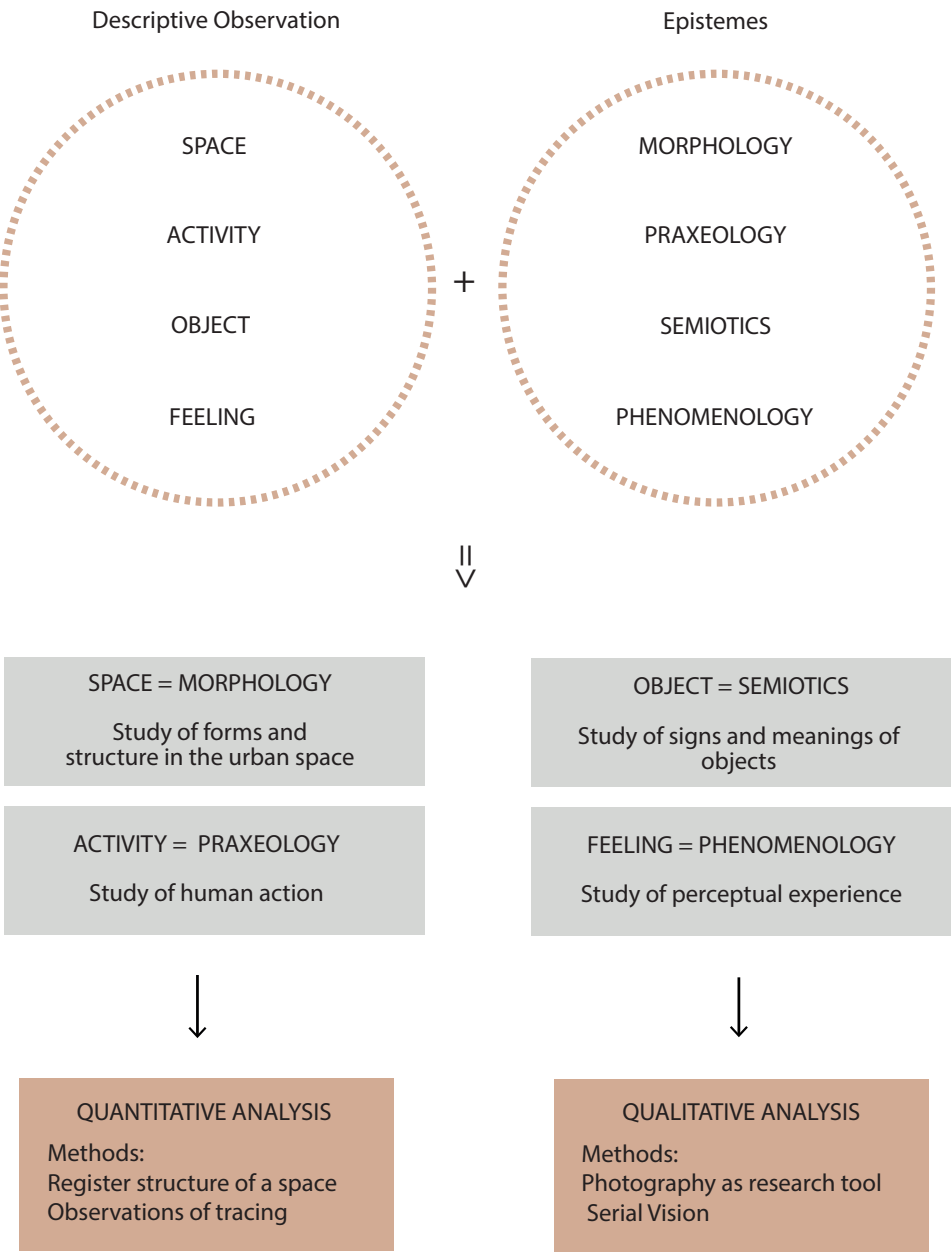


Fig. 3.3 - Illustrates how the analysis of the urban spaces are structured into qualitative and quantitative analysis

3.2.1 Quantitative methods

The quantitative analysis consists of collecting data of *morphology* and *praxeology* in the urban spaces. To collect these data the methods *mapping*, *observation*, and *tracing* are used. The methods *mapping*, *observation* and, *tracing* are used as a quantitative approach since they collect general data of human acting. Together the different quantitative methods will give an overview of the specific urban space, and thereby allow to go deeper into the analysis of the space by using qualitative analysis as described in section 3.1.2.

Register structure of a space

The structure of the urban spaces (morphology) will be analyzed according Loidl and Bernard's (2014) definition of spaces. Their definition is divided into four different spatial structures: *Closed spaces*, *Boundary Opening*, *Transparent spatial boundaries*, and *Open spatial boundaries*, see fig. 3.4. Here boundaries are den link between the "inside" (the space within the context) and "outside" (context), that defines a space and thereby its morphology. The analysis of the space's boundaries will be plotted on a map of the specific space. The collected knowledge from this analysis will be the basis for the next analysis *Observations and tracing*, where the morphology serves an essential factor for human activity.

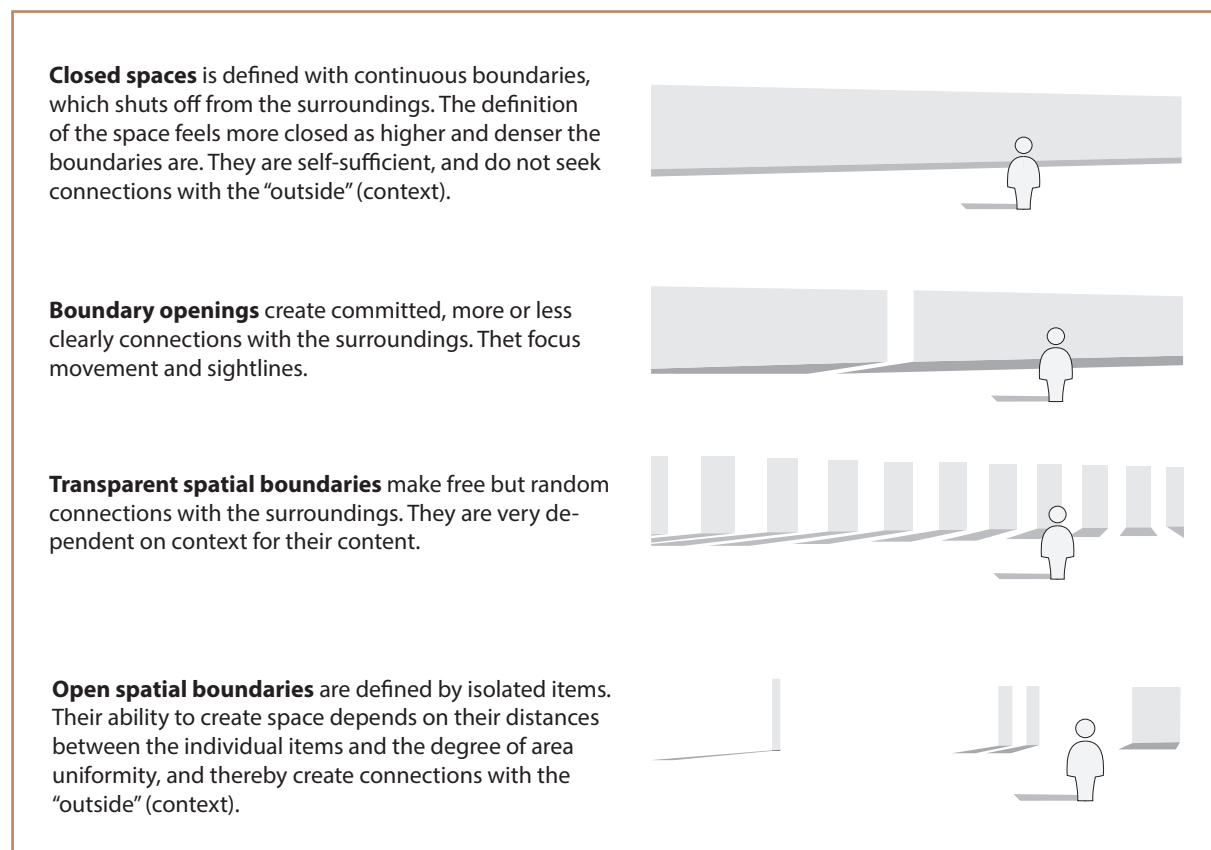


Fig. 3.4 - Illustrates four definitions of space (Loidl & Bernard, 2014)

Observations of tracing

The human activity (praxeology) of an urban space is registered by using the quantitative method; *tracing*, developed by Jan Gehl and Birgitte Svarre (2013). The method is to register the movement of people's patterns within a space. Moreover, it will give knowledge about specific movements inside a specific space; paths, common directions, flows, which entries are popular and which are not etc. The human activity is registered by observing people within the space. The observed movements are shown with lines on a map of the space during a period of 1 hour. The method of drawing movements on a map gives a clear picture of dominant and less dominant paths as well as populated and less populated areas (Gehl & Svarre, 2013).

3.2.2 Qualitative methods

The qualitative analysis will investigate how the urban spaces are perceived visually and thereby which feelings that occur in the perceiver's mind. An analysis of the shadow's semiotics is investigated by using the method of photography to illustrate the observations which are collected at the time the analysis was performed. Moreover, it will be examined, how shadows create smaller spaces within the big space by a phenomenological approach with the use of the method *Serial Vision* (Cullen, 1961). The two analysis are based upon the quantitative analysis so that the structure (morphology) and human activity (praxeology) are further explored.

Photography as a research tool

The investigation of the semiotics of shadows will be communicated by the use of photography. With photography you are able to communicate and structure data, and it is thereby a tool to visual communication which include meanings (semiotic), and interpretations based on context (Close, 2007). Photography has the potential to communicate the observed reality, and thereby be a method to generate knowledge of a visual language (Moran & Tegano, 2005).



The semiotics of shadows will be investigated on basis of theory about how objects cast different shadows and how these are perceived as structural indicators. Therefore, as mentioned in section 3.1, the examination of semiotics are related to the morphology, because it is the object's cast shadows that are the focal point. Where the shadows of objects become the elements that structure a space.

Serial Vision

To investigate how shadows are perceived by the observer in the urban space a phenomenological analysis approach, called *Serial Vision*, is used. *Serial Vision* is a method which use sketches to illustrate the view from the observes perspective, which Gordon Cullen explains as:

"To walk from one end of the plan to another, at a uniform pace, will provide a sequence of revelations which are suggested in the serial drawings opposite, reading from left to right. Each arrow on the plan represents a drawing. The even progress of travel is illuminated by a series of sudden contrasts and so on impact is made on the eye, bringing the plan to life..." (Cullen, 1961, p. 17, ll. 1-10).





This chapter will investigate how shadows are presented in two urban spaces - Piazza di Spagna (The Spanish Steps) in Rome, Italy (section 4.1), which is followed by an analysis of Israels Plads located in Copenhagen, Denmark (section 4.2). These two urban spaces are selected because both spaces have staircases which steps are used as hang-out spots for people. The aims of the analysis are to examine how light and shadow act within the spaces based on the methodologies of epistemes - *morphology*, *praxeology*, *semiotics*, and *phenomenology* - by using quantitative and qualitative methods. Each analysis is made only once, and thus only light and shadows from this given time slot are described in this chapter.






Fig. 4.1 - Map of Rome, where the white dotted circle illustrates where Piazza di Spagna is located

4.1 ANALYSIS OF PIAZZA DI SPAGNA, ROME

Piazza di Spagna in Rome is located in the city center, see fig. 4.1. The steps are used as a hang-out spot, and are visited by a lot of tourists and locals both in daytime and nighttime. The space is one large staircase, which people use for sitting, walking and enjoying the view of Rome's roofs and spiers. The Danish architect and urban planner Steen Eiler Rasmussen, gives a beautiful description of Piazza di Spagna, where he associates people's movement on the staircase with a ceremonial dance:

"With its bends and turns, its design seems to have been based on an old-fashioned, very ceremonial dance, the Polonaise, in which the dancers advance four by four in a straight line and then separate, two going to the right and two to the left; they turn, turn again, curtsy, meet again on the large landing, advance together, separate once more to left and right, and finally meet again at the topmost terrace where they turn to face the view and see Rome lying at their feet." (Rasmussen, 1959, p. 136, ll. 6-16)

The analysis of Piazza di Spagna was made the 23th of March 2019 in the afternoon on a sunny day. The specific day was selected by the author because of the weather conditions. Also the time of the day is carefully chosen, since the cast shadows are longer and more sharply recorded at the pavement, because the sun is lower in the sky than it is at noon. The author has consciously selected a sunny day to get the best impression of the shadows acting in the urban space.



Fig. 4.2 - Photograph of Piazza di Spagna in the late afternoon, where the rays of the sun no longer reach the lowest part of the staircase. (The photograph is captured later the same day the analysis was made, 23th of March 2019, 7 pm)

SPACE	Big staircase	Bended paths	Level differences	Hang-out spot	Surrounded by buildings
ACTOR	Tourists	Locals			
ACTIVITY	Breaks	Walking from A to B	Hang-out		
OBJECT	Steps used as benches	Granite pavement			
ACT	Having a break	Tourists taken pictures			
EVENT	Observing	Relaxing			
TIME	Daytime				
GOAL	Urban hang-out spot				
FEELING	Relaxed	Many people walking and sitting	Experience of human activity		

Fig. 4.3 - Illustrates findings from the first impression of Piazza di Spagna in Rome. Focus areas are highlighted.

4.1.1 First impression

The first part of the analysis of Piazza di Spagna in Rome is made without prejudice in mind to give an overview of the space and what is occurring, and thereby identify the major features of the space of interest. All nine major dimensions have been taken into account for the initial observations in order to achieve a broad impression of the space. Afterwards, four of the major dimension are highlighted as the most important areas, see fig. 4.3. These four dimensions will, in collaboration with the four epistemes, be the framework for the quantitative and qualitative analysis.

The author's first impression of Piazza di Spagna adapts to Rasmussen's (1959) description of the space. The first that is noticed is that people are walking up and down the steps and are stopping at the platforms to either take pictures or enjoy the view of the city. By having Rasmussen's description in mind, it does really look like people are dancing up and down the steps, because the movement of the people is quite uniform - they walk with the same speed and stop and turn around at the same spots. In addition to this, people who sit on the steps seem like audiences to the dancers. In total, the urban space is a gathering point, where people are having a break, observing other people, or use the staircase as a path when walking from A to B.



Fig. 4.4 - Photograph of Piazza di Spagna at noon on a cloudy day (The photograph is captured the 20th of March, 12:30 pm).

4.1.2 Quantitative analysis

The quantitative analysis is made by observations in a time slot of 1 hour. The findings from the analysis, which is shown in fig. 4.5, illustrates how people are acting within the space according to the different boundaries which are structuring the space. The *morphology* and *praxeology* are both illustrated on the same map, because the two epistemes are dependent, in the sense that people are acting based on the structure of the space as mentioned earlier.

Morphology

First of all, the space is build up by different levels of steps, and is structured by three kinds of boundaries, that are illustrated with ● in fig. 4.5. The space is surrounded by low walls that create continuous boundaries - *closed space*. This closed space gives the user an overview of the size of the space, and thereby immediately reveals that the space is relatively small and easy to navigate in. Due to the low walls that surround the staircase, the space does not feel as if it is excluded from its surroundings.

Furthermore, a *transparent spatial boundary* is present in the middle of the space with a platform behind it. This creates a smaller space within the space, which is not excluded from the rest, because of the transparent spatial boundary that is shown by a wall of columns. The wall of columns also acts as a fence, where people automatically are drawn to, because “something” is expected on the other side of the fence. In this case people are using time at this platform behind the transparent spatial boundary because this something is an overview of the entire space.

In one end of the staircase a fountain is preventing people from walking straight on to the street, which extents ones view to a shopping street for pedestrians. The fountain is creating an *open spatial boundary* where people have to decide their further movement whilst still having an overview of the space, because the boundary does not obstruct people’s view.

Praxeology

The movement of people are illustrated with black lines on the map, fig. 4.5. The space has two entries, one at the top of the staircase and one at the bottom. This only allows people to enter the space by using these two entries. Both of these are obstructed by either *transparent* or *open spatial boundaries* it is observed that this causes people to walk slower or stop up at both ends of the staircase. When people then enter the space, they either sit on the steps or walk. It is observed that the most common movements are along the continuous walls that surrounds the staircase. A few people where walking in the middle of the staircase and, here it is noticed that these people where walking slower than people walking near the *closed boundary*.

Closed space -
where people walk along

Transparent spatial boundary -
where people stop up

Open spatial boundary -
where people stop up

N ⊖ Fig. 4.5 - Findings from quantitative analysis
(Morphology and Praxeology).

4.1.3 Qualitative analysis

The qualitative analyses are focusing on shadows in the space and how the contract between light and shadow creates smaller spaces in the space. The analysis of the shadows semiotics is shown by photographs of how the objects within the space create shadows that give information of the morphology of the space. Moreover, a visual experience through the space - a Serial Vision - is illustrated by sketches. Both analyses will give a feeling of how the space is perceived and experienced from the authors point of view.

Semiotics

The different boundaries that structure the space are creating various cast shadows, which are pictured in fig. 4.6. Each of these cast shadows will create solid or transparent shadows depending on their objects, which in this case is represented as different boundaries (these are described earlier in section 4.1.2). The solid cast shadows on the steps of the staircase, which are shown in picture 1 and 2, are giving depth to the space and tell the viewer/user that the space is surrounded by solid and sharp rectangular objects. The shapes of these sharp shadows on the steps create a frame around the space, which furthermore defines how big the space is - in the sense, that the length of the solid cast shadows will either open up the space or make it seem smaller according to where the sun is placed in the sky.

Picture 3 and 4 show shadows which indicate that something is obstructing the space. The shadows illustrate that the objects, who cast the shadows, are not continuous solid objects but curved and thereby allow the sunlight and shadows to create organic patterns upon the pavement and steps. The shadows created by these objects provide an understanding of the space's *morphology* by indicating a *transparent spatial boundary*. Likewise, the shadows themselves indicate that "something happens" in this part of the staircase, as the pattern, which alternately is made up of light and shadow, is drawing people's attention and thereby causes people to walk to that specific area. Furthermore, the shadows are casted upon a flat surface that increases the length of their shapes and by that paint a big area of the pavement in a curved mixture of light and shadow.

Additionally, picture 5 illustrates a cast shadow on a flat surface. As well, the shadow signals the shapes of the objects. Even though the objects are placed behind the author, the shadows clearly tell information on the objects. In this case, it is clearly visible that the author is in front of a old-fashioned street lamp and a sharp shaped fence.



Fig. 4.6 - Photographs showing different cast shadows
(The photographs are captured 23th of March 2019, 4:15 pm).



Fig. 4.7 - The arrows refer to where, and in which direction, the sketches are drawn.

Phenomenology

The details of shadows, which are examined above, will be illustrated in a larger scale. Via the analysis tool *Serial Vision* (Cullen, 1961), the shadows are explored with the focus of how they create smaller spaces within the space, see fig. 4.8. The author was walking through the space with a sketchpad and when the space changes, by opening up or narrowing in, the space within the big space was sketched. The focus of the sketches were how the shadows were acting at the specific moment in the specific section of the space. The four sketches are giving an impression in a bigger perspective of how the shadows acts in the space based on the objects, which create them. All four sketches illustrate that the space is dominated by contrasts created by light and shadows. Mende (2010) states, that these different layers from light to dark, that are presented at Piazza di Spagna, are an important factor for human attraction to a space and thereby print the impression of the space into our minds. In addition to this, the big shadows from buildings and small object shadows from the fences, pillars, street lamps, and steps are presented in all the sketched sections according to the definitions of shadows by Frandsen (1984). As shown in sketch 1, a big shadow from the building, is dividing the space into two areas that makes the space seems smaller than it really is. Moreover, the pillars, which are placed in the illuminated area, stand out as small dark elements that give a feeling of tranquility due to the soft shapes of their shadows which differs from the edged shadows that surround them. In sketch 2, 3, and 4, the cast shadows from the continuous solid walls emphasize the morphology of the steps. These solid and sharp shadows are drawing dark lines upon the steps which, in Tanizaki's (2001) words, create beauty and thereby appeal to people by creating a relaxing atmosphere.

4.1.4 Concluding remarks

Piazza di Spagna is well visited, and the steps are used for slow walking but especially for sitting. The low and transparent boundaries make the space understandable and clear, which guide people instinctively to walk along the low walls whilst people who stay longer automatically move to the middle of the staircase. Cast shadows from the boundaries and smaller objects emphasize the simple structure of the space.

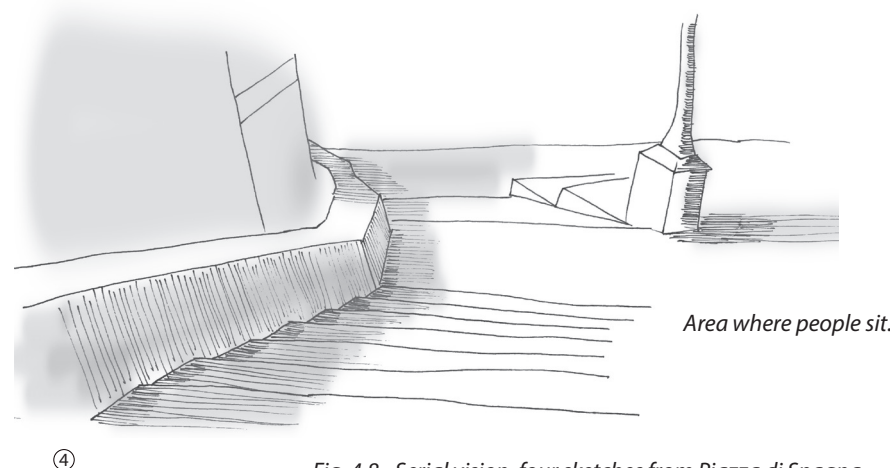
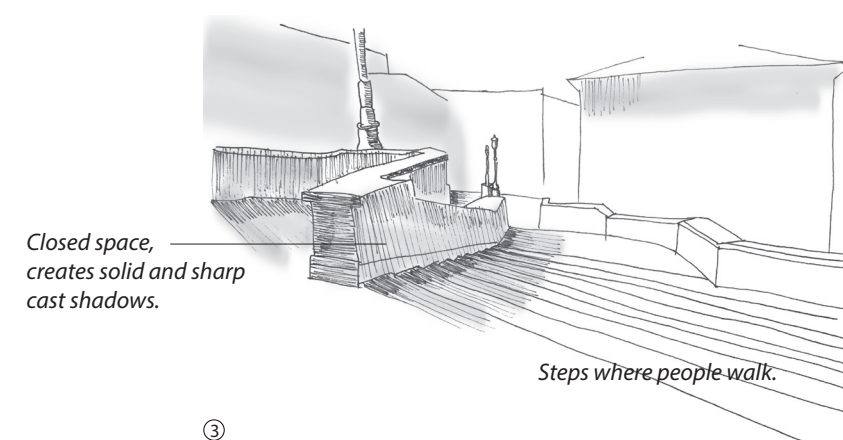
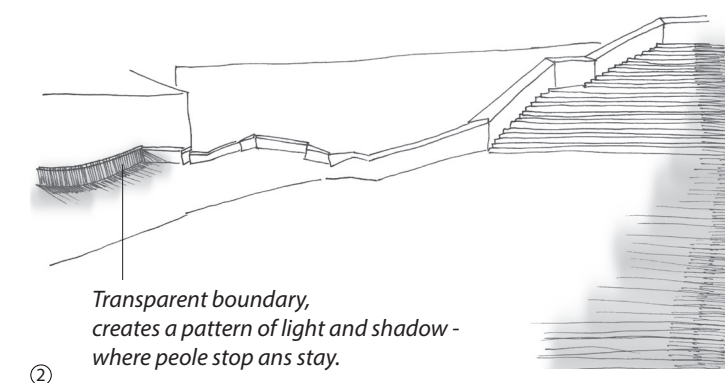
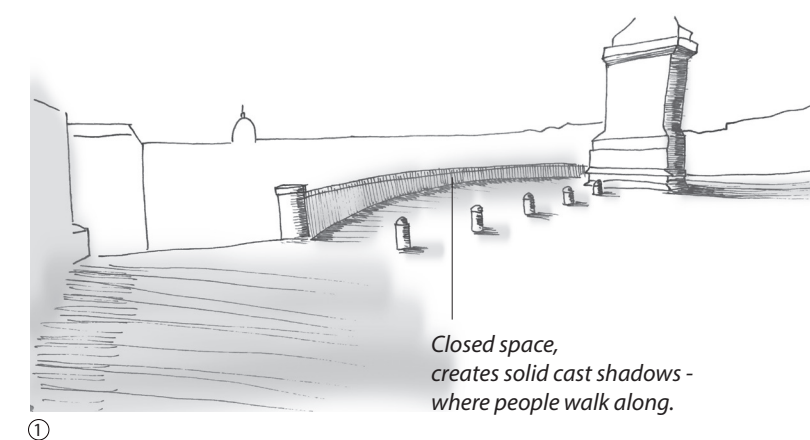


Fig. 4.8 - Serial vision, four sketches from Piazza di Spagna



Fig. 4.9 - Map of Copenhagen, where the white circle illustrates where Israels Plads is located.

4.2 ANALYSIS OF ISRAELS PLADS, COPENHAGEN

The simple construction of the staircase at Piazza di Spagne and hereby people's use of it, leads to the following analysis of Israels Plads in Copenhagen, Denmark. Israels Plads is as well designed with steps that people use as hang-out spot. Thereby, the same atmosphere occur within the two spaces, even though they are located two different places in Europe.

Israels Plads is located in the city center of Copenhagen, Denmark, as illustrated in fig 4.9. The urban space is a square divided into two sections. The analyzed part is only the southern part of the square, which is used as a hang-out spot, because of two sitting areas in the two southern corners of the square, consisting of granite elements in the shape of steps. Moreover, it is used as a playground. The analysis of Israels Plads was made the 9th of April 2019 in the afternoon. This specific day is selected because of the weather conditions, which were sunny. At this season the sun is lower in the sky than in the summer time. Therefore, the shadows of the objects are longer that they would be in the middle of a summer day. The author has consciously selected a sunny day to get the best impression of the shadows acting in the urban space.

The reason why Israels Plads is chosen for the second analysis, following the analysis of Piazza di Spagna, is due to the fact that two elements of steps are located in two corners of the square. These are used as sitting areas and are comparable with the steps at Piazza di Spagna, which also are used as a sitting area as described in section 4.1. Hereby, the two analyzed urban spaces have the same aim, because both spaces are used as hang-out spots, where the surfaces are elevated and thereby invite to stay.



Fig. 4.10 - Photograph of Israels Plads in the morning of sunny day.
(The photograph is captured the 13th of May 2019, 11 am)

SPACE	Square / Playground	Trees	Two stairs for sitting	Hang-out spot	Surrounded by buildings
ACTOR	Families	Tourists	All target groups		
ACTIVITY	Breaks	Walking from A to B	Hang-out	Playing / Skating	
OBJECT	Trees	Granite pavement	Staircase as hand-out spot		
ACT	Having a break	Kids playing			
EVENT	Observing	Relaxing	Playing		
TIME	Daytime				
GOAL	Urban hang-out				
FEELING	Relaxed	Many people walking and sitting	Well visited square		

Fig. 4.11 - Illustrates findings from the first impression of Israels Plads in Copenhagen. Focus areas are highlighted.

4.2.1 First impression

The author has visited Israels Plads a lot of times before the analysis was conducted. Therefore, the identity of the urban space is not unknown, and the first impression is characterized by the fact that Israels Plads is used and well-known to the author.

The space is used as a hang-out spot for both locals and tourists. The space is well-visited because of its location next to Nørreport train station and because of Torvehallerne (food market) in the northern part of the square. In addition to this, the space is well-visited by families, where children are playing and skating in the landscaped skating courts and using the playground in the middle of the square. When entering the square, from one of its four corners, one is greeted by a large opening of light which occurs between the buildings that surround the square. Because of the light gray granite which all of the square is decorated with, the square feels really big which is also underlined by the fact, that the square is not occupied by heavy elements. The "interior" is quite minimalistic and only consists of sporadic placed trees surrounded by benches and, in the middle a playground with a fence around it by thin and tall pillars, which do not obstruct the view, is located. Furthermore, in two of the corners of the square big granite elements made up of steps are placed. These are used as sitting spots, and are well-visited on a sunny day.

Because of the fact that the space has been visited by the author several times before the analysis was made, the space, in this context, will be visited with new eyes, since the focus is on shadows. The observations of shadows will be elaborated underneath in section 4.2.2 and 4.2.3.



Fig. 4.12 - Photograph of the staircase at Israels Plads (The photograph is captured the 13th of May 2019, 11 am).

4.2.2 Quantitative analysis

The quantitative analyses of morphology and praxeology are made by an observation method, and both epistemes are illustrated in fig. 4.13. The observations are made within a 1 hour time slot.

Morphology

The southern part of Israels Plads is easy to understand because of its few elements and plane light grey granite pavement. The space is structured by three kinds of boundaries, which are illustrated with ● in fig. 4.13.

Two of the sides of the square consists of tall buildings, which create a *closed space*, where these buildings obstruct the view and thereby create a pocket feeling between the two tall “walls” of buildings. These boundaries shield the square from the traffic and heavy human-activity at Nørreport trainstation. According to this, the space feels quite silence even though it is placed in the most busy part of Copenhagen.

In the middle of the square, thin tall pillars are creating a circle that surrounds a playground. The pillars create a physical boundary but they do not create a boundary which is not possible to look through. Thereby the pillars around the playground acts as a transparent spatial boundary that makes visible connections to its surroundings. The formation of pillars give an impression of being in the middle of the square and something people are drawn to. In two of the corners granite elements designed with steps are located. They have different heights but both of them are still creating a boundary opening, where they create connections to their surroundings but also obstruct the view seen from a human perspective. The one in the northern corner allows the viewer to look over it, but to get past it, it is necessarily to “climb” the steps. The other one in the southern corner, next to Ørstedparken, is three times higher. When climbing these steps, the top of the element gives an overview of the entire square. By that, it creates a stronger boundary opening that tends to become a closed space because it appears as a wall, but still the element is an essential part of the square, and does not give a feeling of it as obstructing ones view.

Praxeology

People's activities are illustrated with black lines on the map in fig. 4.13.

First of all, especially in a sunny day, the square is packed with people who mainly stay and move on the main part of the square - especially the children's activity within the space is difficult to track, because they are playing and skating and thereby their movements are random and inanimate. Therefore, the children's (and other playing/skating people's) movements are not drawn on the map. Instead the author observed individual people and followed their tracks throughout the square. Based on that, a picture is drawn of where the most popular paths are in the space. Here, it is observed that the biggest human activity is across the square, maybe because it is the shortest path through the square, and also because it is the most direct path to the playground in the center of the square. When the author walked at the square, this diagonal path felt as a natural way to go through the space, because the element of steps in the southern corner - the boundary opening - creates an obstacle that unconsciously forces one to move towards the center of the square. Besides that, it is observed that a lot of people are sitting at the two elements of steps. Both of them are equally used, therefore, as seen on the map, some of the human activity is directed towards these sitting areas. Moreover, the streets around the square are used mainly by cars and cyclists and are not taken into account in this analysis because these groupas are not seen as direct users of the square.



N
Fig. 4.13 - Findings from quantitative analysis (Morphology and Praxeology)

4.2.3 Qualitative analysis

The following section will give an introduction to how the space is perceived and experienced from the authors point of view. This is investigated within the two epistemes semiotics and phenomenology. The analysis of the semiotics of shadows are shown by photographs, that show the shadows of the objects which is a part of how the space's morphology is experienced. Furthermore, a phenomenological approach is illustrated by sketches to give informations on how the shadows are perceived. It also contributes to a better understanding of how it is to walk through the space.

Semiotics

As aforementioned, Israels Plads is clear to understand and its morphology is simply structured with only few different elements. These elements do not obstruct the view and thereby no hidden corners occur.

Even though the space is structured quite minimalistic, various shadows occur based on these few elements (see fig. 4.14). The different boundaries that are elaborated earlier cast different shadows which extend the shapes of the objects' morphology. The cast shadows of the buildings create a big solid shadow that cover the square more or less depending on the sun's position at sky. At the time of the day when the analysis was made, the sun was positioned so that the square almost entirely was lit up by sun light. Thereby, the buildings did not create shadows which cover big parts of the square. Because the analysis was made in the middle of the day, the shadows that appeared, based on their objects, were sharply drawn at the pavement. As seen in picture 1 and 2, the pillars' cast shadows really emphasize the "airy" construction of the transparent spatial boundary. Likewise, the shadows highlight where the pillars overlap, as illustrated in picture 2, and this emphasize a more visible entry to the playground.

At picture 3 and 4 smaller elements and their shadows that occur in the space are seen. The objects themselves do not create boundaries, but these objects and their shadows contribute to a space that attracts the author's mind, because of its circular and sharp drawn shapes on the pavement. The attached shadows on the two objects that are illustrated, also emphasize the objects' shapes. Based on this, the curved objects appear even more curved, and there is no doubt that the objects are totally circular, which is strongly emphasized by both their attached and casted shadows.

Cast shadows and attached shadows are as well seen in picture 5 and 6, where the structure of the steps is highlighted because of the contrasts that both of these shadows create. In addition, at picture 7 and 8 a tree's cast shadow create a sparkling impression of the steps. Here, it is clear that the shadow is coming from an organic object, even though the object is not visible at the picture. Thereby, the perception of the steps is more blurred than the perception of the steps in picture 5 and 6. The structure of these are not invisible. Their structures are not the first that attract our eyes, instead it is the organic, sparkling and wavy shadows that immediately draw our attention. Thereby, it is essential to emphasize, the big difference between the perceptions of the same object, according to its cast and attached shadows and how other cast shadows of objects influences the perception of the steps.

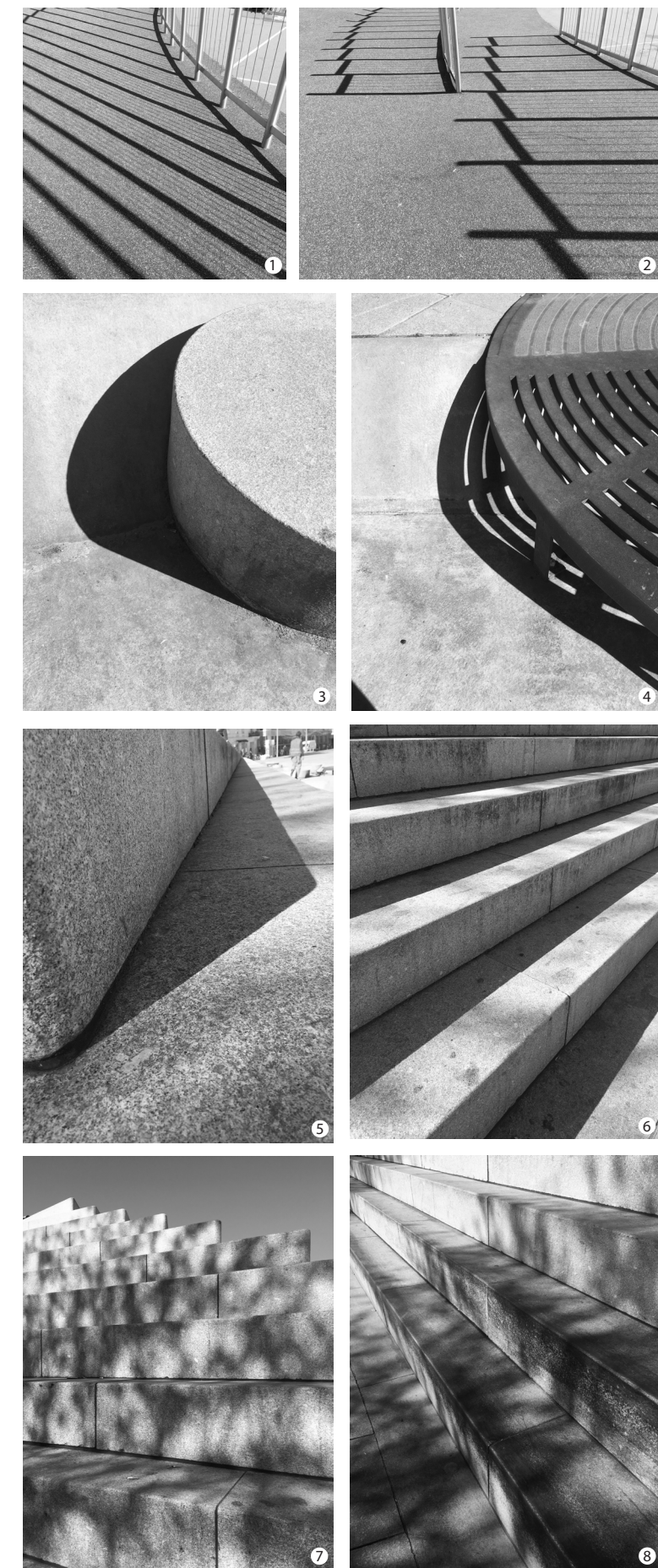


Fig. 4.14 - Photographs show different cast shadows
(The photograph is captured the 9th of April 2019, 3 pm).

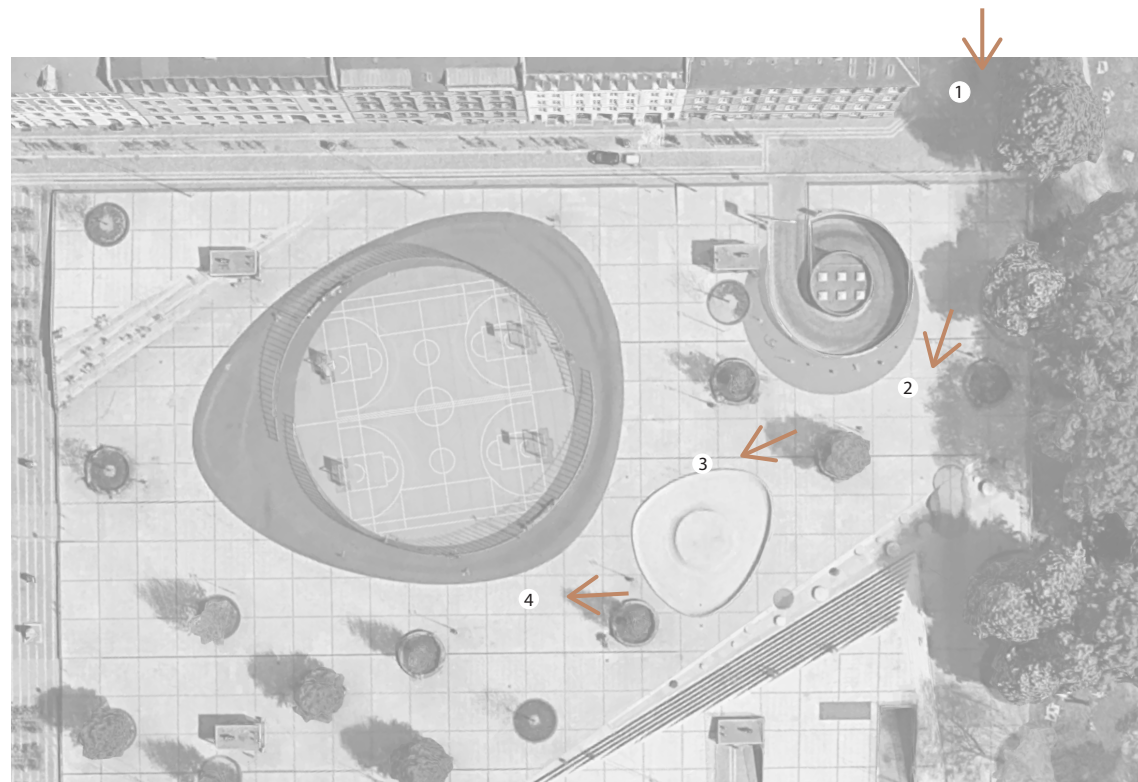


Fig. 4.15 - The arrows refer to where, and in which direction, the sketches are drawn

Phenomenology

The shadows of the objects, which are examined above, will in this section be investigated by the use of the method serial vision (Cullen, 1961), which is illustrated by sketches in fig. 4.16. The sketches will give an impression of how the shadows were acting at the specific moment in the specific part of the space. The four sketches are giving an impression of how the shadows act in the space based on their objects.

Sketch 1 illustrates a big amount of sparkling shadows which are casted from Ørstedsparken's trees which are bordering the square. Due to the trees' airy shadows, they do not create a dominant shadows that feel heavy on the light surface. However, the sparkling shadows still contribute with the contrasts between light and darkness that is an essential part of attract people's mind, which Mende (2010) states. Moreover, the big amount of sparkling and airy shadows from the trees differ from the other shadows that are presented at the square. These shadows are casted from objects which are more or less individually located around the square. Furthermore, the organic and wavy shadows from the trees inside Ørstedsparken are contrast to the rigorous and plain surface of the square. This gives a feeling of the fact that the area which bordering the square has a different morphology than the square itself. The sketches are showing how the urban space is structured by objects that create areas of shadows which are placed sporadically across the square. There are no areas within the space that are more covered by shadows than other areas. This gives a relaxed feeling, because there is a balance in the amount of light and shadows, and therefore the space does not feel visually heavier in some areas than others. These sporadically occurring shadows are shown in sketch 2, 3, and 4, where the shadows are casted from the individually placed trees.

4.2.4 Concluding remarks

At Israels Plads it is the playground, located in the middle, which is the focal point of the square. The two staircase elements in the corners, bind the square together. When people sit at the steps, their vision is directed towards the same - the middle of the square. The staircases also act as focal points, as the view from the elevated steps gives a clear understanding of the space. As well, the staircases are eye-catching when their steps cast sharp shadows, or when the steps are hit by organic shadows by the crowns of the trees.

The two analyzed urban squares and the findings are the basis for the problem statement. The problem statement is elaborated in the following chapter 05.

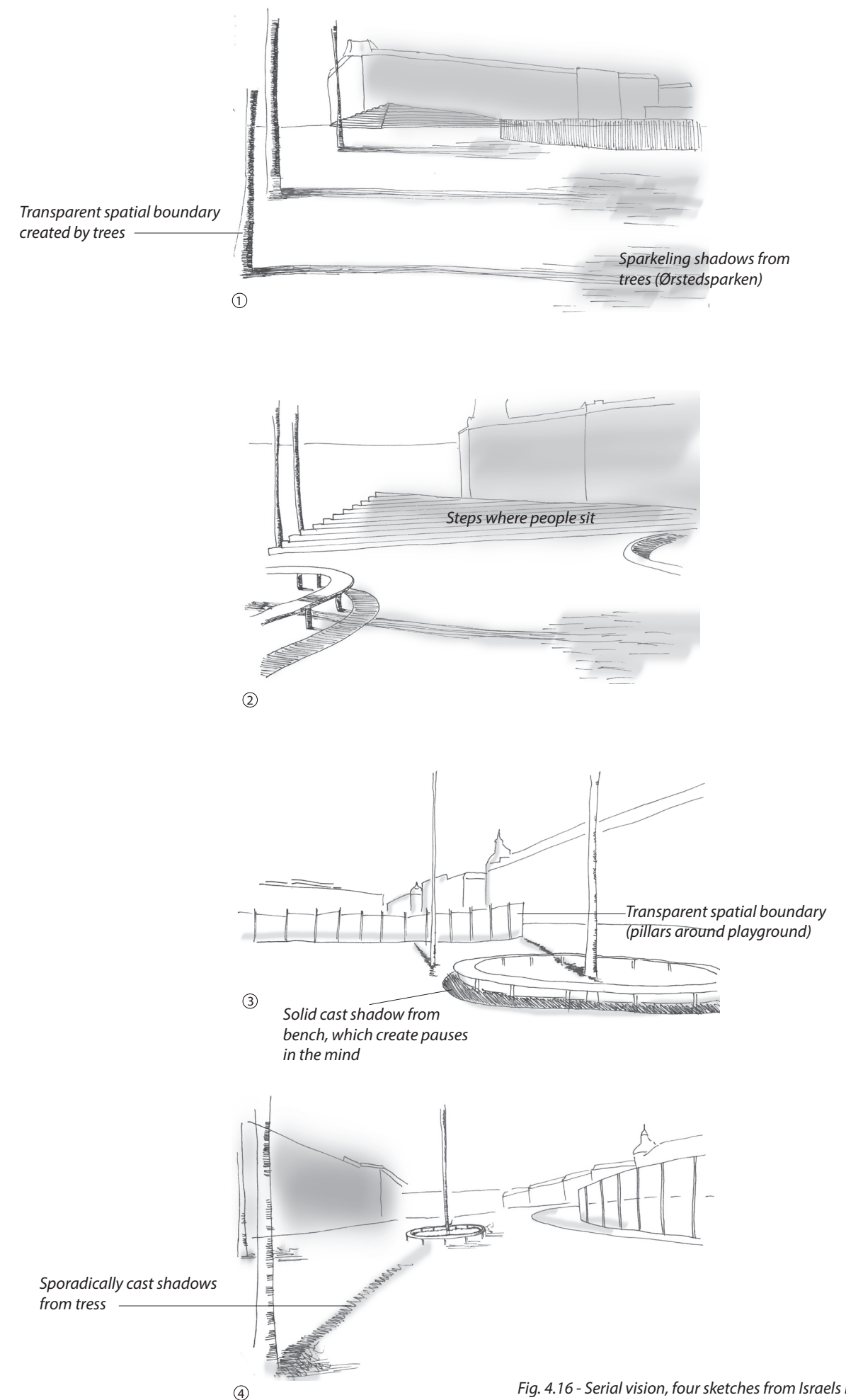


Fig. 4.16 - Serial vision, four sketches from Israels Plads



PROBLEM STATEMENT

05

Remarks from analyses

Based on the theory and the findings from the two analyses of Piazza di Spagna and Israels Plads it is defined that attendance of shadows, in spaces with human activity, is important to fulfill the visual experience of a certain space.

Based on the two analyses it is observed, that spaces are perceived differently when the focus has been on shadows and how these change the space. Changes depend on the presence of shadows and the appearance based on the sun's position in sky as well as the shadows sharpness based on weather conditions. All these mentioned factors, that play a role in the perception of shadows in the urban space, is considered and the author is thus aware of changes in the presence of shadows during a day. It has to be mentioned, that the author is well-aware that the observed shadows within the analyzed spaces would appear different if the spaces were explored another time of the day or year, and in other weather conditions.

The intention with the two analyses are to examine the general presence of shadows in urban spaces, and is thereby the basic study for what to be further and deeper investigated and tested. Through the investigation of the two urban spaces, it is found that staircases and steps create interesting shadows and draw people's attention. The two analyses are important parts of the process of this thesis of further examination of shadows on one object in the urban space - in this case *staircases* and *steps*.

The author's focal point for both analyses are the staircases, which are represented at both analyzed spaces. For both spaces the staircases are used as sitting areas and hang-out spots, which therefore are a central part of the space and also invite people to stay at the place for a longer period of time. Thereby, it is decided that staircases are the focus for the further investigation and leads to the problem statement.

Problem statement

The staircase as an object, is a small part of a larger picture - the urban space. The staircase, which is the focus of this project, is thus an example of an object, that is part of the creation of an urban space. The studies of staircases' shadows, that are performed in this thesis, are therefore intended to be projected onto other objects in the city.

Synthesizing the theory and finding from analyses leads to the following problem statement for the thesis:

By focusing on designing with shadows the perception of a staircase structure can be more useable and attractive and thereby increase the use of urban spaces.


To examine how shadows can increase the use of a staircase the two epistemes *morphology* and *semiotics* are investigated by the appearances of the three shadows by Sadowski (2017): *cast shadow*, *attached shadow*, and *shading*. Thereof, the author's assumption is, that if the morphology of the staircase and semiotics of the individual steps are understandable it will cause an increase in the *praxeology* of the staircase. Likewise, the attraction will be explored according to the distribution of the three shadows. Moreover, how the various amounts of light and shadow create patterns and shapes that attract the human eyes and mind and by that increase the feeling and experience of the space (*phenomenology*).

To investigate the four epistemes and thereby answer the problem statement, shadows will be examined in four experiments. The experiments are performed at Israels Plads on the southern staircase of the square. The experiment is elaborated in chapter 06.




EXPERIMENTS & TESTS

06



The following chapter is describing four experiments with shadows, which are performed at Israels Plads at the staircase at the southern part of the square. The experiments are performed by the author of the thesis with help of an assistant. The experiment is performed at night using artificial light. The artificial light is used to create daylight situations, as the purpose of the experiment is to examine the perception of shadows based on the direction of the light source (which either simulates natural light (daylight) or illuminates from other angles). The experiments are commented by subjective meanings by the author. Furthermore, to explore the findings from the experiments and confirm or reject the authors subjective conclusion of the findings, a questionnaire based upon photographs from the experiments, is presented to 10 test persons. The test persons have no prior knowledge of the experiments or the purpose of the experiments beforehand. The findings from experimentation (which are exclusively commented by the author) and result from the questionnaires are compared and thereafter developed further into design principles for illumination on steps in chapter 08.



6.1 PROCEDURE OF EXPERIMENTS

6.1.1 Purpose of experiment

The purpose of this experiment is to answer the problem statement by investigating how shadows are acting on a staircase and the human perception of it. The investigation is within the scope of *cast shadow*, *attached shadow*, and *shading* as well as, how the distribution of the three different shadows affect the expression of the staircase's steps.

According to Sadowski (2017), see section 2.1.1, a low-angle light (such produced by the sunrise and sunset) creates elongate shadows of the object, whereas the opposite, a high-angle, creates shadows that are shortened. Furthermore, an angle of forty-five degrees produces an accurate and sharp shadow of the object (where both the high angle and the forty-five angle are produced by midday light). Based on Sadowski's theory, this experiment is made with an expectation that when illuminating staircase's steps from different directions and different angles the expression of the three shadows; *cast shadow*, *attached shadow*, and *shading* will appear differently. Furthermore, it is expected, that it is possible to illuminate the steps, so that the viewer will be aware of the structure (*morphology*) of the staircase and thereby make the individual steps more easy to "read" (*semiotic*), which will entail people to use and climb the staircase (*praxeology*) and finally to increase the visual experience of the staircase (*phenomenology*).

Additionally, according to the theory described in chapter 02, Japanese architects use the nature's qualities when designing, by using shadows to create contrasts and movements in the spaces, and thereby contribute with a knowledge of the outer context of either the season or the time of the day (Moore & Ørskov, 2011). Thereby, the author will examine if the human perception prefers artificial light that is simulated according to the position of the sun at sky, so that the direction and angle of artificial light corresponds to how natural light (sun light) is emitted from the same direction and angle. Or if the direction of the light is subordinated when humans experience artificial light at night.

The findings from the experiment will exclusively be commented on the basis of the author's subjective opinion. To either confirm or reject the author's subjective opinion on findings from the four experiments, the findings will further be tested by the use of questionnaires with 10 test persons, which have no knowledge of the author's thoughts of the purpose or findings of the experiment. The outcome of the questionnaires is elaborated in section 6.7.



Fig. 6.1 - Photograph of cast shadows from people walking on a staircase

6.1.2 Site of experimentation

The southern staircase at Israels Plads is selected as site for experimentations. This area is selected due to the fact, that the staircase is not illuminated by artificial light at nighttime and thus are in darkness. It should be mentioned, that light from street lamps, light from apartments' windows etc. are disturbing the otherwise dark area, so that it is not in total darkness.

As illustrated at the plan drawing of the staircase in fig. 6.2, it is seen that the staircase is not a regular staircase but an element built up by steps. Because of the staircase's design the length, height, and depth of the individual steps are bigger than a regular staircase's steps. Due to this design, it is possible for the author to move freely on the staircase, as it is not limited by railings or walls. The context of the staircase is irrelevant for this experiment as it is only the perception and expression of its individual steps that are the focal point in this thesis.

6.1.3 Experiment setup

The experiment is divided into four smaller experiments in order to investigate how a light beam is expressed from different directions. The four different directions are illustrated as points 1, 2, 3, and 4 in fig. 6.2. The placement of the four experiment points are selected according to the movement of the sun at sky. Hereby, point 1 is directed toward east where the sun rises. Point 2 and 3 are directed toward south where the sun is positioned in the middle of the day, and at this moment will be placed highest on the sky. Point 2 will present the sun's position a bit before midday, whereas point 3 is directed to where the sun is positioned in the early afternoon. Finally, point 4 is directed west where the sun is positioned in the late afternoon/evening.

For each of the four points different angles are used to investigate how the light and shadows are expressed on the steps. The experiments will be performed by pointing a light beam at the reference point (illustrated in fig. 6.2) from angles of -30° , 0° , 30° , 45° , and 60° . The positive angles are selected by the author according to the theory of Sadowski (2017) as described in section 2.1.3. The negative angle and the angle of 0° are determined by the author to explore the direction of the light beam from an unnatural light direction. The reference point is the same for all four point, so that the findings from each experiment are based on the same conditions. Each of the angles are illustrated and elaborated further in the description of the experiments underneath.

The experiments are made in the evening of the 21th of April after sunset to get the best perception of the shadows that are casted from the artificial light beam. The artificial light source is placed on a tripod to accommodate that the light is placed at exactly the same spot for all presented angles at each point. Likewise, the pictures are taken so that they capture as much of the illuminated area as possible. The illuminated area constitutes only a small part of the staircase, since the span of the light beam was limited. The different light and shadow scenarios are photographed with a handheld camera. Therefore, the photographs are not taken from the same positions. In addition to this, the angles are measured from the reference point by using an angle measurement-app on a smartphone.

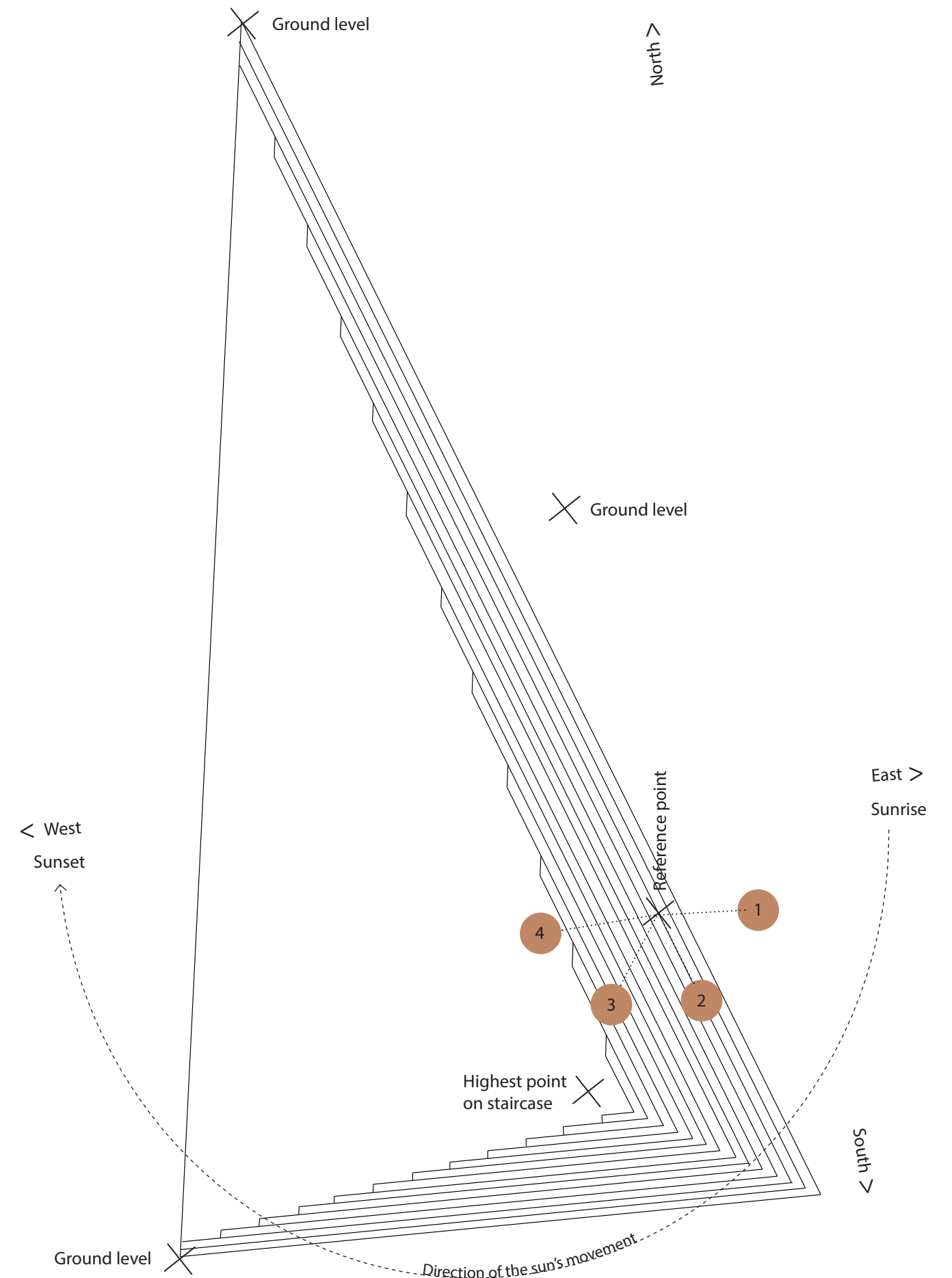


Fig. 6.2 - Plan drawing of the staircase at Israels Plads

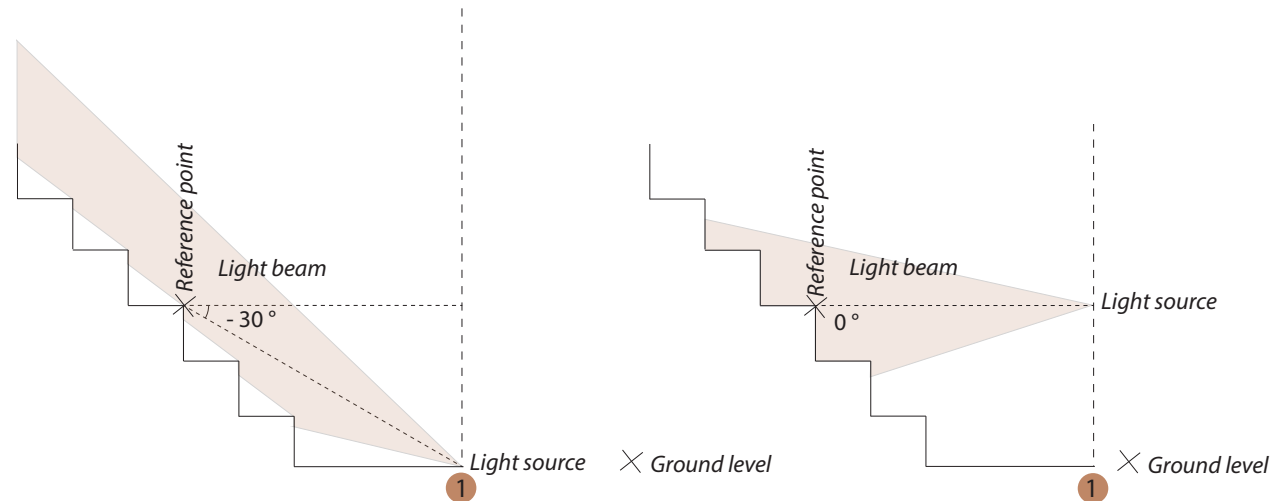


Fig. 6.3 - Illustrations of point 1 from an angle of -30° and 0°

6.2 EXPERIMENT - POINT 1

The first point of the experiment is placed at the bottom of the staircase, and is pointing towards east. The first point will represent the light of the sun at sunrise, when it is illuminated from low angles 0° and 30°. These two low angles, therefore, simulate the natural sun light when the sun is positioned towards east. Further added are two angles, -30° and 45°, to illustrate the possibilities of artificial light and its benefits to create light from other angles than the natural sun light. All four angles are measured from the reference point.

The findings from the first experiment are divided into two sections. Here the angles -30° and 0° are presented together because their appearance of shadows are quite similar. The same are the findings from the angles of 30° and 45°.

The author's expectation of the outcome of experiment 1 was that the low angles of 0° and 30°, which are simulating the morning sun light, would create sharp cast shadows from the steps. The creation of sharp shadows from a low angle are expected to be a visually attractive setting because the morphology of the steps is standing out.

Point 1 - angle -30° & 0°

The findings from experiments with the angles of -30° and 0° are illustrated at the photographs on fig. 6.4 and 6.5. Fig. 6.4, illustrates the creation of shadows from a light beam from an angle of -30°. It is visible that the cast shadows and attached shadows are occupying a big amount of the staircase. Therefore, half of the steps are illuminated which creates lines that are in big contrast to the otherwise dark areas. This is creating a setting that disturbs the overall understanding of the morphology of the staircase. Thereby, the semiotics of the individual steps are hardly explained to the viewer, because it is not easy to understand the height, width and depth of the steps. Additionally, finds the pattern of light and shadows the author attractive because of the continuous pattern of alternating darkness and light.

From the experiment with an angle of 0° it is seen, in fig. 6.5, that no cast shadows are created. The shadows that occur are attached shadows on the individual steps. In this experiment, the light and darkness are evenly distributed. Hereby, the author finds the morphology of the staircase and semiotics of the steps easy to understand, because of the awareness of where the steps start and ends. Furthermore, this entails that the praxeology increases due to the clarity of the view.

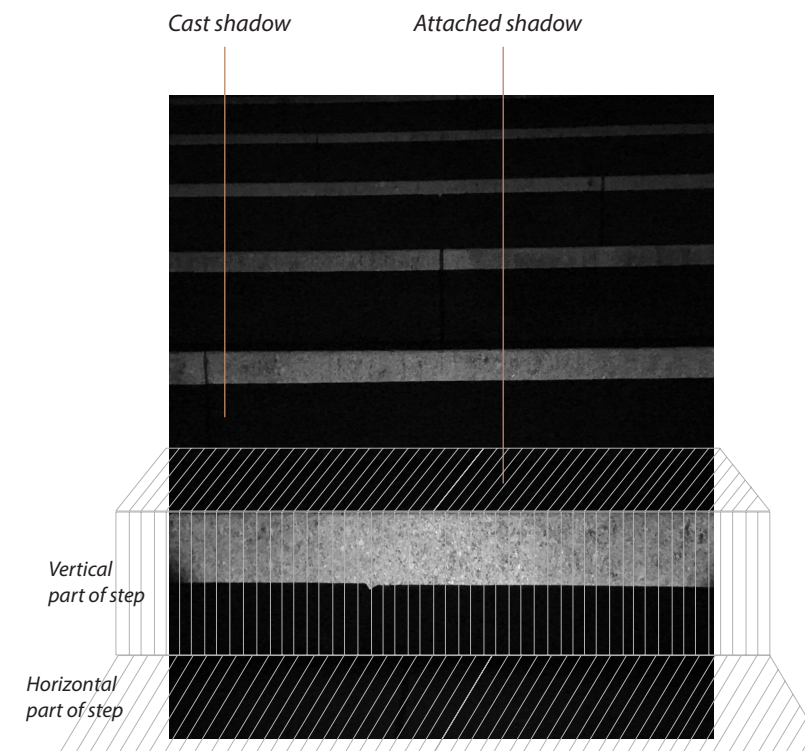


Fig. 6.4 - Photographs of point 1 from an angle of -30°, with hatches to emphasize the steps

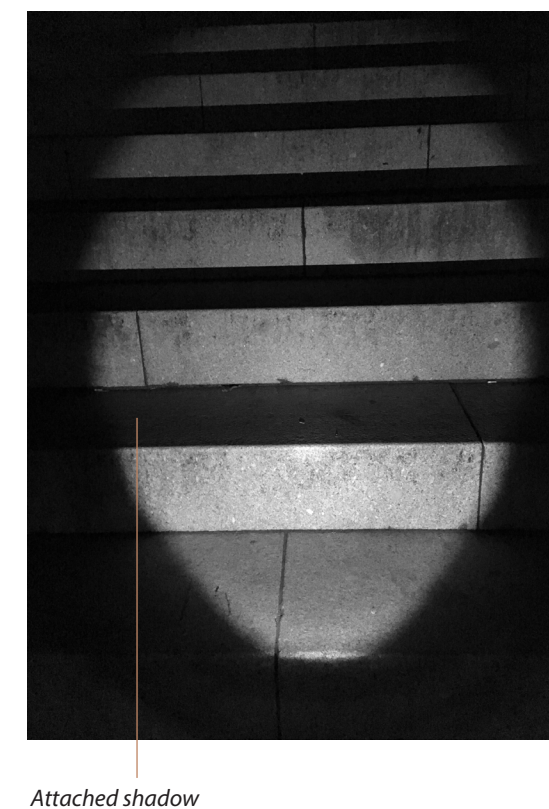


Fig. 6.5 - Photographs of point 1 from an angle of 0°

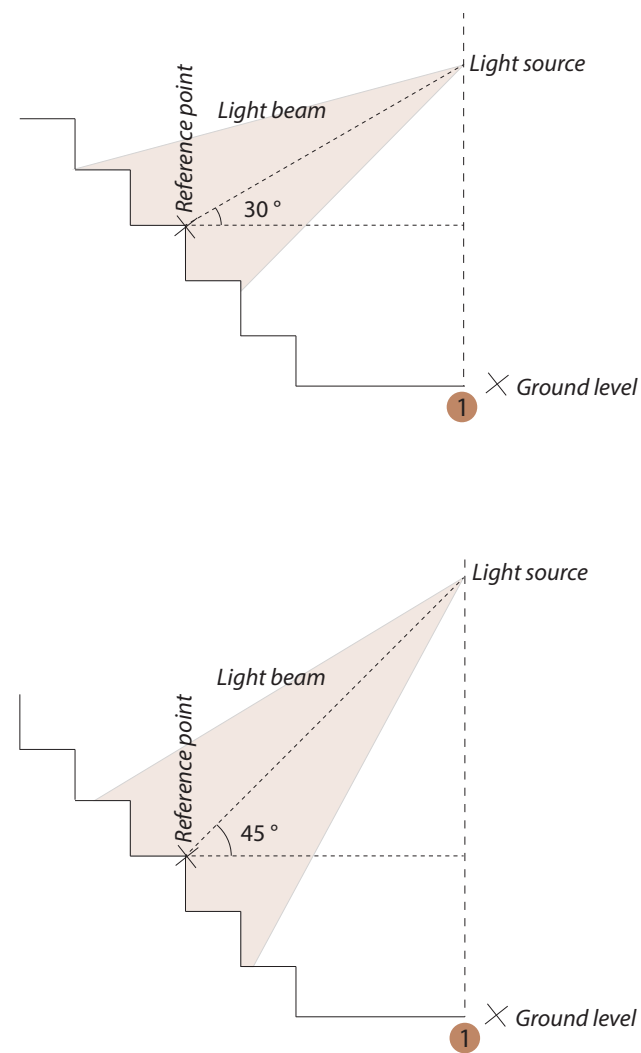


Fig. 6.6 - Illustrations of point 1 from an angle of 30 ° and 45 °

Point 1 - angle 30 ° & 45 °

The findings from experiment with angles of 30 ° and 45 ° from point 1, are shown in fig. 6.7 and 6.8. Here, the two settings are equal, where no shadows occurred. The steps are totally lit up, and thereby all details on the steps' surfaces are highlighted by shading. These settings do not hide in the dark, but on the contrary, the staircase appear flat without structure. Even though the staircase seems flat, the morphology of the steps are visible when climbing them.

Sum up of point 1

The expectations of experiment 1 are consistent with the findings. The author finds the production of a low angle shadow, from a 0 ° light beam most appealing. This setting creates the most attractive cast shadows which are sharp and thereby give an overview of the morphology of the staircase. The cast shadow as well underline the individual step's semiotic by indicating, with contrasts of light and shadows, the depth and height of a single step. Moreover, the setting attracts the human eye (the author's eye) to the stringent pattern of continuous vertical lines. Thereof, the perception of the steps, when they are illuminated by simulated morning light, appeal to the eye and mind (phenomenology).



Fig. 6.7 - Photographs of point 1 from an angle of 45 °

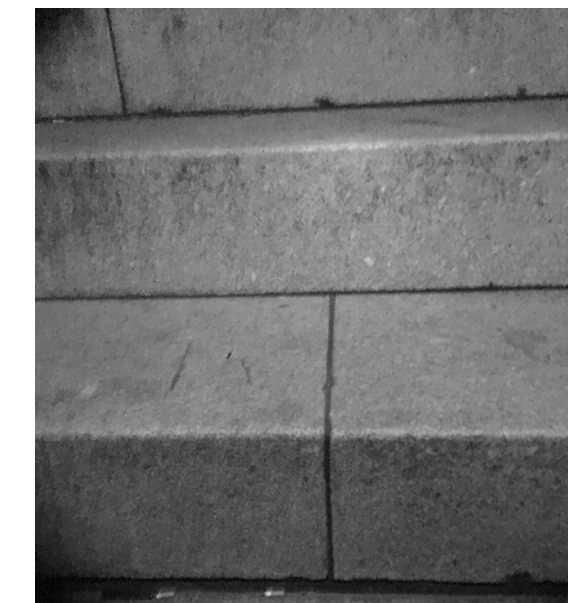


Fig. 6.8 - Photographs of point 1 from an angle of 30 °

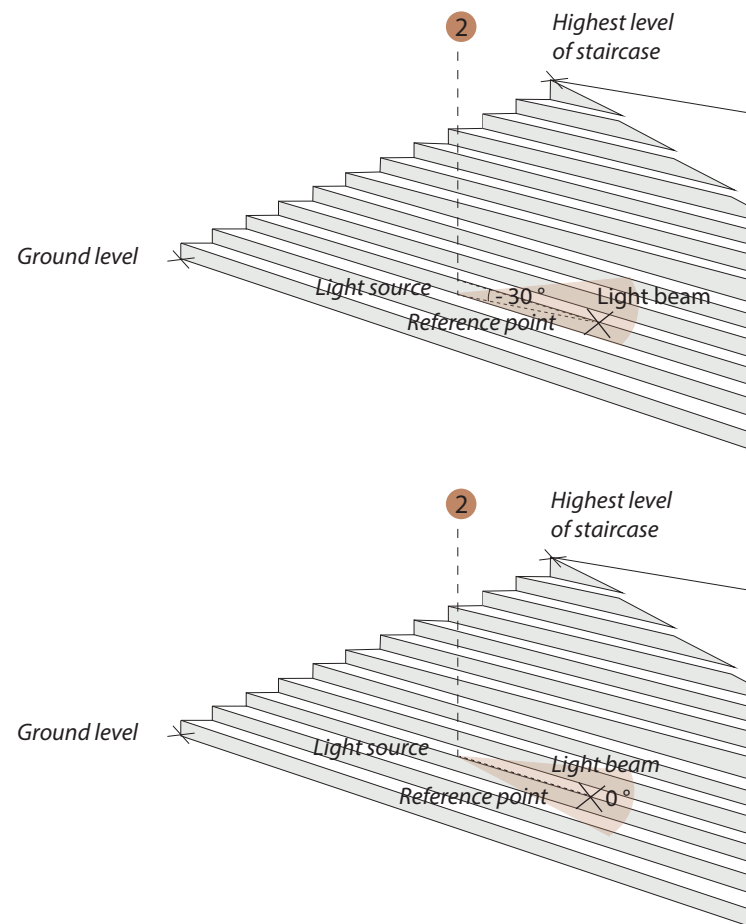


Fig. 6.9 - Illustrations of point 2 from an angle of - 30 ° and 0 °

6.3 EXPERIMENT - POINT 2

Point 2 is directed toward south and is placed at the third step of the staircase. This point is simulating where the sun would have been positioned in a bit before midday, when the reference point is illuminated by angles of 30 ° and 45 °. In this experiment as well two angles are added to illustrate artificial light's possibilities. The added angles are - 30 ° and 0 °, which create light and shadows that would not appear by the light of the sun.

Again, the findings are divided into two section, because the shadows, attached shadow and shading are quite equal perceived at angles of - 30 ° and 0 °, and for 30 ° and 45 °.

The author's expectation of the second experiment was that the highest tested angles of 30 ° and 45°, would produce shadows that create the best expression of the steps. Opposite, the low angles are expected to produced shadows that would be long and blurred and less attractive compared to the high-angle shadows.

Point 2 - angle - 30 ° & 0 °

The findings from the experiments with angles of - 30 ° and 0 ° are illustrated on the photographs in fig. 6.10 and 6.11. Fig. 6.10, illustrating the creation of shadows from a light beam from a angle of - 30 °, is showing that only the vertical part of the step is illuminated. This lit up part draws the attention as the shading creates a detailed surface. Additionally, the remaining part is left in the dark. This scenario, of illuminating a small part of the staircase, does not increase the praxeology of the staircase as the semi-otic is not clear because of the invisibility of the individual steps.

When the light is pointed at the reference point from an angle of 0 ° (fig. 6.11) the perception of the steps is blurred and the morphology is as well not easy to understand in this scenario. No big contrasts between the shading and the attached shadows occur, and therefore the step's semiotic is not underlined.

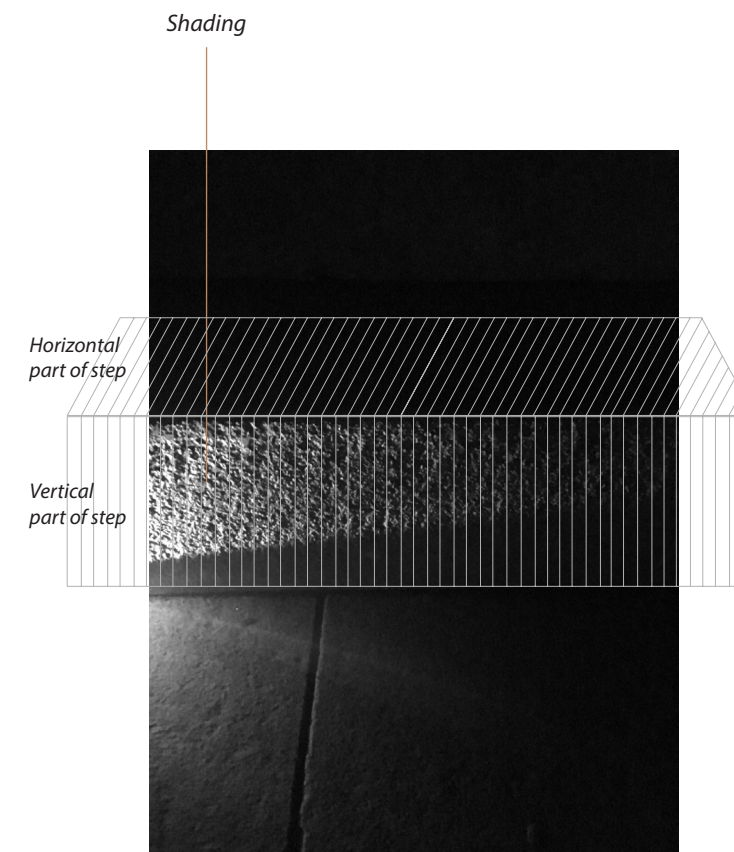


Fig. 6.10 - Photographs of point 2 from an angle of - 30 °, with hatches to emphasize the steps

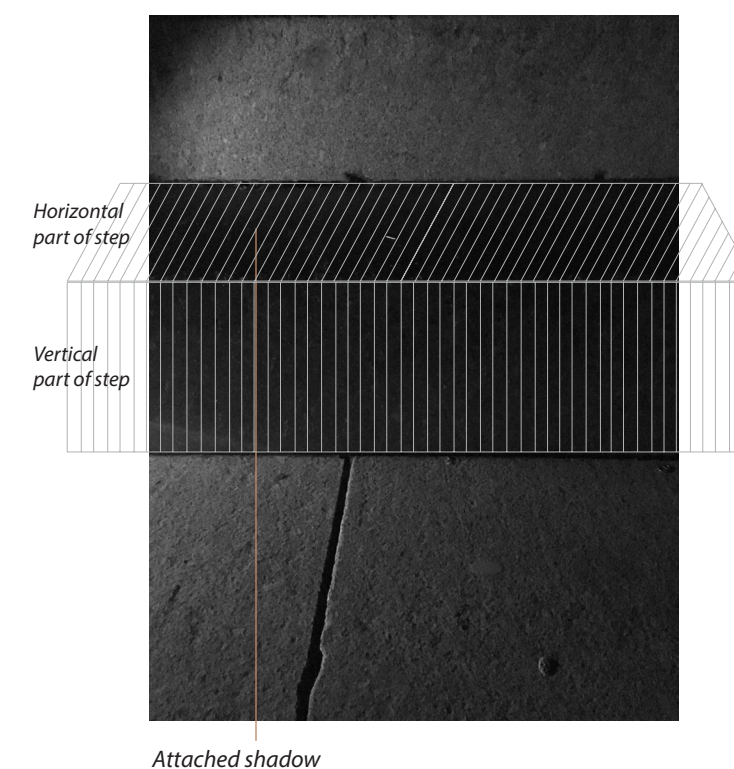


Fig. 6.11 - Photographs of point 2 from an angle of 0 °, with hatches to emphasize the steps

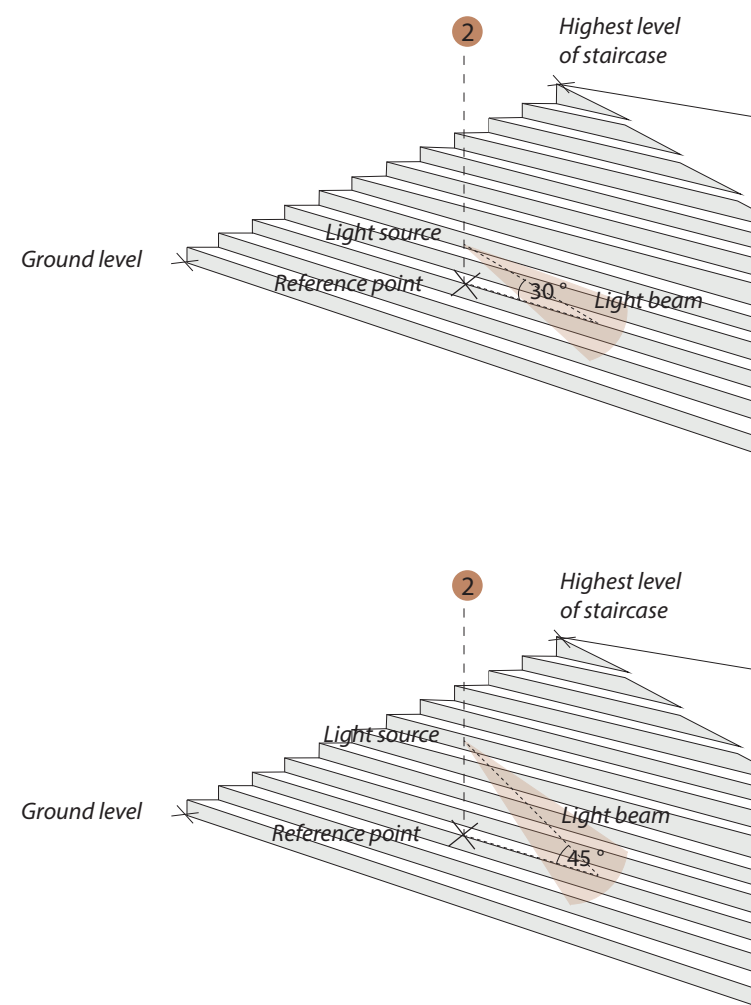


Fig. 6.12 - Illustrations of point 2 from an angle of 30 ° and 45 °

Point 2 - angle 30 ° & 45 °

The findings from the experiments with angles of 30 ° and 45 ° from point 2, are shown in fig. 6.13 and 6.14. The findings from the two experiments are quite similar. Both experiments create attached shadows on the vertical part of the individual steps, which increase the semiotic, because the scenarios give a clear sense of the step's height. Contrary to this, the illuminated horizontal part of the steps also appears understandable, and thereof the morphology emphasizes. Equal amounts of light and shadow are presented which gives a perceptual balance and thus appear calm to the author's eye and mind.

Sum up of point 2

In this experiment the expectation also corresponds with the findings. According to the author the findings are showing, that when the light is pointed from angles of 30 ° and 45 ° the staircase is perceived more attractive. This is due to the balance between light and darkness, which increase the understanding of the step's semiotic. Thereby, the viewer is completely conscious of the fact that it is a staircase and the recognizability of the morphology will increase the praxeology. Furthermore, it is observed that when the artificial light from angles of 30 ° and 45 ° which simulate natural light are used, the optimum results of shadows occur on the steps.

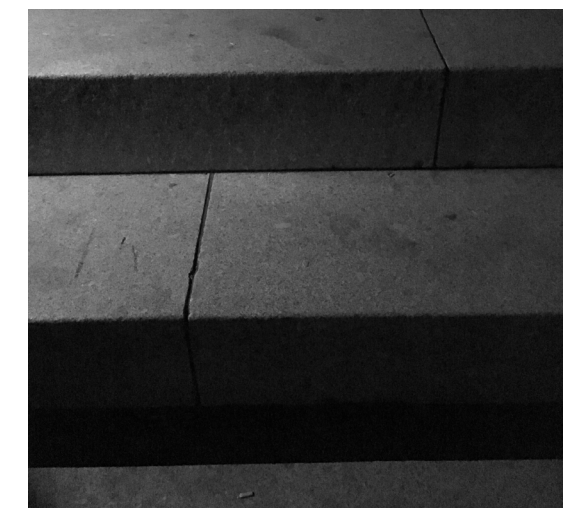
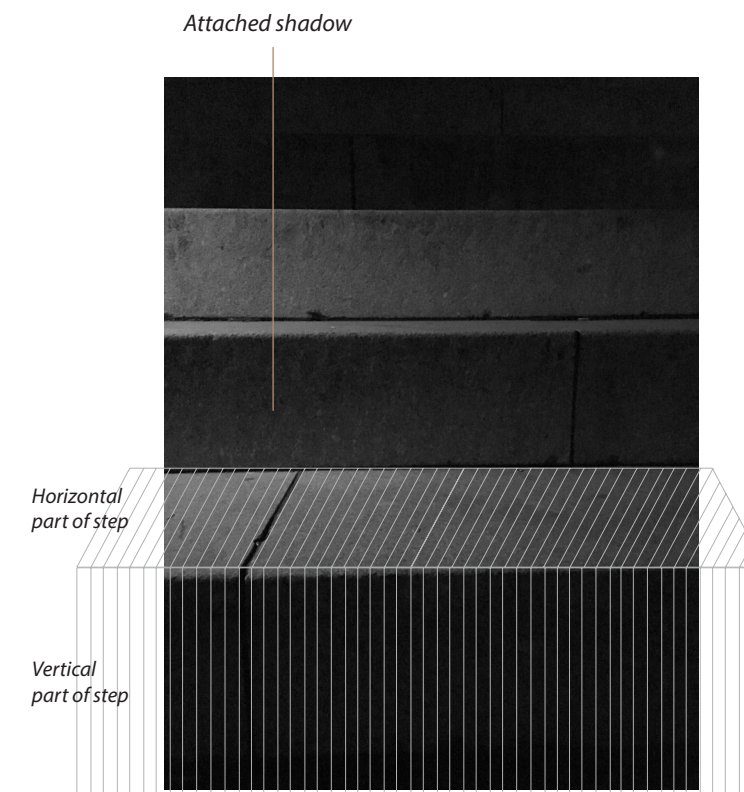


Fig. 6.13 - Photographs of point 2 from an angle of 30 °, with hatches to emphasize the steps

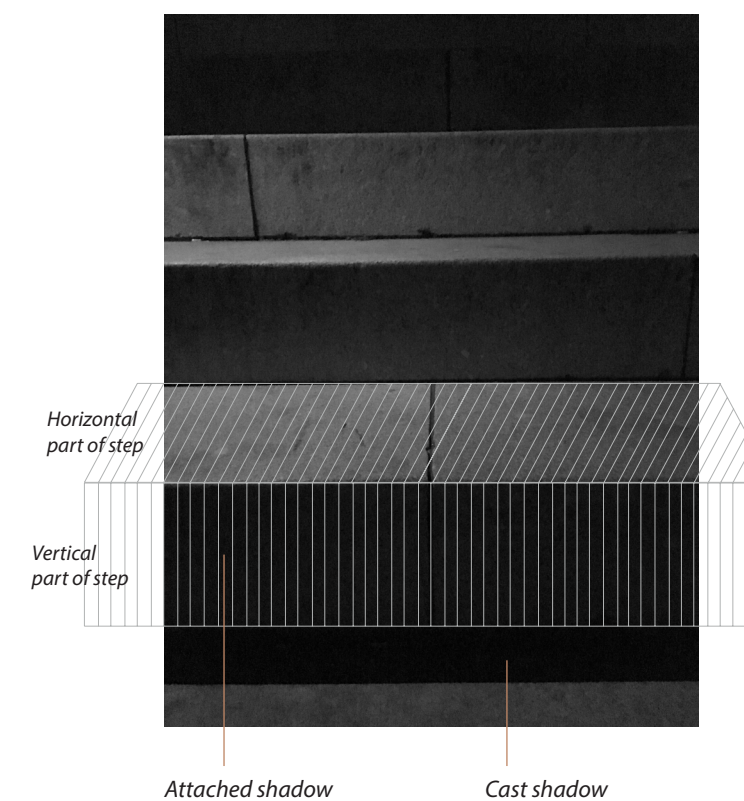


Fig. 6.14 - Photographs of point 2 from an angle of 45 °, with hatches to emphasize the steps

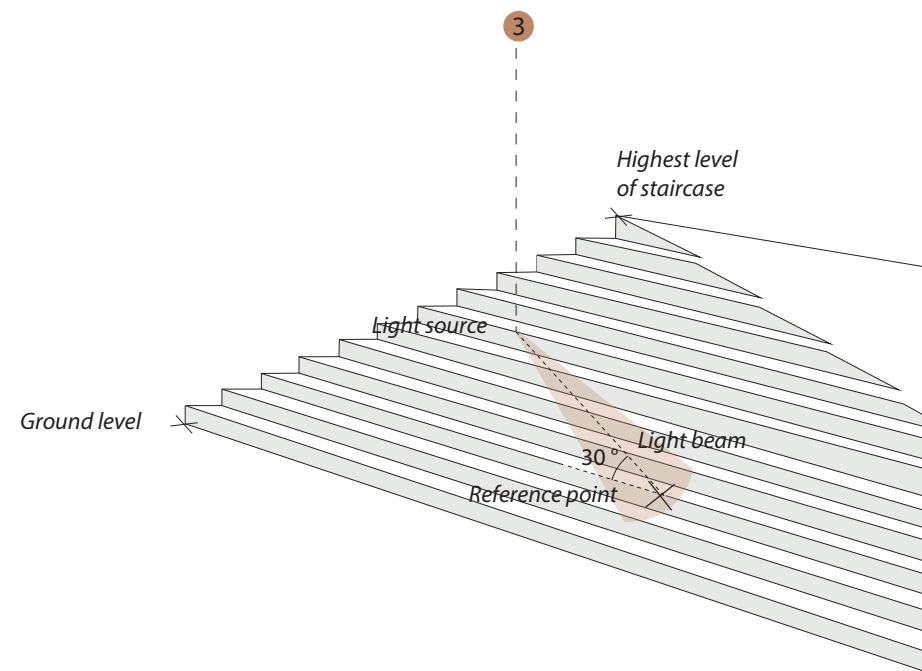


Fig. 6.15 - Illustrations of point 3 from an angle of 30 °

6.4 EXPERIMENT - POINT 3

The third point is placed at one of the top steps of the staircase and is as well pointed toward south like point 2. When the steps are illuminated from this direction of high angles of 45 ° and 60 °, it will simulate the natural early afternoon light. Moreover, a lower angle of 30 ° is experimented with to create light that is an alternative to the sun's light. In this experiment, only one low angle light beam is represented as it is not possible to hit the reference point from a lower angle than 30 °.

The findings from this experiment are again divided into two sections. The findings from experiments with an angle of 30 ° are described first and afterwards the findings from 45 ° and 60 ° are described together, since the findings from these two angles give a similar result, which differs from the experiment with a light from a low angle.

The author's expectations of this experiment were that a low angle light beam would create long cast shadows from the steps, which would obstruct the idea of how the staircase's steps are structured. Additionally, the high angle shadows are shorter and sharper and therefore they will highlight the structure and attention of the individual steps.

Point 3 - angle 30 °

The findings from the experiment with an angle of 30 ° are photographed in fig. 6.16, where the steps are almost in total darkness. The only part of the staircase that is illuminated is the edge of the individual steps. This low angle of light produces a scenario where the morphology and semiotic are not present, which causes that the access to the steps is very difficult.

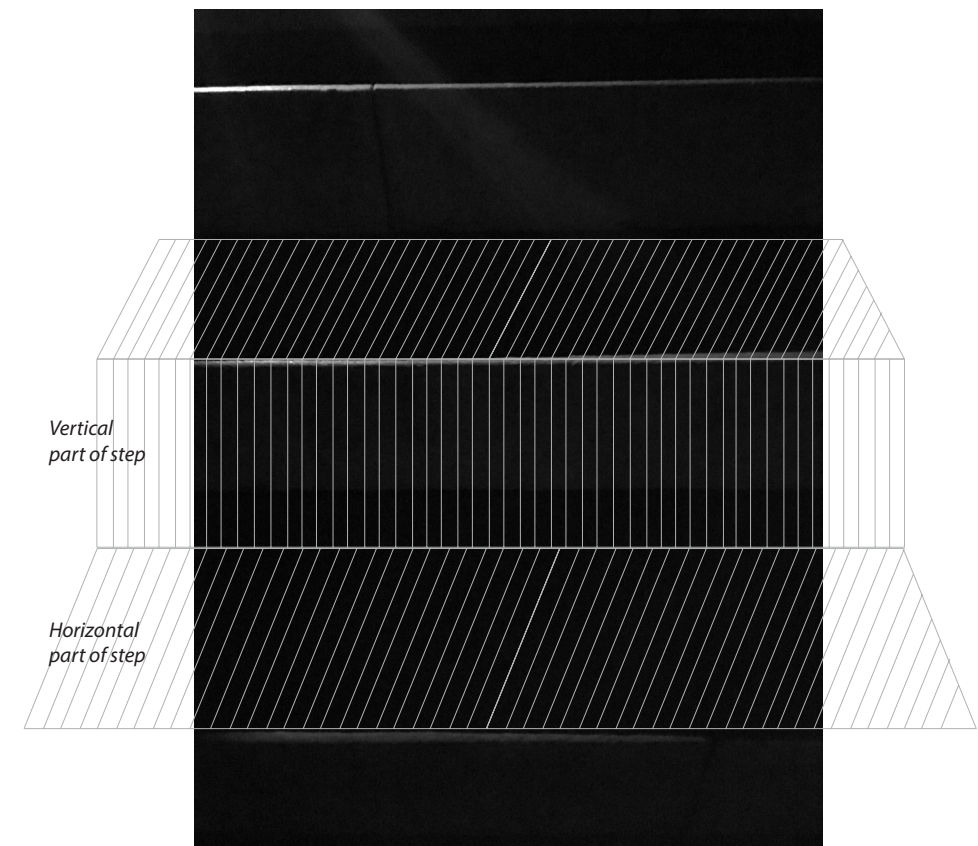
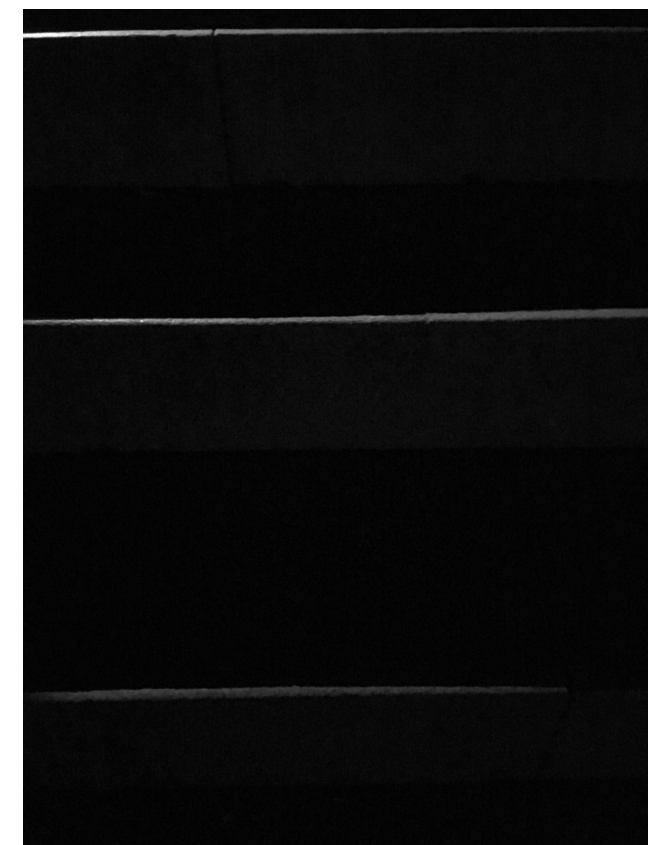


Fig. 6.16 - Photographs of point 3 from an angle of 30 °, with hatches to emphasize the steps



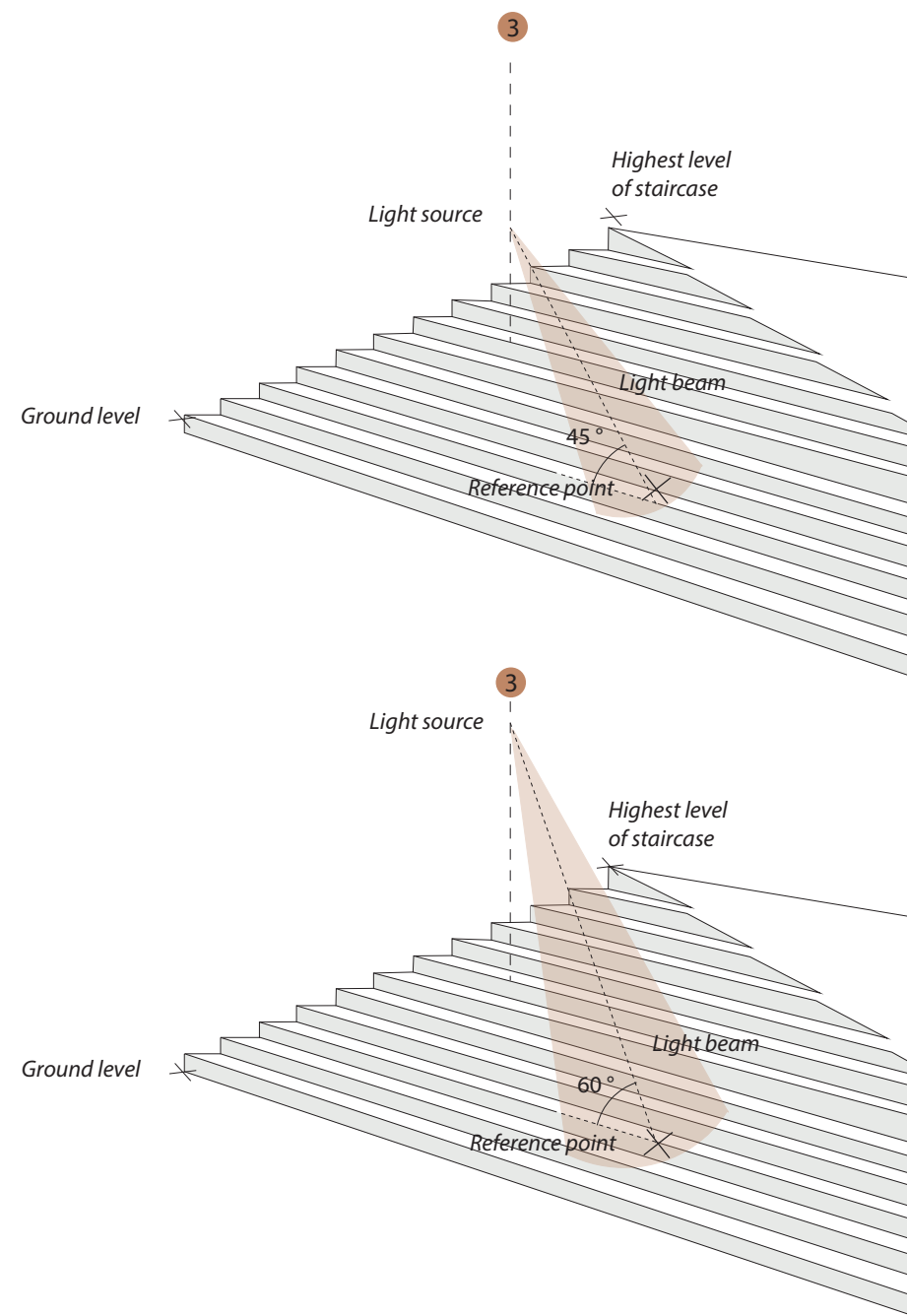


Fig. 6.17 - Illustrations of point 3 from an angle of 45° and 60°

Point 3 - angle 45° & 60°

In contrast to the previous experiment, the experiments with angles of 45° and 60° entail a scenario where the steps are visible. The findings, which are quite equal, are illustrated in fig. 6.18 and 6.19. Here, the steps are highlighted due to their sharp cast shadows and dark attached shadows on the vertical part of the steps. The semiotic of the highlighted individual steps also contributes to an emphasizing of the morphology. Likewise, a balance between light and darkness occurs, which appeals to the author's visual attraction of the staircase where a pattern of light and darkness occurs (phenomenology).

Sum up of point 3

Based on the authors' opinion, the ideal result of experiment 3 appears when the light is simulated as natural sun light when the stairs are illuminated from angles of 45° and 60°. The expectations of the experiment are as well consistent with the findings, where the high angle light beams accentuate the semiotics of the steps and as well give an overview of the morphology. Because on this, the impression of the staircase results in a relaxed feeling, that occur within the balance between light and shadow (phenomenology). Similar to the previous experiments, the simulated natural light gives the most visually pleasing results.

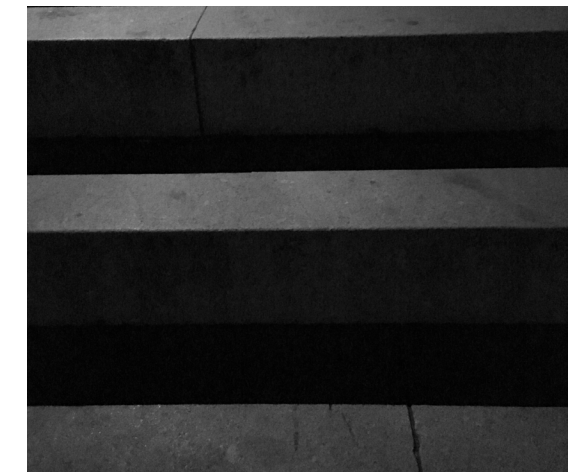
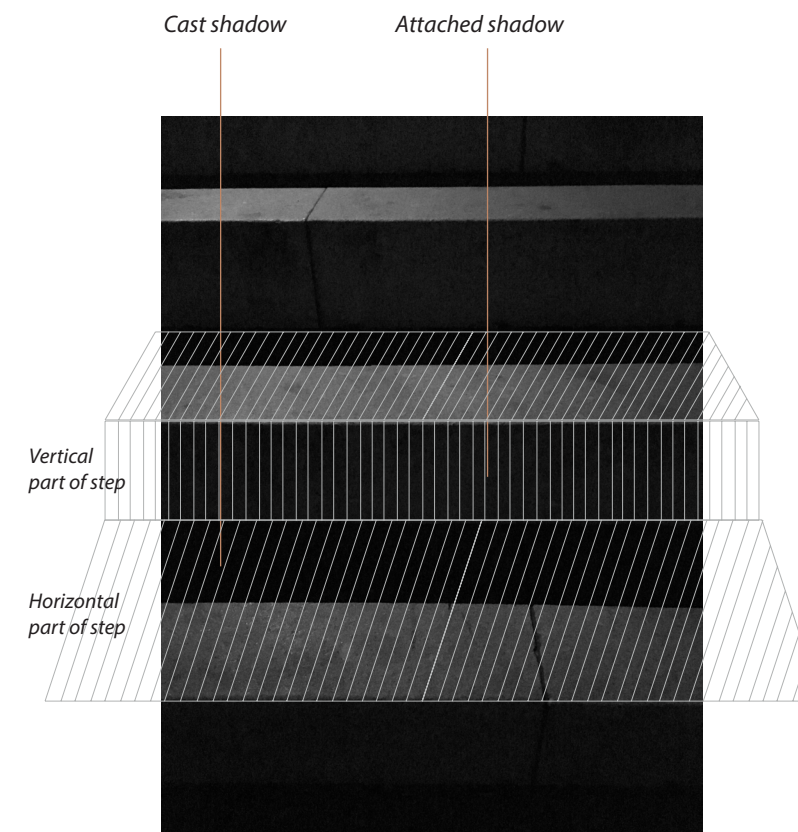


Fig. 6.18 - Photographs of point 3 from an angle of 45°, with hatches to emphasize the steps

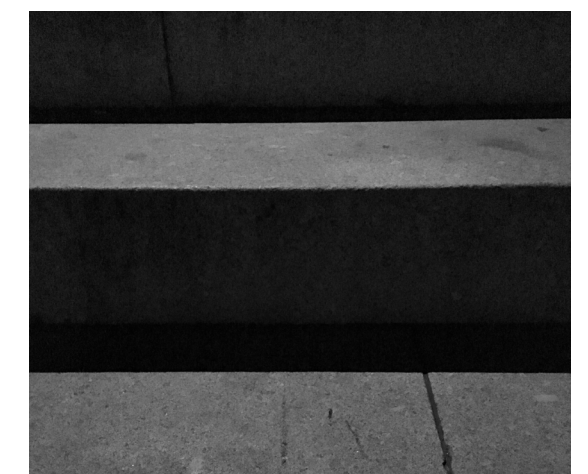
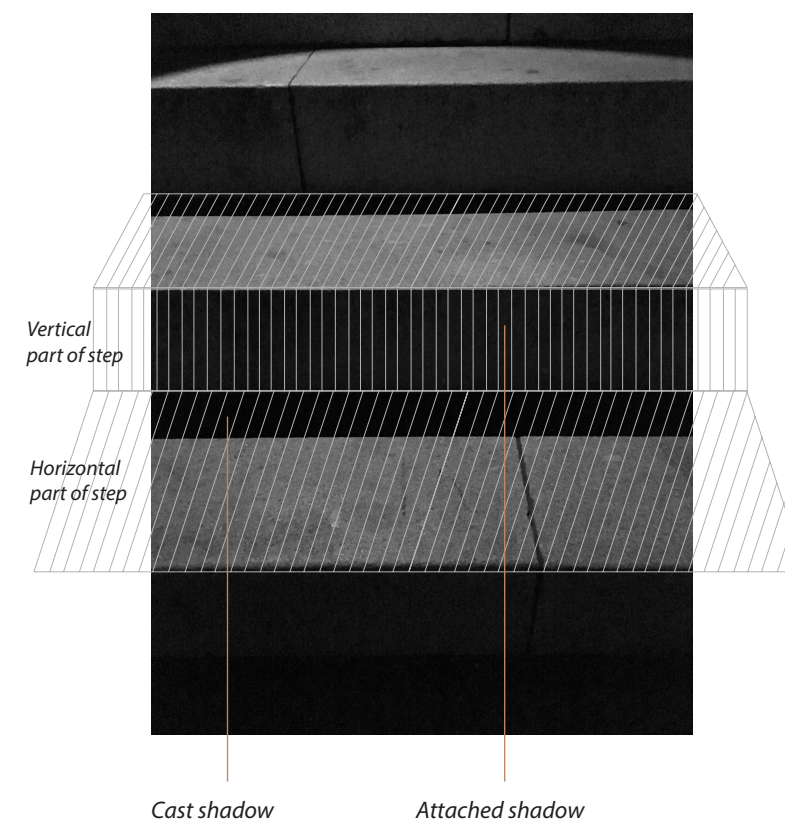


Fig. 6.19 - Photographs of point 3 from an angle of 60°, with hatches to emphasize the steps

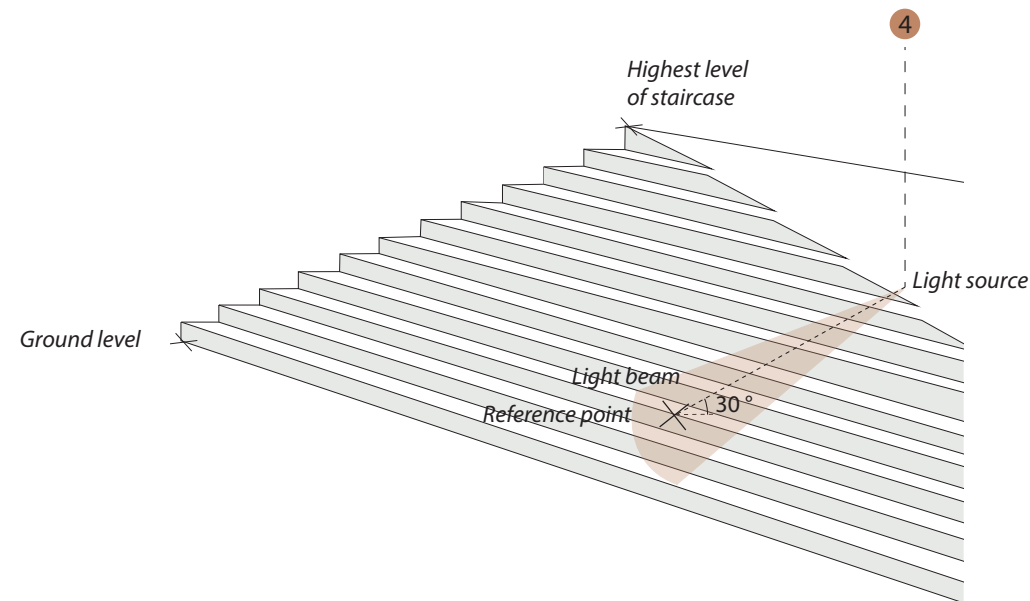


Fig. 6.20 - Illustrations of point 4 from an angle of 30 °

6.5 EXPERIMENT - POINT 4

The last experiment will examine light and shadows from point 4. The point is located on the top of the staircase, and is directed toward west. When the steps are illuminated from this direction of a low angle of 30 °, it will simulate the natural evening light, since the sun naturally is positioned low at the sky around sunset. Here, it is as well not possible to illuminate the reference point from lower angles than 30 °, since the light beam would be pointed directly at the surface of the staircase and therefore would create no effect. Thereof, other angles are added to investigate the possibilities of shadows from artificial light. Here the description of the experiment of 30 ° is separated from the findings of experiments with an angle of 45 ° and 60 °.

It was expected that the light beam pointed from high angles, which does not represent the natural light, would create the most attractive shadows due to the fact that they produce sharp and short shadows. This setting is expected to highlighten the steps' structure and thereof make them clearly to understand when climbing the staircase. Opposite, the angle of 30 ° is expected to create a setting where the steps are in darkness because the individual steps shadow each other.

Point 4 - angle 30 °

The same results are shown in this experiment as in experiment 3 from the same angle. The findings from an angle of 30 °, which is seen in fig. 6.21, show that the staircase is in almost total darkness, where it is only the edges of the steps which are illuminated. The perception of the staircase's morphology is relatively invisible, and therefore the semiotics of the steps are not understandable either.

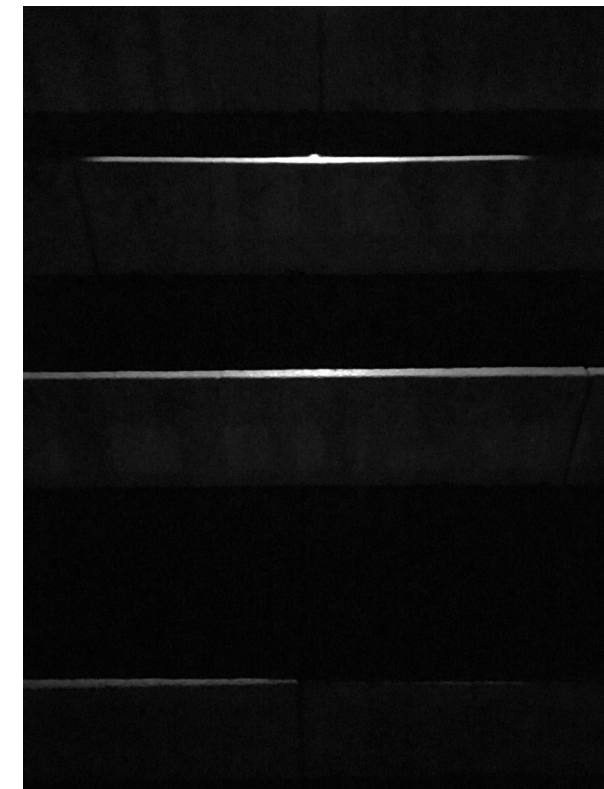
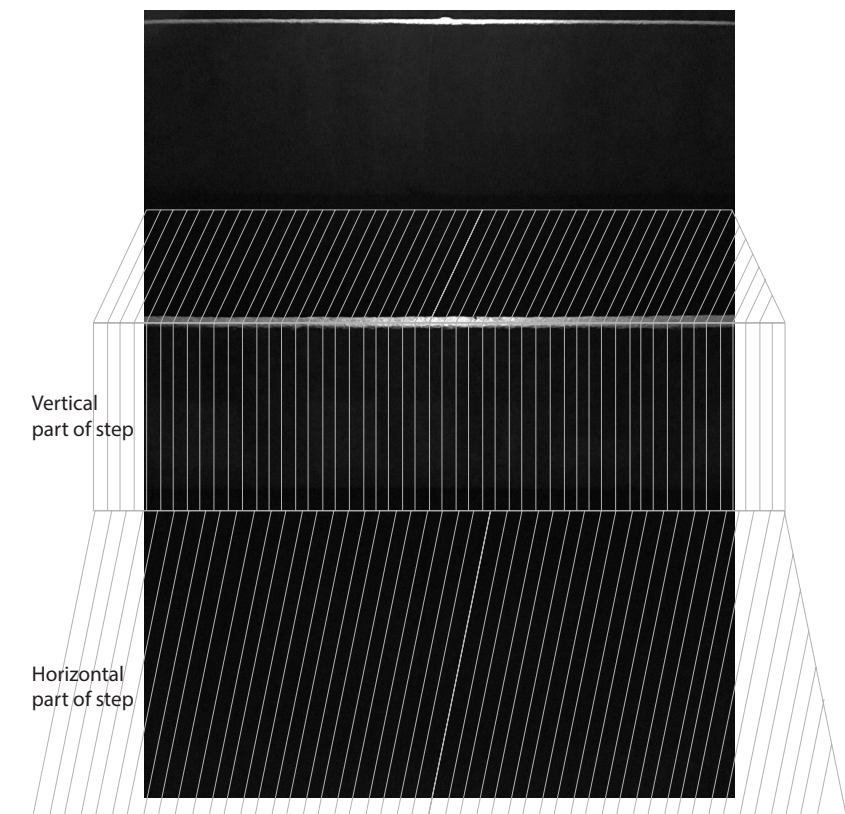


Fig. 6.21 - Photographs of point 4 from an angle of 30 °, with hatches to emphasize the steps

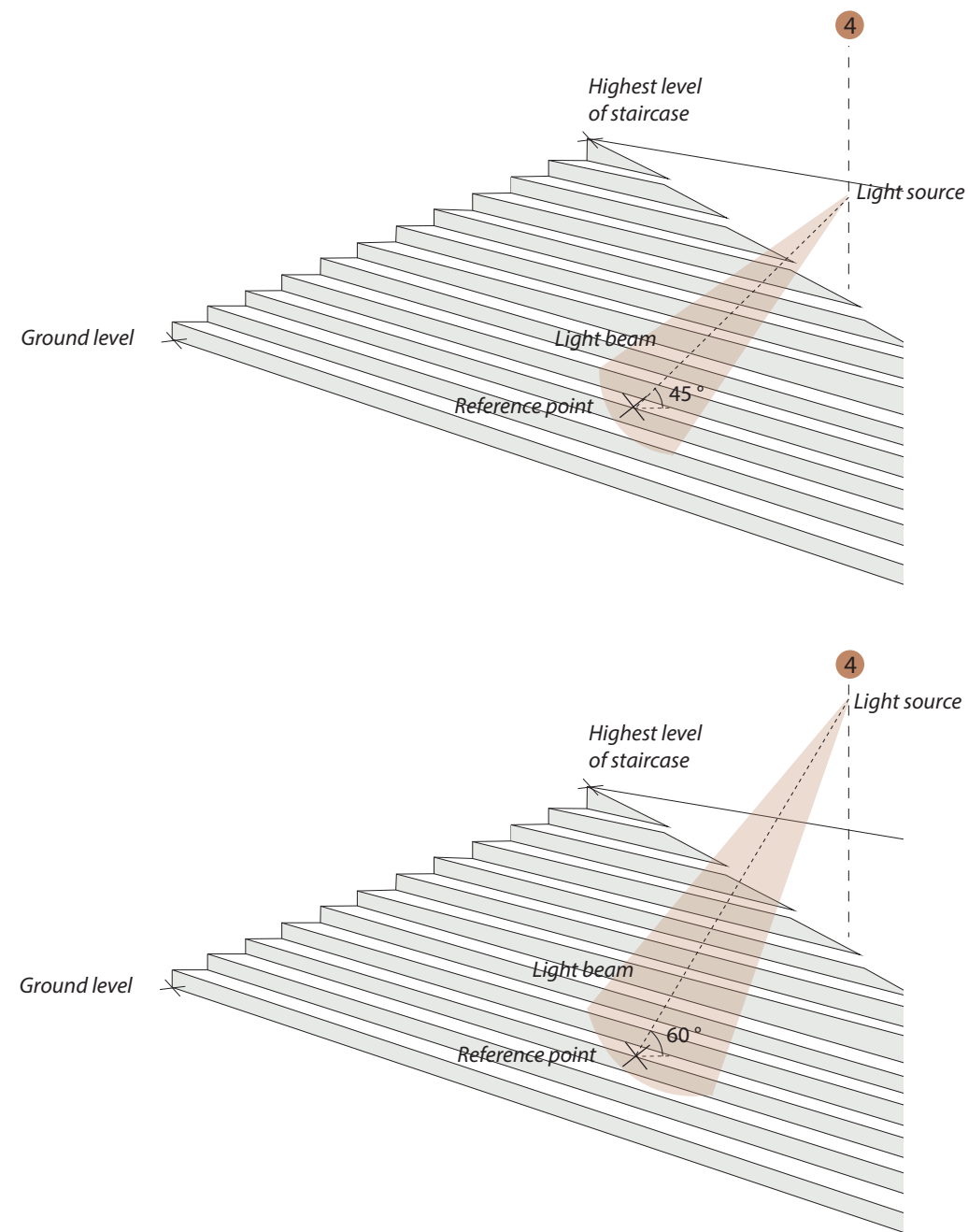


Fig. 6.22 - Illustrations of point 4 from an angle of 45° and 60°

Point 4 - angle 45° & 60°

The findings from the experiments with the two angles of 45° and 60° are illustrated in fig. 6.23 and 6.24. Both experiments are showing a similar result, that emphasize the semiotic of steps and therefore makes the staircase's morphology easy to understand. It is also experienced in this experiment, that when the cast shadows are short and sharp the perception of the steps are more attractive, and as well when the distribution of light and shadows are similar, the staircase expresses a certain calm feeling (phenomenology).

Sum up of point 4

This final experiment is showing that the perception of the steps is emphasized when illuminating the staircase from a higher angle than with the opportunities from natural light. Thereof, by exploiting the possibilities of artificial light, the semiotics of the steps are more clear to understand. Thereby the author finds the illumination from a high angle more attractive, because the light and shadow patterns are appealing to relaxation and thereby the experience of climbing the staircase is more alluring (phenomenology). The findings consistent with the expectations of the experiment.

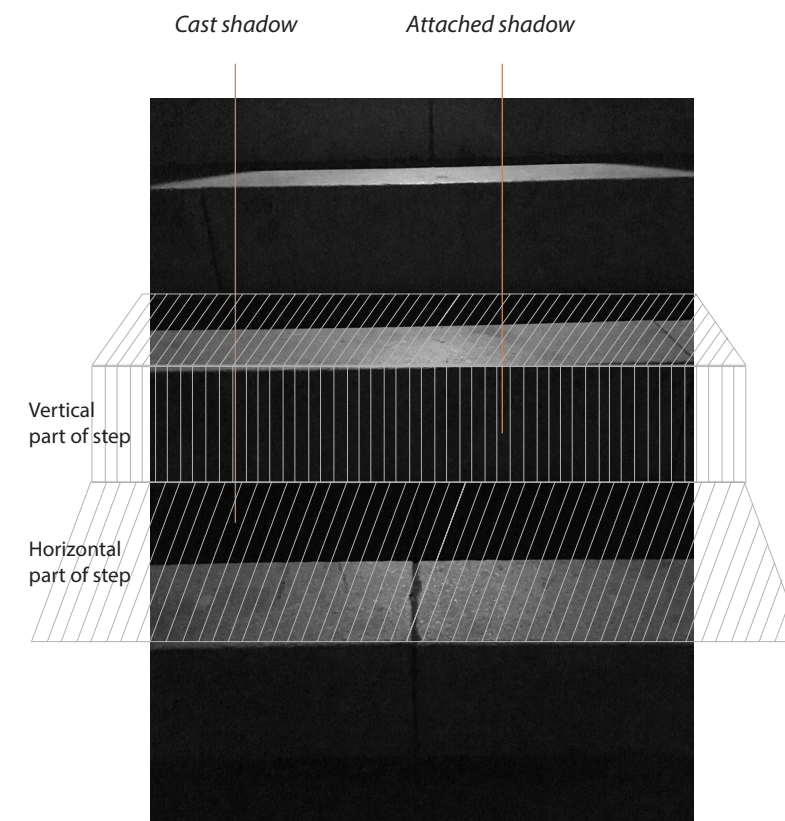


Fig. 6.23 - Photographs of point 4 from an angle of 45°, with hatches to emphasize the steps

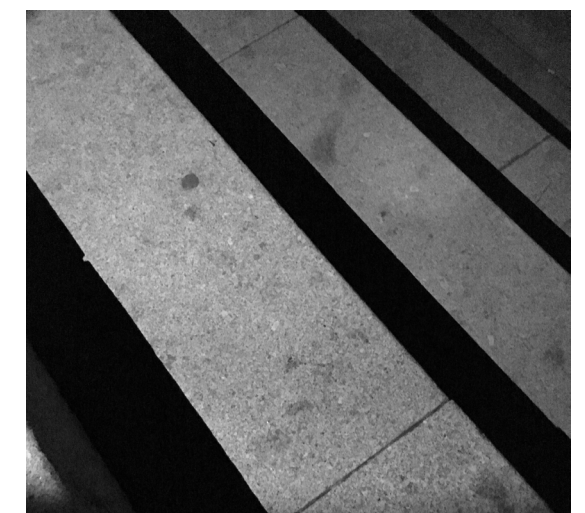
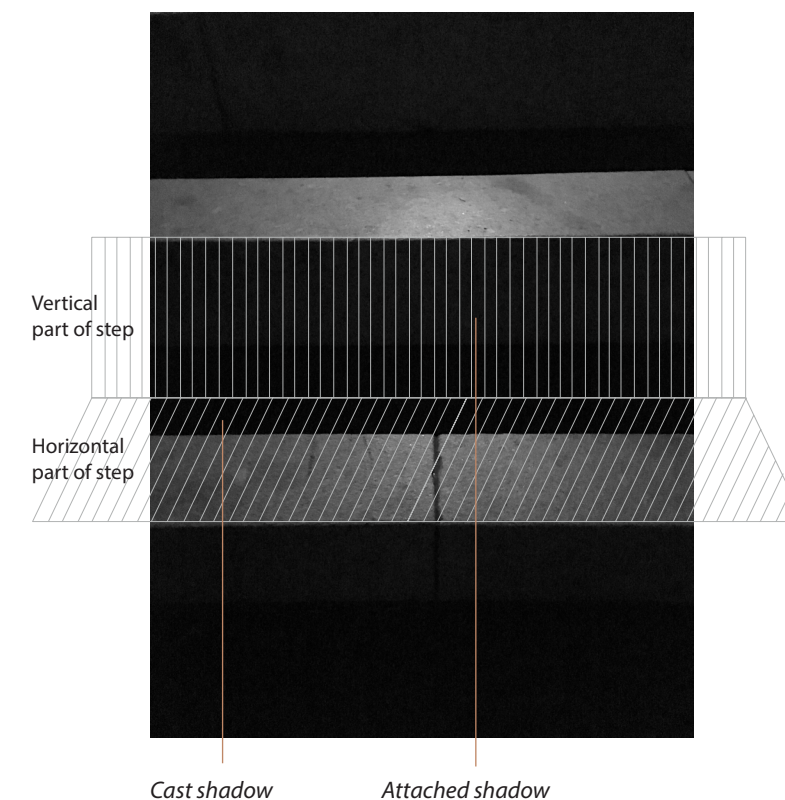


Fig. 6.24 - Photographs of point 4 from an angle of 60°, with hatches to emphasize the steps

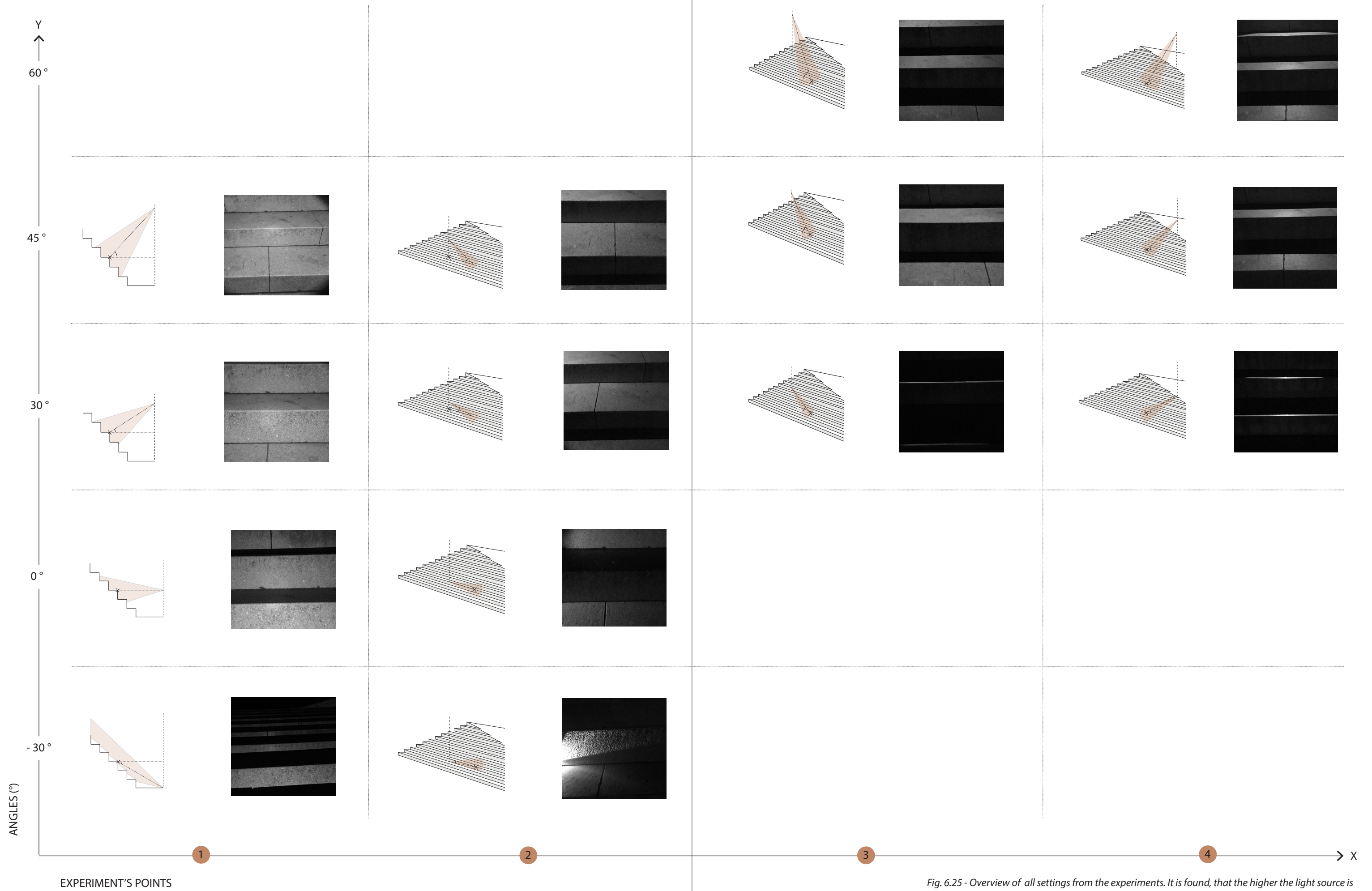


Fig. 6.25 - Overview of all settings from the experiments. It is found, that the higher the light source is placed on the staircase the more dark and sharp the shadow becomes

6.6 FINDINGS

The findings of the experiments are commented according to the author's subjective meaning of the experienced scenarios, and the optimum settings are illustrated in fig. 6.26. As seen at the figure, the biggest part of the optimum findings are under the category "simulated natural light". The findings that simulate natural light are, first from point 1 when the light beam is pointed from an angle of 0°. The most popular findings from point 2, occur when the light beam is pointed from the angles of 30° and 45°, and for point 3 the most popular scenario is seen when the light beam is pointed from angles of 45° and 60°. All these presented scenarios give an overview of the morphology of the staircase, underline the semiotics of the individual steps, which cause an increase in the praxeology. As well, the balance of light and darkness appeal to the eye and mind (phenomenology).

Only one of the settings is producing a favourable result, when the light beam is illuminating the staircase from angles of 45° and 60°. These two angles are higher than the opportunities of natural light. Similar to the aforementioned three settings, this setting produces shadows that increase the understanding of semiotics of the steps, which causes the morphology of the staircase to increase. Moreover, the pattern created by light and shadows gives a feeling of relaxation, and thereby the experience of climbing the staircase is more appealing (praxeology and phenomenology).

Bias

The author is aware of possible biases, which impair the quality of the findings of the experiment. First of all, the experiment area is depended on the span of the light beam, which could not reach a big area of the staircase. Thereof, for some of the experiments only few steps are illuminated, which entails that one does not have the possibilities to give an overview of a larger area. According to this, the photographs, which are documenting the various findings, are taken so that they capture the light and shadows the best way. Therefore, some photographs are taken at a close range whilst others are taken from a longer distance. Photographs taken from exactly the same position would have been less difficult to compare and moreover show to test persons (the test with test persons are elaborated in section 6.7). Furthermore, the staircase at Israel's Plads is well known by the author and therefore also its morphology. This causes biased notions of the productions of light and shadows which might affect how the findings are ranked and commented by the author.

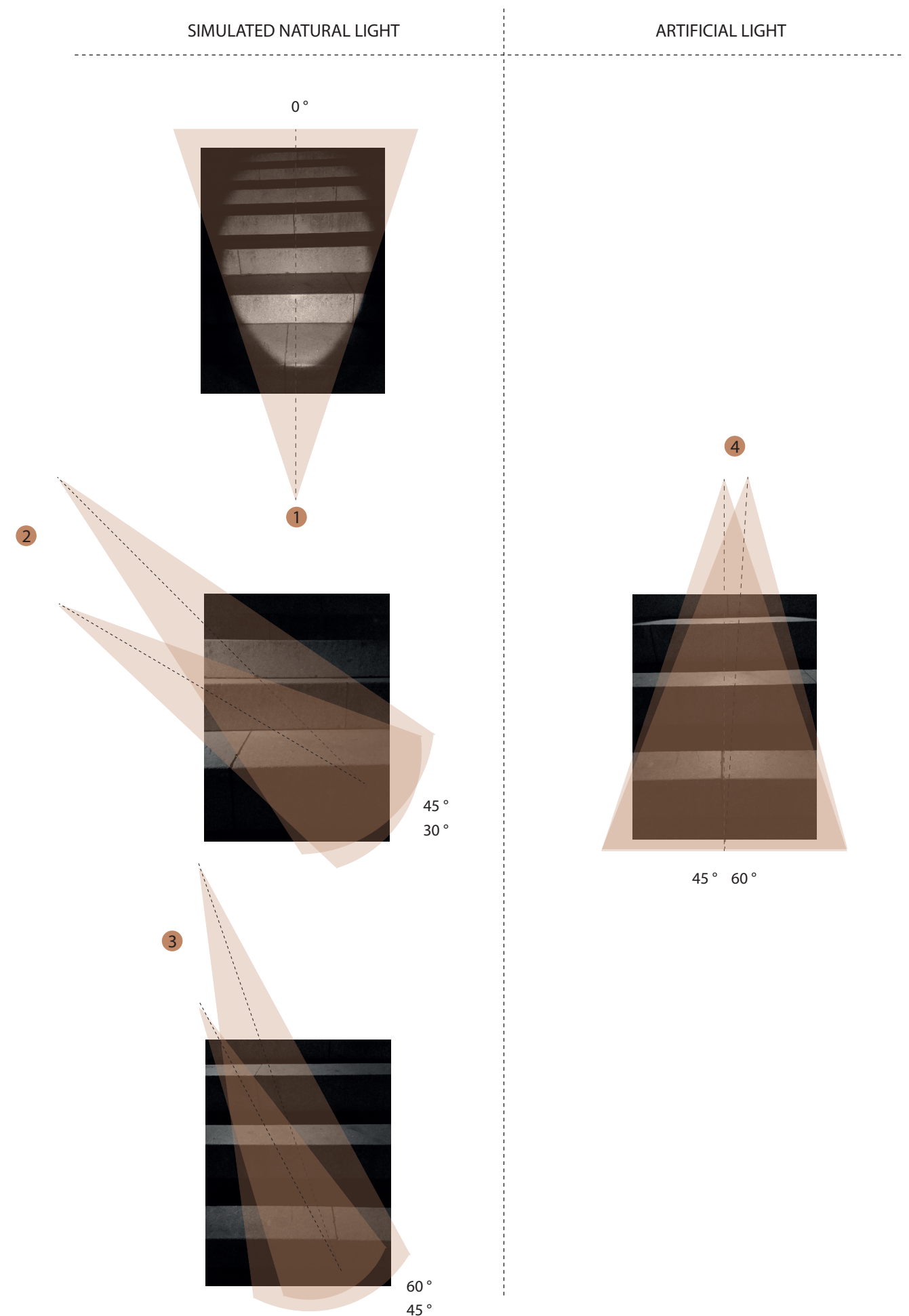


Fig. 6.26 - Illustrates the popular findings, according to the author of the thesis, divided into artificial light and simulated natural light



Fig. 6.27 - Photographs of test person

6.7 TESTING

The purpose of the testing is to either confirm or reject the author's subjective meanings and comments on the findings of the experiments. To confirm or reject the author's findings a test consisting of 10 test persons is performed. As mentioned earlier, the author highlights one light and shadow setting from each experiment point, which the author finds visually pleasing and attractive according to the three shadows *cast shadow*, *attached shadow* and *shading*. Moreover it is tested, how these contributes to increase the staircase's *morphology*, *praxeology*, *semiotics*, and *phenomenology*.

6.7.1 Procedure of tests

The findings, illustrated as photographs, from experiments are presented to 10 test persons, who have no prior knowledge about the purpose of the experiment beforehand or any information about the author's subjective meanings and comments of the experiment. The test persons will be presented with findings from the experiment divided into three scenarios, where each scenario consists of four photographs (an example of the questionnaire is presented in Appendix A). The test persons are not aware of how the photographs are structured within each scenario. The author has structured the three different scenarios so the first scenario is presenting findings from angles of -30° and 0° (which are experienced from point 1 and 2). Second scenario presents angles of 30° (which are experienced in point 1, 2, 3, and 4). The last scenario, is showing photographs of experiments with angles of 45° and 60° (which also are experienced in point 1, 2, 3, and 4). This means that, the scenarios are presenting all low angles together, angles of 0° separately, and high angles together - pointed from different directions (point 1, 2, 3, and 4). The four photographs within each scenario are shown in the questionnaire, and the test persons are asked to rate them on a scale from 1-4, where 1 is dislike and 4 is like. Furthermore the test persons are presented with three different contexts, where the following questions are asked:

1. *Imagine standing in front of the staircase and you are about to climb it.*

On which of the following scenarios would you feel most comfortable when climbing the steps?

The purpose of the question, is to investigate which direction and from which angles light and shadows that increase the perception of the *morphology* of the staircase are produced.

2. *Imagine standing in front of the staircase and you are about to climb it.*

On which of the following scenarios do you find it easiest to understand the structure of the steps? (The height of the steps, the length of the steps etc.)

This question is asked to examine which directions and angles that produce light and shadows that have the possibilities to increase the *semiotics* of the individual steps, by letting the test persons consider the where they find it easiest to understand the height, length etc. of the steps according to the different light/shadow scenarios.

3. *Imagine you are out with your friends and are having a break.*

On which of the following scenarios would you stay for a longer time?

The purpose of the question is to investigate which directions and angles that produce light and shadows that appeal to human's feelings by attract the eyes and mind (*phenomenology*).

The author assumes that the *praxeology* increases as a result of intelligibility of the other epistemes; *morphology*, *semiotics*, and, *phenomenology*. Praxeology is not directly investigated here, because the test are performed with only visual material, where praxeology requires that people spend time at the staircase by walking up and down the steps.

The answers from the 10 test persons are illustrated in the next section 6.8. Furthermore, the test persons' answers and the author's subjective findings are compared and discussed and developed into design principles for how to illuminate staircases in general to better accommodate the perception and expectation of an urban space.

6.8 RESULTS OF TESTING

The test results are illustrating how 10 random test persons are experiencing three scenarios (shown by photographs from the experiment) within three different contexts. This section is structured so the three test results are presented separately in section 6.8.1, 6.8.2 and, 6.8.3. For each test, all 10 test persons ratings are illustrated and the rates are expressed by values to clarify which setting(s) is the most popular among the test persons. Furthermore, the most popular settings are highlighted by ----- to simplify and illustrate the results that will be further discussed in chapter 07.

6.8.1 Test - part 1

The first part of the test examines which of the settings that creates the most understandable perception of the *morphology* of the staircase, and is illustrated in fig. 6.27. Here, the test persons are asked the following question:

*Imagine standing in front of the staircase and you are about to climb it.
On which of the following scenarios would you feel most comfortable when climbing the steps?*

The first scenario, where photographs of low angle light beams from point 1 and 2 are presented, shows that illuminating the staircase from point 1 (directed towards east) with an angle of -30° is the most popular (value 3.5). Likewise, the illumination from point 1 with an angle of 0° almost had the same rating (value 3.4). Additionally, the illumination from point 2 (directed towards south also from angles of -30° and 0°) were the most unpopular ones with ratings on 1.4 and 1.6.

The second scenario, which consists of photographs showing scenarios from 30° from all four points, illustrates that point 1 and point 2 were most popular with almost same rates (3.5 and 3.4). Again, the less popular settings have half the score in the rating (point 3 and 4).

The third scenario, that presents photographs of point 1, 2, 3, and 4 with high angled light beams (45° and 60°), show that illuminating the staircase from point 1 (directed towards east) with an angle of 45° gives the most popular result (score: 3.3), followed by point 2 (directed towards south) also with an angle of 45° .

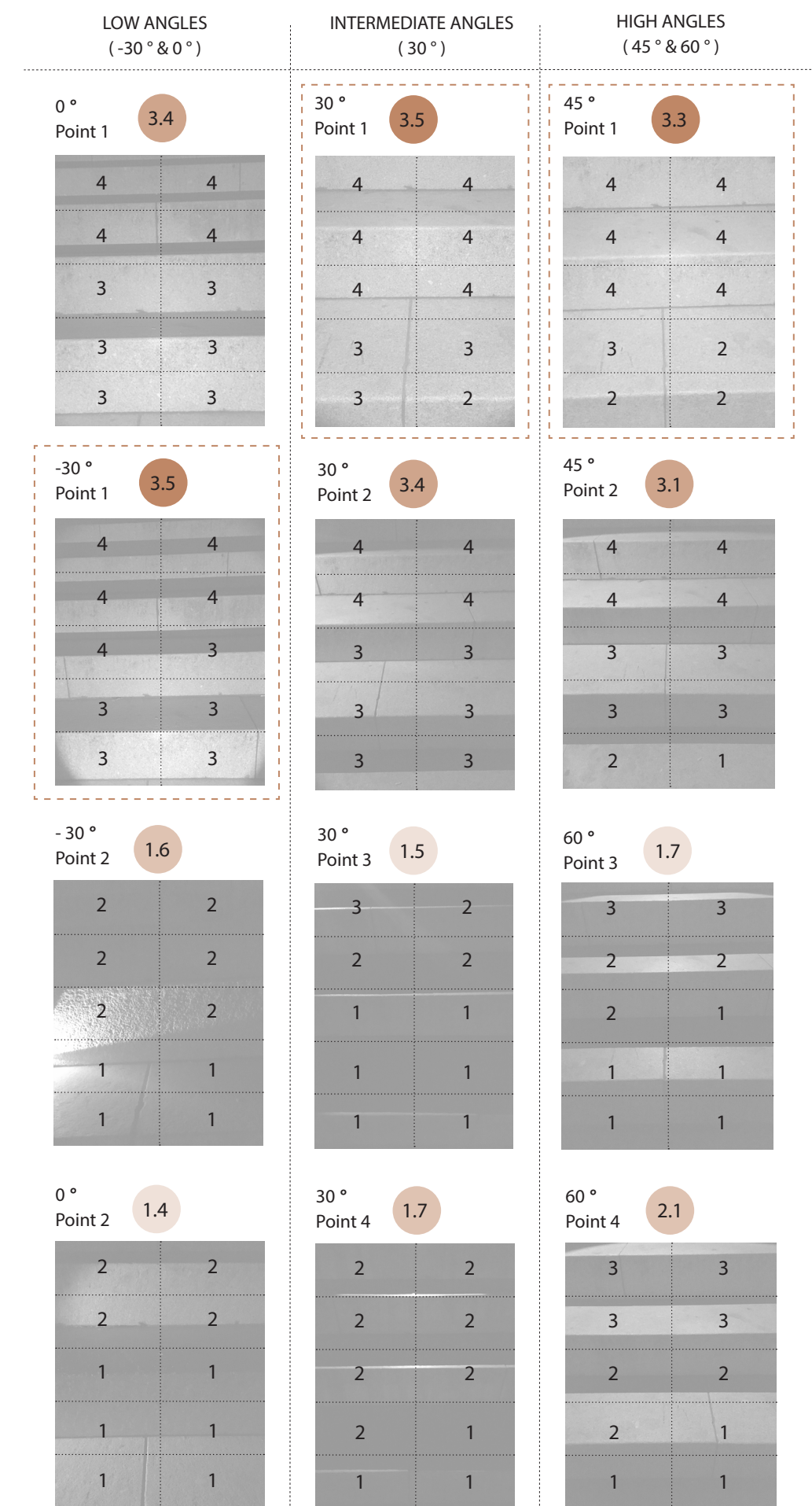


Fig. 6.27 - Results from test 1. Rates of each scenario is expressed in values, where 4 is the highest value.

6.8.2 Test - part 2

The second part of the test is investigating the *semiotics* of the staircase's steps, and its results are illustrated in fig. 6.28. The test is made by asking the test persons the following question:

*Imagine standing in front of the staircase and you are about to climb it.
On which of the following scenarios do you find it easiest to understand the structure of the steps?
(The height of the steps, the length of the steps etc.)*

The first scenario shows that the test persons do clearly agree that point 1 with an angle of -30° , is creating the most clear perception of the steps (value 4). Point 1 from an angle of 0° , is also rated with a high score (value 2.9). Opposite are the angles of -30° and 0° from point 2 less popular among the test persons as they only have half the score.

In the second scenario, the most popular setting is shared between point 1 and 2. Both points are illuminated from an angle of 30° (each photographs are rated with a value of 3.5). Points 3 and 4, as well illuminated from angles of 30° is less popular with scores on 1.6 and 1.4.

Similar, in the third scenario, the most popular setting is shared between point 1 and 2. Here, both points are illuminated with a light beam angle of 45° (each photograph is rated with values on 3.0). Point 4 which is illuminated from an angle of 60° is popular among the test persons as well with a score on 2.8.

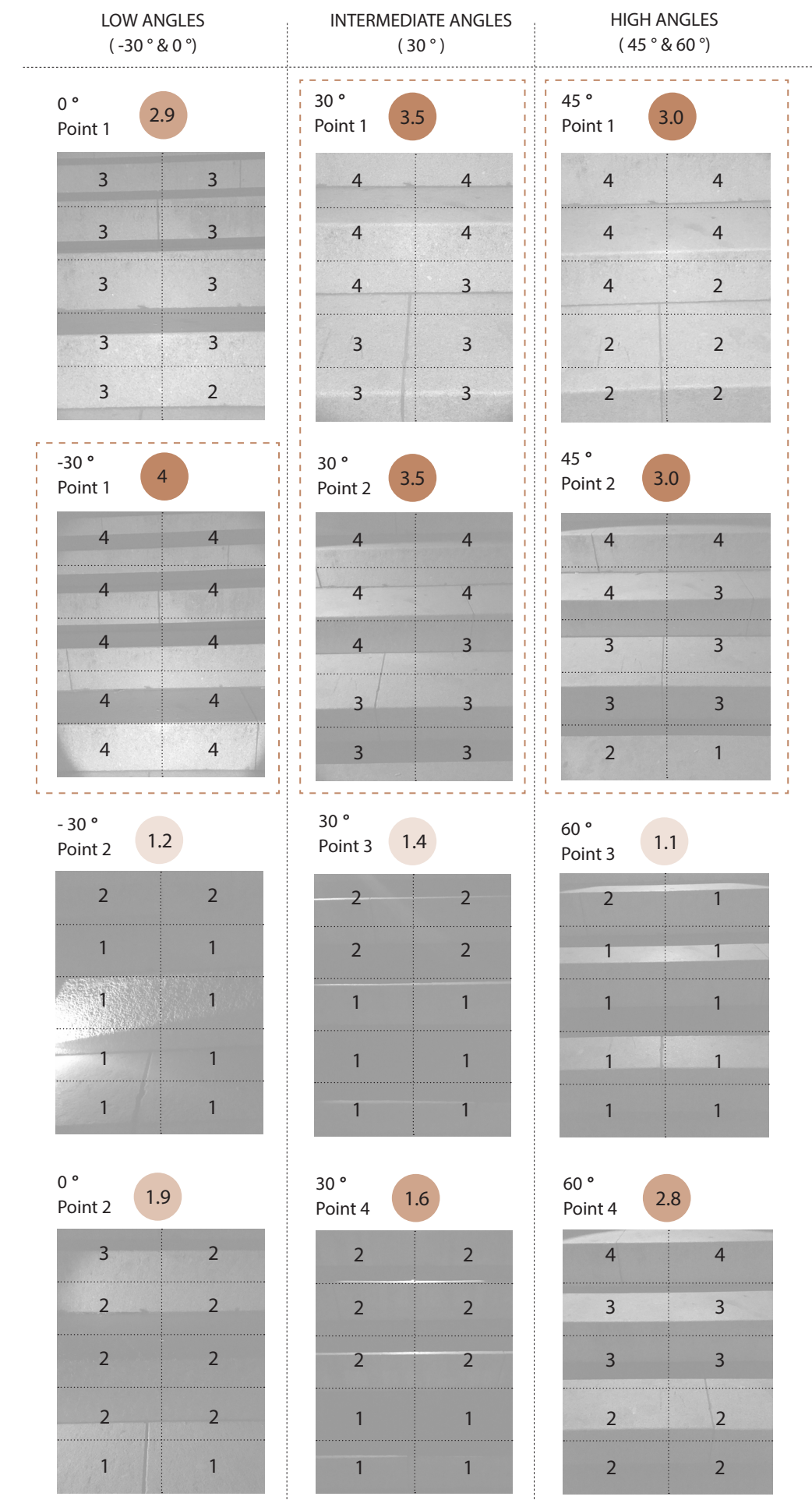


Fig. 6.28 - Results from test 2. Rates of each scenario is expressed in values, where 4 is the highest value.

6.8.3 Test - part 3

The third part of the test examine which setting that creates light and shadows that appeal to the feelings (*phenomenology*), and is illustrated in fig. 6.29. This is tested by asking the test persons as followed:

Imagine you are out with your friends and are having a break.

On which of the following scenarios would you stay for a longer time?

Scenario 1 is showing that point 1 which is illuminated from an angle of -30° is having the highest score with a value on 3.5. Point 1, which is illuminated from an angle of 0° , is almost as popular with a score on 3.1. Thereof, these photographs appeal to the test persons more than the photographs from point 2 which is also taken from angles of -30° and 0° which have scores with values on 2.2 and 1.1.

Point 2 which is illuminated from an angle of 30° is by far the most popular with a score on 3.9. In addition to this, the test persons are not entirely agreeing on the other photographs, which are showing point 1, 3, and 4, as they are almost rated with an equal score.

In the third scenario the test persons do not fully agree on which of the photographs that are the most popular, as they have relatively the same rates of value 3.2 (point 4, 60°), value 3.0 (point 3, 60°), and value 2.5 (point 2, 45°). Though, it is clear that the least popular light/shadow setting is point 1 which is illuminated from an angle of 45° .

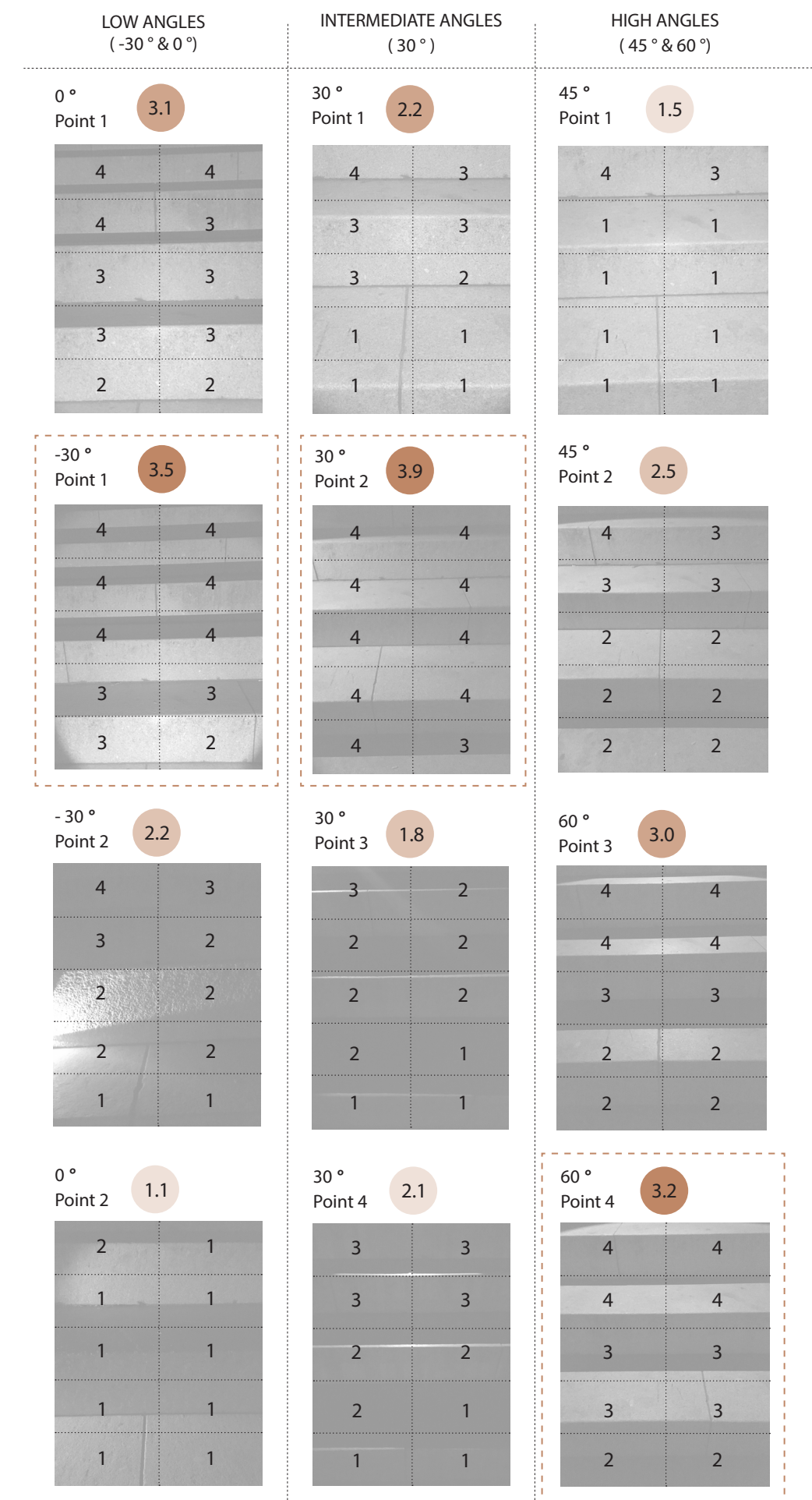


Fig. 6.29 - Results from test 3. Rates of each scenario is expressed in values, where 4 is the highest value.

6.9 SUM UP OF TESTS

The results of all three tests (questionnaires), are collected in fig. 6.30. Concluded from the tests are that in general all test persons did relatively agree in their answers to the questionnaire. Especially in test 1 and 2, the results were convincingly the same. The answers from test 3 were more distributed among the different photographs. Furthermore, it is noted that the answers from test 1 and 2 are quite similar, because the three angles -30 °, 30 °, and 45 ° from point 1 are the most popular among the test persons for both of the tests. The outcome of this test is, according to the author, that the results of the two tests were quite similar, and also that the difference between the structure of the staircase (morphology) and the understanding of a single step (semiotics) are related to each other. In addition to this, it is found in test 2 that two of the scenarios, two photographs are agreed as being the most popular light/shadow setting. The two settings that share the most popular results are entirely different, seen from the amount of present shadows. Due to that no shadows at all occur by angles of 30 ° and 45 ° from point 2 compared to angles of 30 ° and 45 ° from point 2 where the steps are alternately covered by light and shadows. Likewise, the three results from scenario 1, 2, and 3 (test 1 and 2) are different, approximately, because the amount of light and shadow differs greatly from one another - from an entirely illuminated staircase (seen from point 1 with angles of 30 ° and 45 °) to relatively darkened steps (seen from point 1 with an angle of -30 ° and from point 2 with angles of 30 ° and 45 °). For test 3, the results are markedly different from the two previous tests. This is due to the fact, that the third question deviates from the other questions, by demanding the test persons to consider their feelings when rating the photographs. The results of test 3 are quite similar, since all three photographs capture the steps with an even distribution of light and shadow. Overall, the results are predominantly represented by the production of light and shadows from point 1 and 2. In addition to this, it is observed that no results from point 3 is rated as most popular.

Bias

The author is aware of bias which impair the quality of the results of the tests. The test persons were exclusively presented to photographs of the different light and shadow settings, whereas the author is aware of the fact that the illuminated staircase is perceived differently in reality, and thus the test answers might be different if the test was made on the location. Thereby, it is required that the test persons should imagine being at the location. It is therefore taken into account that the test persons are not at the location when they participate in the test. To accommodate this bias, it is important to repeat that the author has investigated the light and shadow scenarios in reality and on location, and that the test is performed with the aim of either reject or confirm the author's findings of the experiment.

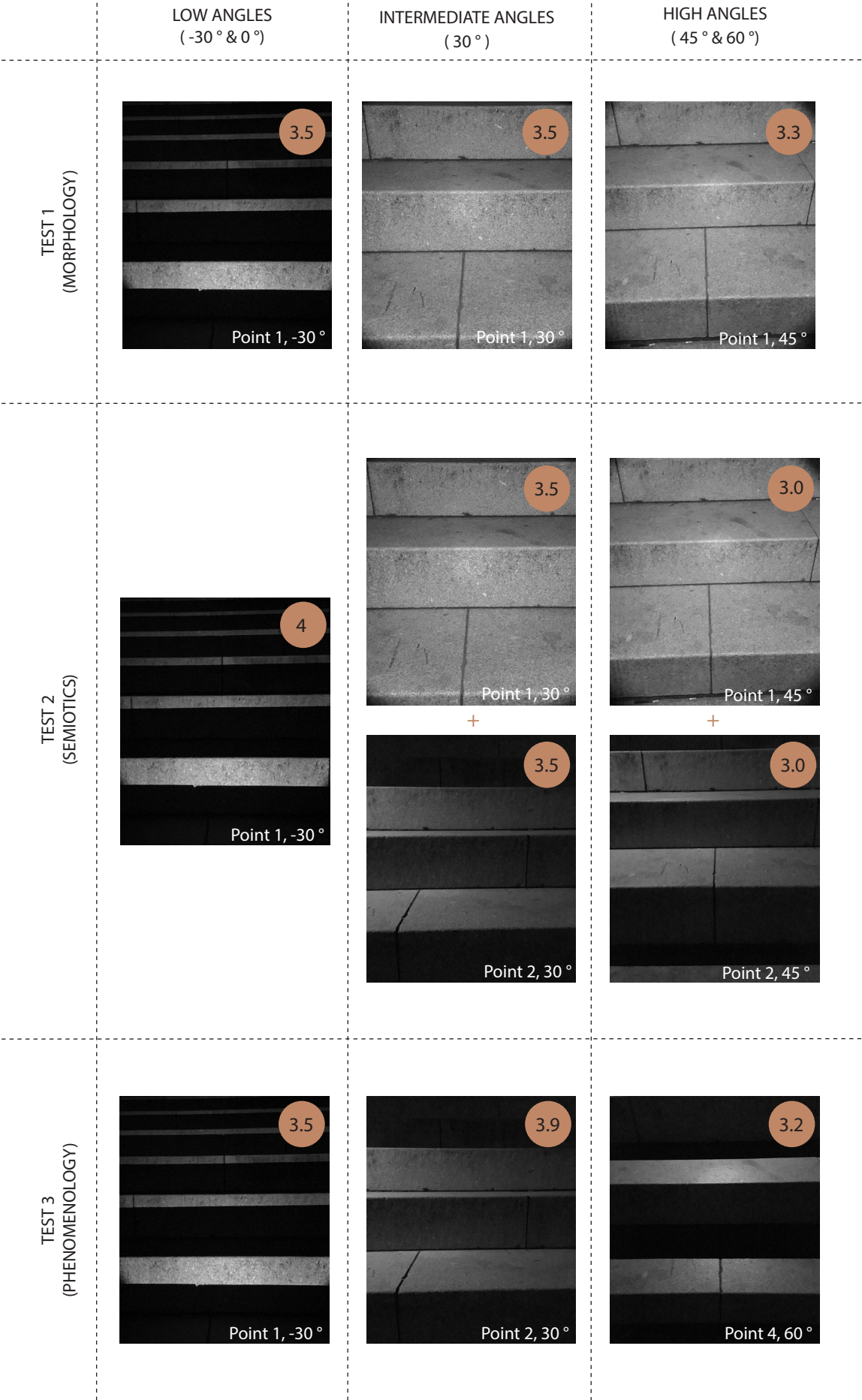




Fig. 6.30 - Overview of test results




DISCUSSION

07



The following chapter elaborates on a comparison of the author's findings from the experiments and the test persons answers from the questionnaire. The comparison is made according to the four epistemes: *morphology*, *praxeology*, *semiotic*, and *phenomenology*. Subsequently, the comparison will be summarized adding the author's interpretations of these. The discussion of the compared findings from experiment and the results from test, are the basis of two design principles, which will be developed in chapter 08.



7.1 COMPARISON OF EXPERIMENT AND TEST

The following section is structured so the author's subjective findings from the experiments are compared to the test persons' answers of the test. The author's most popular findings from the experiment are based on theoretical knowledge (theory introduced in chapter 02). The findings from the author is illustrated in fig 7.1 and the test persons answers are collected and illustrated in fig. 7.2. The confirmation and rejections of the findings from experiment will be elaborated in the followed subsections.

7.1.1 Morphology

The morphology of a staircase is examined in test 1. Test 1 shows that people prefer the photographs taken when the light beam is directed towards east (point 1) with angles of -30 °, 30 °, and 45 °, as illustrated in fig. 7.2. Two out of three results (30 ° and 45 °) are illuminating the steps completely. This answer the author finds surprising, because the author's notion is that the perception of the staircase is more understandable when shadows occur. Therefore the test persons answers do not match the author's findings, which is illustrated in fig. 7.1.

Although disagreement between some of the experiment's finding and the test's results occurs, the angle of -30 ° from point 1 corresponds completely with the author's preference for an angle of 0 ° from point 1 as well. Thereby, on the basis of the comparison it is found that, to accommodate the understanding of a staircase's morphology, the steps must be covered as little as possible by shadows. Thereby the stairs seem clear and no obstacles can be hidden in the darkness of the shadow. Furthermore it is found that, according to the understanding of the staircase's structure, the test persons prefer an illumination which does not simulate natural sun light, since the most popular answers are with light beams illuminating the steps from angles that would never appear with natural sun light from point 1 (directed towards east).

7.1.2 Praxeology

The praxeology is not directly investigated in the testing, because the test is performed with a visual approach. The author believes that praxeology should be experienced by the test persons being able to move around the location (staircase) itself. The author assumes that human activity on a staircase increases as a result of intelligibility of the three other epistemes (morphology, semiotics, and phenomenology). The author has considered the praxeology when contemplate the different light and shadow settings during the experiments. This was possible as the author was at the location during the experimentation, and thereby could move at the staircase whilst experimenting with the various light and shadow settings. The test persons did not have this possibility, and thereby the praxeology will not be discussed. As mentioned earlier the human activity is not subordinated hence it is not deeper investigated in this thesis. Exclusively based upon the author's examinations, the consideration of praxeology is used in the development of design principles in chapter 08.

7.1.3 Semiotic

The semiotic of the steps are investigated in test 2. As illustrated in fig. 7.2, it is found that the test persons prefer illumination from both point 1 (directed towards east) and point 2 (towards south) from angles of -30 °, 30 °, and 45 °. Among two of the answers the most popular settings is shared between two, which differ from each other. Due to the fact, that the author's findings are equal to point 2 with angles of 30 ° and 45 °, it is determined that these two settings will be used in the further discussion (hereby the two other photographs are crossed out in the illustration, fig. 7.2). Different from the previous test, it is seen that it is important for both the author and the test persons that the steps are illuminated so shadows occur. It is interesting that the test persons answers varie in this test compared to test 1. The author finds the two epistemes morphology and semiotic dependent, and thus expected answers equal to test 1. As two out of three test answers are identic to the author's findings, it is determined that the understanding of individual steps increases with the vertical part of the step is in shade and the horizontal part is lit up. This equal distribution of light and darkness emphasize the steps' semiotic and it is especially reinforced when light abruptly turns into darkness exactly on the edge of the steps. Furthermore it is found, according to the understanding of the steps' height, depth etc., that the test persons predominantly prefer an illumination which simulate natural light (except point 1, -30 °), which is produced, when the staircase is illuminated from point 2 with angles of 30 ° and 45 °.

7.1.4 Phenomenology

The phenomenology is examined by letting the test persons reflect upon, which of the light and shadow settings they could imagine as a space they would stay for a longer period of time. The test persons are therefore forced to imagine the space and consider which feelings would arise in the specific moment. This test varies from the two previous tests. For this test all answers from the test persons are where the illumination of the staircase produces significant light/shadow settings, as illustrated in fig. 7.2. The significant settings appear when the steps are illuminated from point 1 (east) -30 °, point 2 (south) 30 °, and point 4 (west) 60 °. Predominantly the results of the test similar to the author's findings (see fig 7.1), since the settings from point 2 (30 °) and point 4 (60 °) confirm the author's inquiries of appealing shadows on the steps. The illumination from point 1 with an angle of -30 °, is the only results that differ from each other. Concluded, both the author's findings and the results of test persons are that the presence of shadows is essential when attracting people to a certain space (the staircase in this case). Moreover, it is observed that the most popular settings (for both author and test persons) when shadows that are sharp and dark are produced, and thereof create an experience of, that the understanding of the staircase is emphasized by shadows that appeal to the human eyes and mind as well. Furthermore it is found, according to the investigation of peoples' experiences (phenomenology) of the staircase, that the test persons do not prefer illumination that simulates natural light, since two of the answers are producing light which can not be created by natural sun light.

7.1.5 Sum up and interpretations of comparisons

Based on the comparison of the author's findings from the experiment and the test persons answers, it is concluded, that almost all the preferred settings contained a presence of shadows - mainly shadows that appear with significance sharp shapes.

Especially, these significant shadows occur when the staircase is illuminated from point 1 with an angle of -30° . This setting is popular among the test persons, since it appears in all three test results. Conversely, this light/shadow setting is not among the author's favorites, because this setting is illuminating the staircase with an angle, which will dazzle people (which are sitting on the steps or are walking from down the staircase) due to bright light coming from below.

Besides that, it is observed that light/shadow settings from point 3 is not represented at all in the test persons' answers, and that only one setting from point 4 is selected as most popular. These settings create a greater amount of shadow and light, which the author finds satisfying as most of the popular findings from experiment are settings from point 3 and 4. It is interesting, that the test persons do not find settings, which produce dark and sharp shadows appealing (in test 1 (morphology) and test 2 (semiotic)), even though Sadowski (2017) states that the human perception of shadows acquire crucial knowledge and understanding of the physical properties of the objects in our surroundings.

In addition to this, as mentioned above, it is found that almost all popular settings contain shadows. This confirm the fact of that shadows create contrast in urban spaces and entail that the experience of the space remains in human memory and not will slip past (Cullen, 1961). It is found that shadows are essential for creating urban spaces that give information of the surroundings and attracts people, and will therefore be the basis of the design principles, which are introduced in chapter 08.

As seen in fig. 6.25 it is found, that the findings from test 1 (morphology) and test 2 (semiotic) are seen on the left side of the x-axis (where the light source is placed on the lower part of the staircase). Opposite, the findings from test 3 (phenomenology) are seen on the right side of the x-axis (where the light source is placed on the upper part of the staircase). The figure illustrates, that the higher the light source is placed on the staircase the more dark and sharp the shadow becomes. Hereby, it is found (according to test persons), that the staircase is easier to understand when the amount of light is greater than the amount of shadows. Additionally it is found, that the darker and sharper the shadows become on the staircase, people get more attracted to stay at the area for a longer period of time. The appearance of shadows are, according to the author, appealing as well.

Concluded is, that the morphology increases when the staircase is covered as little as possible by shadows. It is interpreted that people feel safer if the steps are clear and no obstacles can be hidden in the darkness of the shadow. With this in mind, the author takes the freedom to roughly equate morphology with semiotic, since the semiotic of the individual step is part of the overall perception of the staircase. According to the semiotic of the steps it is found, that the understanding of the individual steps increases when the balance between light and shadow is equal. Here, it is observed that the steps are emphasized when the vertical part of the step is in shade and the horizontal part is lit up. This is confirmed by Mende (2010), when he writes that our eyes follow shadows not light, and that shadows are the basis of our movement and behavior in a space. Additionally, the phenomenological approach to the staircase has given results that indicate that shadows are essential when attracting people. It is observed that the most popular settings (for both the author and the test persons) produce shadows that are sharp and dark. This is claimed by Tanizaki (2001) when he describes, that shadows are essential to "build up" spaces and a factor for creating beauty that appeal to human's mind.

If the three epistemes - *morphology*, *semiotics*, and *phenomenology* - are met, the author assumes that the human activity (*praxeology*) at a staircase increases as a result of intelligibility of the other epistemes.

Based on results from the test persons it is found, that there is no connection between whether the light source should be placed so that it simulate natural sun light or is subordinated. According to the author, as illustrated in fig. 6.26, the findings are mainly in the category which simulated natural light. Disagreement between author and test persons results in the fact, that it is secondary whether light is simulated as natural light or not. By this conclusion, it is rejected that simulated natural sun light appeals to people instinctively, and will not be taken into consideration in the following development of design principles.

7.1.6 Staircases as focus area

Findings from comparisons of experiment and test lead to the developing of two design principles, which are introduced in chapter 08. The principles will be about illumination on staircases and thereby achieve shadows, which emphasize the structure of the staircase and entails that the staircase is easy to read as well as attractive and inviting. Staircases - objects which are a part of structuring an urban space - become the focus in this thesis based on findings from the two analyses. The analyses are used as a tool to examine the general occurrence of shadows in urban spaces. Therefore, the two analyses are an essential part of this thesis' process, since they narrow down the focus, from observing shadows generally in urban spaces, to focusing on the perception of shadows on an simple object - in this thesis a *staircase*.

The further investigation is on human perception of shadows on staircases. Based on analyses, it is found that staircases can be used for both staying and for moving from A to B, and are therefore areas with several functions. Here, the interest of staircases arises due to the fact, that light and shadow have potential to support the use of staircases as an area where people move from A to B as well as an area to stay for a longer period of time. These findings on staircases are the focus point from the analyzed urban spaces, and therefore the analysis leads to the experimentation and testing of shadows on staircases.

The design principles (introduced in next chapter 08) are developed on the basis of staircases, where the four epistemes will optimize and increase the potentials of a staircase's several functions (walking and staying, which is found in the analyses). Thus, the epistemes are incorporated into the two design principles as examples of how to create light and shadow settings with the purpose of illuminating objects, that surrounds us in the urban space, and entails shadows that are informative as well as attractive and inviting.

ATHOR'S FINDINGS
(According to the author, all findings underneath
meet all four characteristics of the epistemes)

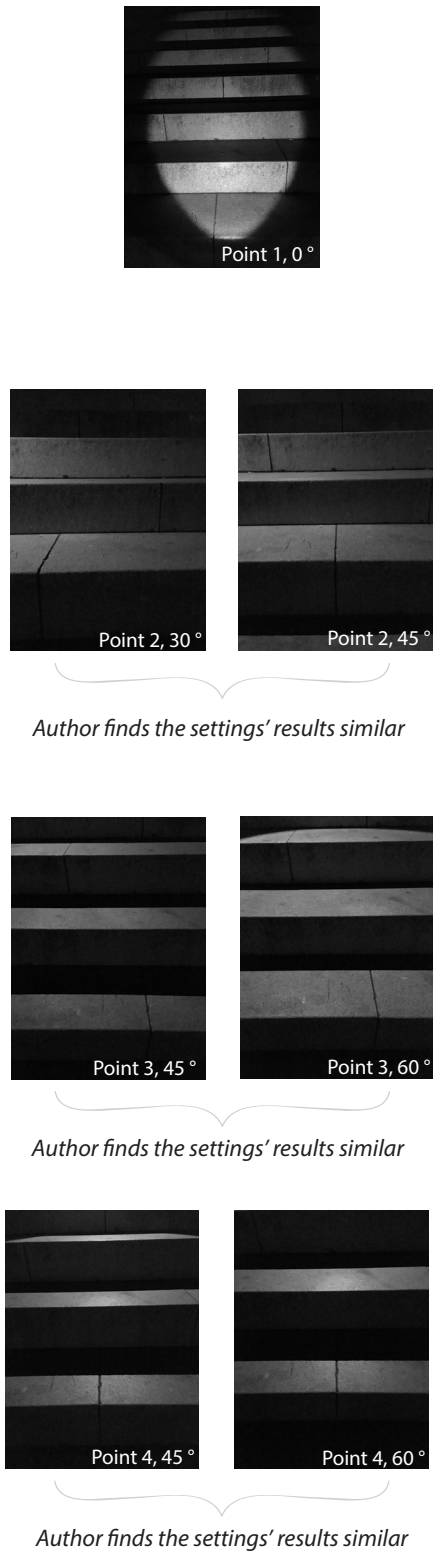


Fig. 7.1 - Sum up of the author's findings from experiment,
where the shadows are found most attractive and informative

TEST PERSONS' ANSWERS
(The results are divided into test 1 (morphology),
test 2 (semiotic), and test 3 (phenomenology))

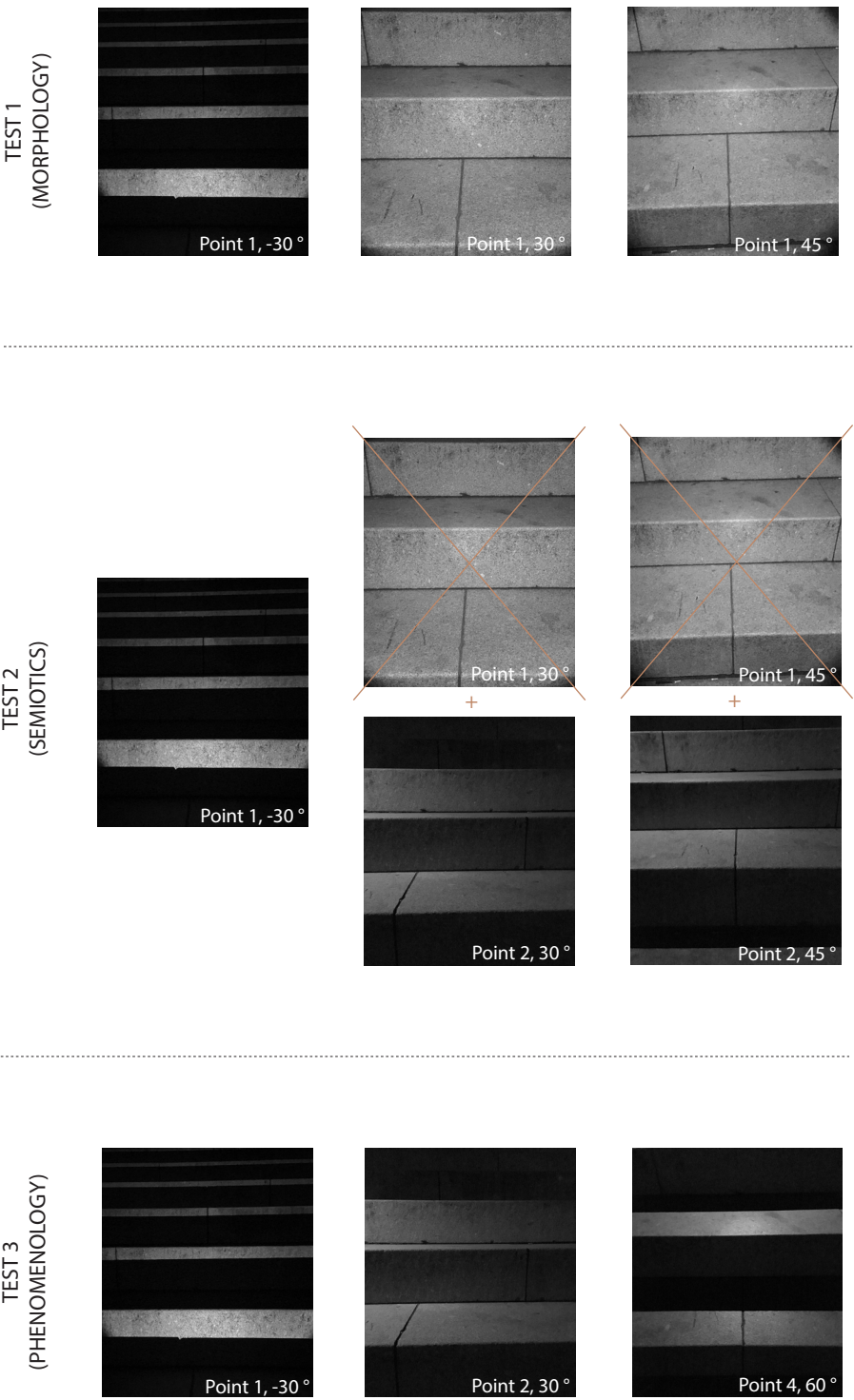




Fig. 7.2 - Sum up of the test persons most popular answers from questionnaire.
(Two photographs are crossed out in the illustration, since they are not used
for further investigation, see section 7.1.3)




DESIGN PRINCIPLES

08



The following chapter is introducing two design principles for designing with shadows in the urban space. The two design principles are developed based upon the discussion of the author's findings from the experiment compared to the results from the test, and from theory. The design principles are examples of how to illuminate objects in the urban space based on the investigations of shadows achieved in experiment and test. The two design principles will meet the four epistemes. Thereby, the *methodology of epistemes* is used to increase the understating of shadow's significance in the urban space.

Design principle 1 is meeting the epistemes *morphology* and *semiotics*, which leads to an increase of *praxeology*. Design principle 2's aim is to attract people's feelings (*phenomenology*), which also causes an increasing of the episteme *praxeology*.



8.1 FRAME OF THE DESIGN PRINCIPLES

The design principles are focusing on the phenomenon *shadow*, and how this can increase peoples perception, attraction, and feelings. This is based upon focusing on use of an urban space by incorporating *shadow* as a design quality. The author's purpose of the design principles is to accommodate the Japanese culture and architecture's philosophy where beauty depends on the use and variation of shadows within a space. According to Mende (2010) and Tanizaki (2001), the Western culture has to be introduced to include shadows as a unique design quality. This should be implemented to increase human's understanding of light itself since light is only perceived by having a shadow, and that shadow does not exist without light. Based on knowledge from theory and findings from experiment and test, two design principles dealing with shadows are developed. The design principles are elaborated in the following section. They are within the focus of illumination on staircases to generate shadows that are appealing to people by being attractive and increase usability by emphasizing the structure of the staircase. The intention is that the principles, which in this case is based upon staircases, further can be applied to other objects within the urban space and in small as well as big perspectives.

The first design principle will meet the epistemes of *morphology* and *semiotic*, and how a staircase is easiest to "read" and therefore understandable for people to facilitate their movements. The author assumes that if the mentioned epistemes are enhanced it will increase the *praxeology*. The principle of structure and movement is elaborated in section 8.1.1

The second design principle deals with the attraction of people to a certain space. In this case, it is a staircase that is used as a hang-out spot, as the use of the staircase at Israels Plads (where the experiment is performed is like this). Thereby, the second principle focuses on attracting people with a *phenomenological* approach which appeals to what people are drawing attention to and find beautiful. This principle of attraction and invitation is elaborated in section 8.1.2.



Fig. 8.1 - Photograph of cast shadows from steps of the staircase at Israels Plads

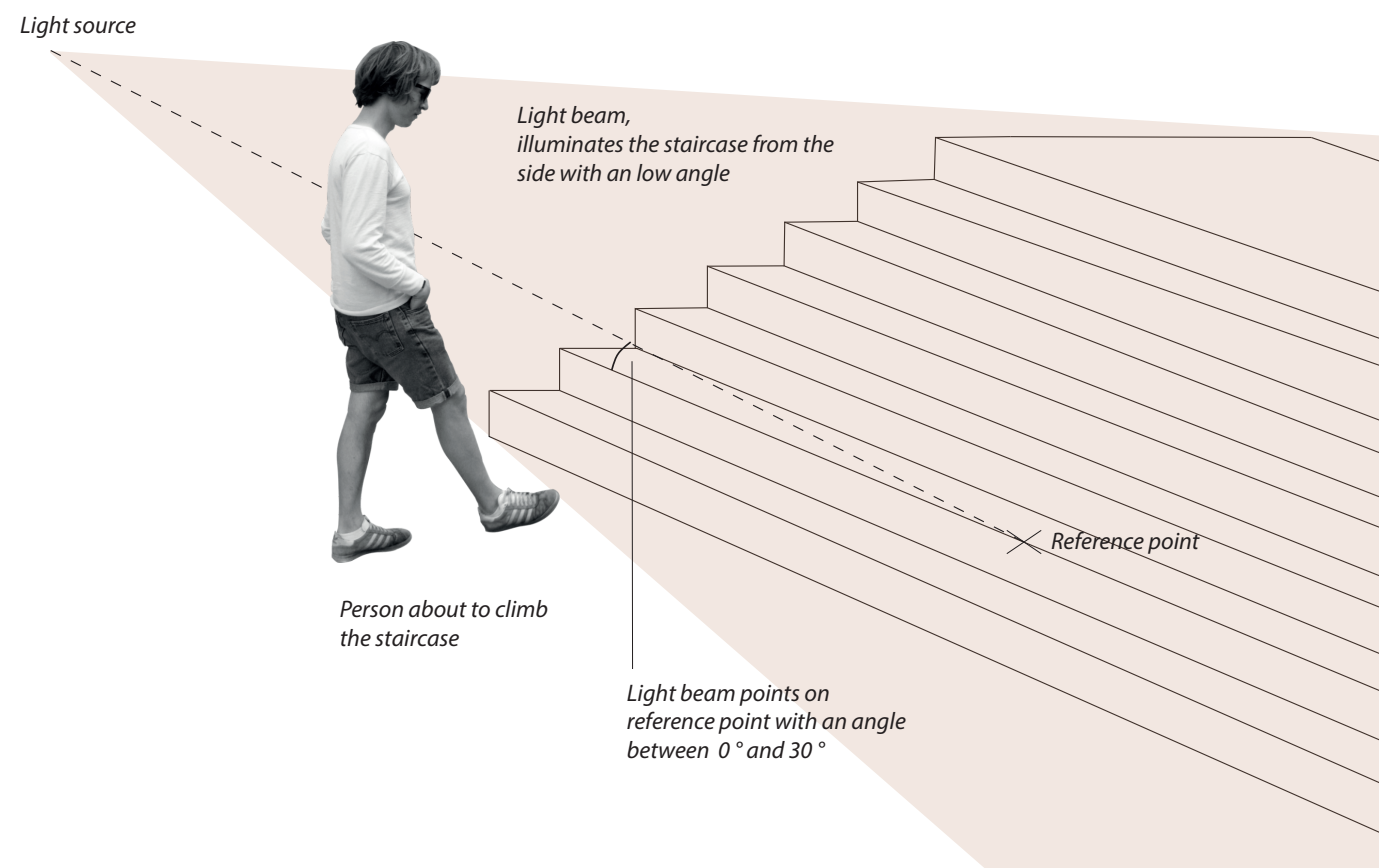


Fig. 8.2 - Conceptually illustration of design principle 1

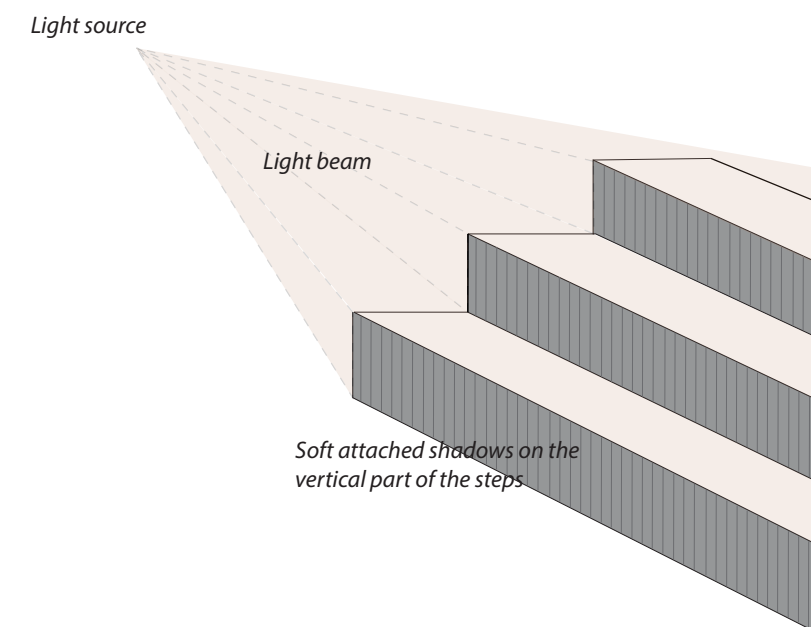


Fig. 8.3 - Detailed section of design principle 1 with light and shadows on the staircase

8.1.1 Design principle 1 - Structure and usability

Design principle 1 is developed on basis of findings from the discussion (chapter 07) which is supported by theory. The aim of design principle 1 is to increase usability by emphasizing the structure of a staircase and hereby the individual steps. Hereby, the two epistemes *morphology* and *semiotic* are met. Moreover, the author assumes as mentioned beforehand that the human activity (*praxeology*) of a staircase increases as a result of intelligibility of the two mentioned epistemes.

The design principle is conceptually illustrated in fig. 8.2, where a staircase is illuminated from the side - so that the light falls along the steps. Furthermore, the light source is placed so that the light beam illuminates the staircase with a low angle between 0° and 30°. This light setting produces soft attached shadows at the vertical part of the steps, as shown in a detail illustration in fig. 8.3. This emphasizes the height and depth of the steps. The soft shadows will not feel dominant but still create a light/shadow pattern, that Tanizaki (2001) states as something that is essential to "build up" spaces and to give the space depth and beauty. The less dominated shadows will accommodate results from the test, where it is observed that an overview of a staircase increases if no dark shadows would hide potential obstacles. In addition to this, it is found that the semiotics of the individual steps is better understood if contrasts are created based on light and shadow settings. The importance of the occurrence of contrasts is substantiated by Cullen (1961), who states that the human mind reacts to contrasts, and thereby an urban space becomes easier to read.

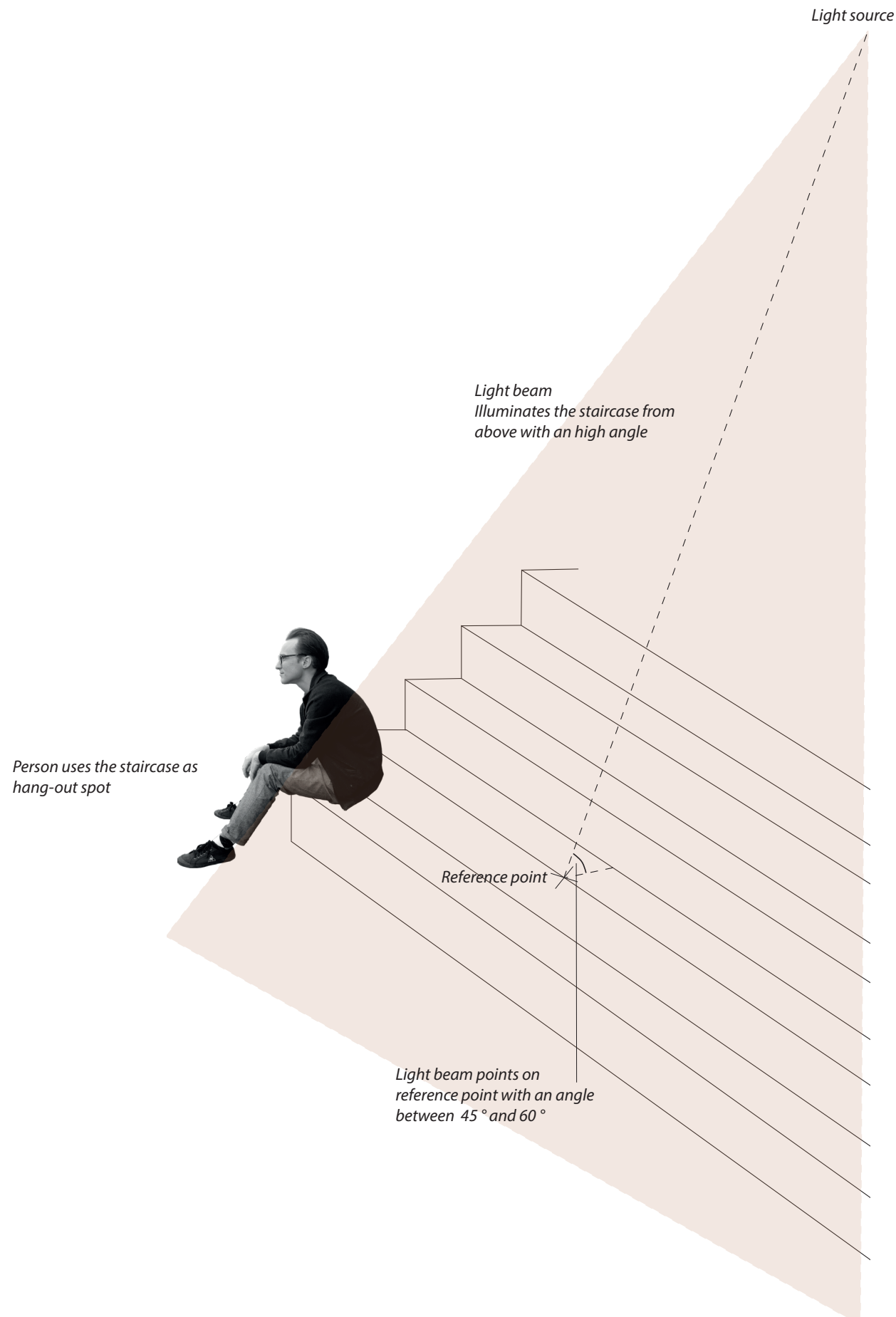


Fig. 8.4 - Conceptually illustration of design principle 2

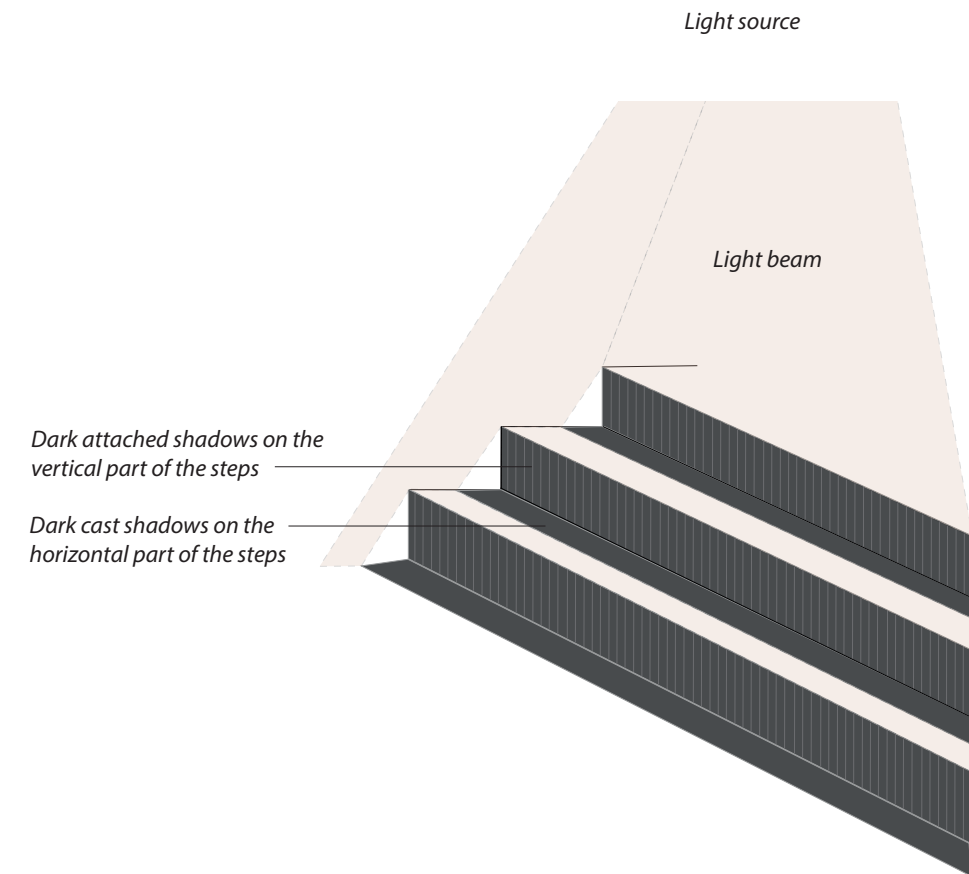


Fig. 8.5 - Detailed section of design principle 2 with light and shadows on the staircase

8.1.2 Design principle 2 - Attractive and inviting

Design principle 2 is developed on basis of findings from the discussion (chapter 07) which is supported by theory. The outcome of design principle 2, is to emphasize affiliation to a space by attracting and inviting people by the use of light and shadows. According to Mende (2010) and Tanizaki (2001), people are more drawn to the patterns of light and shadows that objects creates, than to the object itself. This statement is consistent with the results from the test, where it is found that people are attracted to dark and sharp shadows casted by the steps. Thereby design principle 2, which is conceptually illustrated in fig. 8.4, illuminates a staircase from above, with an high angle between 45° and 60° . This light settings is producing dark and sharp attached shadows on the vertical part of the step and dark and sharp cast shadows on the horizontal part of the step, which is illustrated in fig. 8.5. Interpreted from the test result, significant shadows appeal to people's mind and feelings and therefore attract them to stay in a space for a longer period of time. This is confirmed by Tanizaki (2001), who states that shadows appeal to what people find relaxing, because they create pauses to our eyes when they wander through a space, and thereby contributes positively to people's impression. Therefore, design principle 2 works with the *phenomenology* of the space, since it creates distinctive shadows that attract the eye by creating continuous and relaxing patterns. As well Mende (2010) confirms this, when he states that the appearance of the relation between light and shadow appeal to an elegant and entraining feeling for the viewers. The author assumes that when the design principle attract people's perception and experience by entertain them, it will cause an increase of human activity and thereby meet the episteme of praxeology.

For design principle 2, it is decided that illumination from an angle of -30° pointed from the bottom of the staircase is inexpedient, even though this light setting was popular among the test persons as well and create significant shadow patterns. The problem with this setting is though, that an illumination with this angle will dazzle people due to bright light coming from below.



Fig. 8.6 - Photograph of a pattern of light and a cast shadow from an object - a railing - in a urban space in Rome

8.2 SUM UP OF DESIGN PRINCIPLES

The two design principles: Design principle 1 - structure and usability and Design principle 2 - attractive and inviting, are examples of designing with shadows on objects. In this case the light and shadow examples are developed on an object - a staircase. Staircases are one object among others that built up the urban spaces which people are acting in. The two design principles give examples of illumination of the steps of a staircase to produce shadows that both increase the usability and attract and invite people to stay for a longer period of time at the certain space.

Design principle 1 is aimed at staircases where people are moving - both in high and low speed. The light and shadow setting which is developed in design principle 1 contributes to the understanding of the staircase by emphasizing the individual steps. Because the perception of the staircase and its steps are easy to "read", and thereby the epistemes morphology and semiotic are met, people can walk at the staircase without difficulty. When people are aware of the structure of the staircase the activity on the staircase will be increased, and the episteme praxeology is met.

Design principle 2 is intended for staircases where people would sit and, walk slowly and thereby stay for a longer period of time. The light and shadow setting that is developed in design principle 2 contributes to drawing people's eye by appealing to their minds when the light produces shadows that a visually attractive. Because the light and shadow setting attracts people's feelings and emotions (phenomenology) people are invited to use the space diligently. When the light and shadow setting increases the use of the space, the episteme praxeology is met.

The two design principles of light and shadow contribute to a more appealing experience of an urban space. Together the two design principles increase the quality and hereby meet people's need of a beautiful and involving feeling of the certain space. This will furthermore increase the human activity in the urban space.

It is intended that the two design principles should act as inspiration to illuminate other objects - both large and smaller objects - within the urban space and thereby achieve a city which is increasingly designed for people. When people perceive an urban space as understandable, it will accommodate the usability, and at the same time be attractive by appealing to their eyes and mind. When people's feelings are incorporated in the design of an urban space (eg. by creating appealing shadows), it will entail that people are attracted and thereof get an affiliation to the space. This will further entail that the space feels inviting and contributes to increase an human activity in the city itself.



OUTRO

09

9.1 CONCLUSION

This thesis has investigated the occurrence of shadows by objects in the urban space and the human perception of these. It is found that shadows create contrasts that appeal to human's eye and mind, because it generate pauses when our gaze wanders through a urban space. Pauses, created by patterns of light and shadows, is what we find relaxing and attractive. This cause we get a closer relation to a space and therefore the human activity within the urban spaces is increased.

The two analyzes of Piazza di Spagna and Israels Plads found, that experience of the spaces depending on the appearances and perception of shadows. Cast shadows from objects that are structuring the urban spaces has a big influence of how the spaces are experienced. Both airy shadows from trees and sharp dark shadows from dead objects attracts the author's eye. Thereby it is seen that cast shadows divide spaces into smaller parts which give a better overview as the eye rest in the presence of shadows. Likewise, the light and shadows create patterns, both large and small, that attracts the eyes and mind. Furthermore, it is observed that a lot of human activity orbiting the staircases (used as hang-out spots) that are presented in both urban spaces. This is leading to the experimentation and testing of perception of shadows on a staircase at Israels Plads.

Experiment and testing is performed to answer the problem statement, which is repeated here:

By focusing on designing with shadows the perception of a staircase structure can be more useable and attractive and thereby increase the use of urban spaces.

Concluded on findings from experiment and tests are, to accommodate an understandable *structure* and thereby get a more *useable* staircase, it has to be illuminated so that the staircase is minimally covered by shadows. Shadows still has to be presented to highlight the height and depth of the individual steps, which is meet when the illumination is pointed from the side of the staircase from an low angle between 0 ° and 30 °.

Furthermore it is found, that to *attract* people to the staircase and further to *increase the use* of a urban space in general, the staircase has to be illuminated so that sharp and dark shadows appear. Appealing to human's eye and mind require light and shadow patterns, which achieves by illuminate a staircase from above by an high angle between 45 ° and 60 °.

Light and shadow scenarios are essential qualities to optimize the involvement of people into a design of a urban space. A priority of focusing on designing with shadows will strengthens the relationship between humans and urban spaces. The thesis envision that by bring together human and nature (symbolized by light and shadows) within urban spaces, the perception of spaces will become more attractive and thereby increase the use of them.

9.2 REFLECTION

Methodological reflections

By working with the methodology of epistemes it is the senses and feelings that are focus for approaching a design process. It is the senses that have been used to obtain a realization of phenomena. This methodological approach is chosen to accommodate humans as being a part of urban space as much as the phenomena (objects) that create the space. When working with the idea of the senses as the basis for experiencing and thereby designing, it is important to keep in mind that the epistemes which are worked with are ones that the author has chosen to present. These chosen epistemes emphasize certain layers to experience a space, thereby others are excluded.

Further work

A way to further works the proposals of design principles, is to transform their basic ideas of creating informative and appealing shadows, into other contexts in the city where people are acting. It could be experienced and tested on other objects that people approach, as benches, paths etc., or in a bigger context like creating identity and connections in larger urban areas by improving the appearance of shadows.

FIGURE CREDIT

All figures are produced by the author of the thesis unless stated below.

- Fig. 2.1: On basis of Matt Fajkus and Dason Whitsett’s theory (Fajkus & Whitsett, 2018)
- Fig 2.2: On basis of Piotr Sadowski’s theory (Sadowski, 2017)
- Fig. 2.5: On basis of Sophus Frandsen’s theory (Frandsen, 1984)
- Fig. 3.2: On basis of James P. Spradleys theory (Spradley, 1980)
- Fig. 3.4: On basis of Hans Loidl and Stefan Bernard’s theory (Loidl & Bernard, 2014)
- Fig. 4.1: On basis of Google Maps
- Fig. 4.3: On basis of James P. Spradleys theory (Spradley, 1980)
- Fig. 4.5: On basis of Google Maps
- Fig. 4.7: On basis of Google Maps
- Fig. 4.9: On basis of Google Maps
- Fig. 4.11: On basis of James P. Spradleys theory (Spradley, 1980)
- Fig. 4.13: On basis of Google Maps
- Fig. 4.15: On basis of Google Maps

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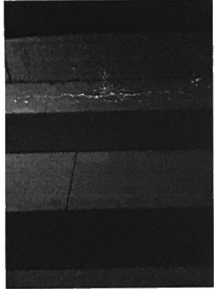
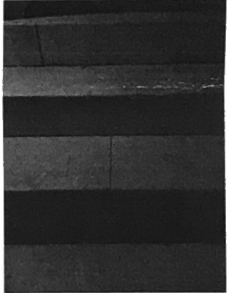


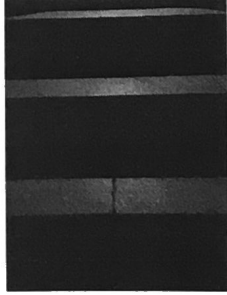


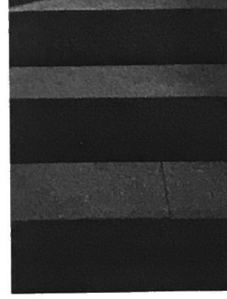
APPENDIX A - EXAMPLE OF QUESTIONNAIRE FROM TEST

Name: JOSEPHINE
Age: 27

The photos are showing a section of a staircase at Israels Plads in Copenhagen.

Imagine standing in front of the staircase and you are about to climb it.
On which of the following scenarios would you feel most comfortable when climbing the steps?

Rate the photos underneath on a scale from 1-4
(1 - dislike, 4 - like)



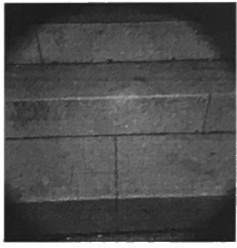





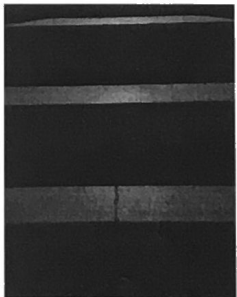

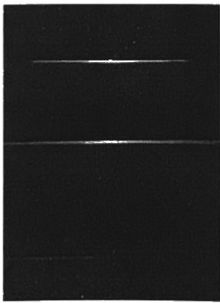
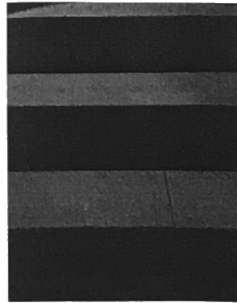
Scenario 1	Scenario 2	Scenario 3
 <div>4</div>	 <div>4</div>	 <div>4</div>
 <div>3</div>	 <div>3</div>	 <div>3</div>
 <div>2</div>	 <div>2</div>	 <div>1</div>
 <div>1</div>	 <div>1</div>	 <div>2</div>

Name:
Age:

The photos are showing a section of a staircase at Israels Plads in Copenhagen.

Imagine standing in front of the staircase and you are about to climb it.
On which of the following scenarios do you find it easiest to understand the structure of the steps?
(The height of the steps, the length of the steps etc.)

Rate the photos underneath on a scale from 1-4
(1 - dislike, 4 - like)

Scenario 1	Scenario 2	Scenario 3
 <div>3</div>	 <div>4</div>	 <div>4</div>
 <div>4</div>	 <div>3</div>	 <div>3</div>
 <div>1</div>	 <div>2</div>	 <div>1</div>
 <div>2</div>	 <div>1</div>	 <div>2</div>

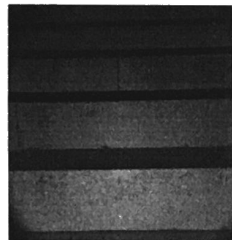
Name:
Age:

The photos are showing a section of a staircase at Israels Plads in Copenhagen.

Imagine you are out with your friends and are having a break.
On which of the following scenarios would you stay for a longer time?

Rate the photos underneath on a scale from 1-4
(1 - dislike, 4 - like)

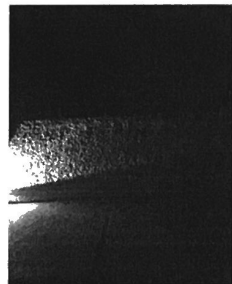
Scenario 1



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Scenario 2



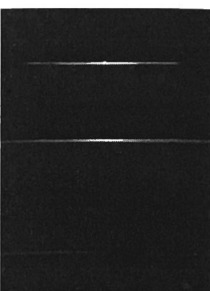
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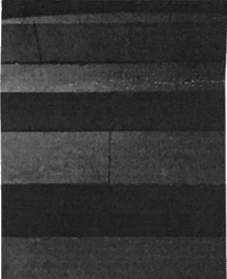


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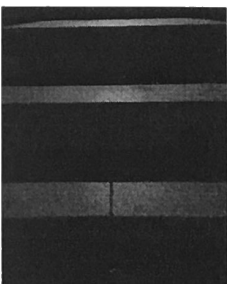
Scenario 3



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