

ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SOCIAL SCIENCES

LIGHT'S IMPACT ON PEOPLE'S PERCEPTION IN INTERIORS

M.Sc. THESIS

Hatice Bürde GÜLTEKİN

Institute of Social Sciences

**International Master of Interior Architectural Design
Programme**

Tez Danışmanı: Prof. Dr. Alpin KÖKNEL YENER

MAY 2014

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To my family,

FOREWORD

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ABBREVIATIONS

IES : Illuminating Engineering Societies

IESNA : Illuminating Engineering Society of North America

EN : Europäische Norm

CIE : International Commision on Illumination

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LIGHT'S IMPACT ON PEOPLE'S PERCEPTION IN INTERIORS

SUMMARY

There is no doubt that light enables not only making interior spaces brighter, but also helps people to experience the space. Lighting design is an art and a technical phenomenon affecting physical and mental health of humans. The aim of the thesis is observing light's impact on perception of people in interior spaces. Light activates sense of sight and enhances the atmosphere of a space. Also, it shapes the space by intensifying the poetic and emotional impact of place. In other words lighting design of an interior should be satisfactory for both functional and psychological perception.

On section 1. *Introduction*, problem definition, aim and content of the thesis is explained.

On section 2. *Perception of Space and Light*, difference between space - place and perceptual space is investigated through definitions underlining the fact that perception and interpretation of space is an important part of space and interior space definitions. Perceptual requirements of occupants in a luminous interior are explained on the next step. Psychological expectations from a visual environment, lighting requirements to visually perceive and evaluate visual information are defined.

Daylight enhances the atmosphere of the space. On section 3. *Perception of Daylit Interiors*, how spatial atmosphere of an interior space shaped with daylight affects people's psychology is investigated through several examples. First, impact of daylight on perception of variation, colour sensation, shadow creation and darkness - brightness contradiction is explained with examples. Then, daylight penetration through the openings and distribution in the space depending the materials are explained.

On section 4. *Perception of Artificially Lit Interiors*, first of all qualities of artificial light that have impact on perception are investigated. Section 4.1. *Impacts of*

artificial light qualities on perception; reveals research on physical qualities such as quantity of light, direction and spatial distribution of light, degrees of brightness contrast that are used by designers to manipulate spatial perception. Associations of colours related to several cultural and social influences as well as universal acceptances are underlined. Colour rendering ability and colour of light sources have also been explained. On 4.2. *Perception oriented artificial lighting*, ways of using pre - explained physical qualities of light - such as quantity, direction, distribution and luminance difference- to manipulate perception of space are explained with several theories of lighting design professionals like Flynn and Kelly. Degrees of excitement (environmental load approach), fundamental concepts of light and lighting patterns that are changed to manipulate subjective impressions of people are described.

On section 5. *Perception of Interiors with Daylight and Artificial Light Integration*, spatial perception in association with both artificial light and daylight is investigated on four different building typologies. Relationship of light with perceived spatial qualities and experienced spatial atmosphere are observed in two different groups : *Function oriented interiors* and *Atmosphere oriented interiors*. These interiors are visited on site and observed according to the qualities explained on section 3. *Perception of daylight interiors* and section 4. *Perception of artificially lit Interiors*.

On section 6. *Experimenting Lighting Design Proposals for a Conceptual Spiritual Contemplation Room*, the theoretical information explained on the previous sections are experimented. Concept of a spiritual contemplation room is decided because of the fact that most of the perception oriented interiors shaped with light on the previous sections were spiritual spaces. The thesis study is done under supervision of Nimbus Group located in Stuttgart, Germany. The room where the experiments are realized is selected under supervision of the company. Results are described under two subtitles as *Daylight experiments* and *Artificial light experiments*.

On section 7. *Conclusion*, assumptions and outcomes derived from the whole study is explained.

Keywords : Perception, Light, Interior, Daylight, Artificial Light, Subjective impression

İÇ MEKANDA IŞIĞIN İNSAN ALGISI ÜZERİNDEKİ ETKİSİ

ÖZET

Işık iç mekanları aydınlattığı gibi insanın mekanı deneyimlemesine imkan sunar. Aydınlatma tasarımı hem bir sanat hem de teknik fenomen olarak insanın fiziksel ve ruhsal sağlığını etkilemektedir. Bu tez çalışması insanın iç mekan algısı üzerinde ışığın etkisini incelemeyi amaçlamaktadır. Işık ile görme duyusu devreye girer ve aynı zamanda bir mekanın atmosferini geliştirir. Ayrıca, mekanın barındırdığı şiirsel ve duygusal etkiyi yoğunlaştırarak şekillendirir. Diğer bir deyişle, iç mekan aydınlatması hem işlevsel hem de psikolojik algıyı tatmin etmelidir.

1. Giriş bölümünde tezin amacı, kapsam ve yöntemi açıklanmıştır.

2. Mekan ve Işık Algısı bölümünde, mekan - yer ve algılanan mekan arasındaki fark tanımlar üzerinden incelenmiş; mekanın algılanması ve yorumlanmasının mekan ve iç mekan tanımlarının önemli bir parçası olduğu vurgulanmıştır. Sonraki adımda, aydınlık bir iç mekanda kişilerin ihtiyaç duydukları algısal gereksinimler açıklanmıştır. İnsanın bir mekandan beklediği psikolojik ihtiyaçlar, görsel algılamayı ve yorumlamayı mümkün kılan aydınlatma gereksinimleri tanımlanmıştır.

Bölüm 3. *Güneşiği ile Aydınlatılmış İç Mekanların Algısı*, güneşiği ile şekillenen iç mekanın insanların psikolojisini nasıl etkilediğini örnekler üzerinden açıklamaktadır. Öncelikle, güneşiğinin özgün niteliklerinin mekanda yarattığı çeşitlilik, renk değişimleri, gölgeler ve aydınlık karanlık karşıtlığının algısı örnekler ile açıklanmıştır. Sonra, güneşiğinin açıklıklardan mekana alınması ve malzemelerle ilişkisinin mekansal algı üzerindeki etkileri açıklanmıştır.

Bölüm 4. *Yapay Aydınlatma ile Aydınlatılmış İç Mekanların Algısı*, yapay aydınlatmanın insan algısı üzerindeki etkisini açıklamaktadır. Öncelikle, 4.1. *Yapay aydınlatmanın fiziksel özelliklerinin algı üzerindeki etkisi* bölümünde ışık miktarı, yönü ve ışığın mekansal dağılımı gibi fiziksel nitelikleri üzerine araştırmalar ortaya konmaktadır. Ayrıca, renk konusuna değinilmiş, çeşitli kültürel sosyal ve evrensel kabullere ilişkin bilgi verilmiştir. Aydınlatma elemanlarının renk oluşturma yeteneği ve ışık kaynaklarının rengi de bu bölümde açıklanmıştır. 4.2. *Algı odaklı yapay aydınlatma* bölümünde, bir önceki bölümde açıklanmış olan ışığın fiziksel özellikleri - ışık miktarı, yönü, dağılımı ve ışığın parıltı farklılıkları gibi - tasarımcılar tarafından mekan algısını değiştirmek için kullanılması, Flynn ve Kelly gibi aydınlatma tasarımı profesyonelleri tarafından ortaya atılan çeşitli teoriler üzerinden açıklanmıştır. Uyarım dereceleri (mekansal yük yaklaşımı), temel aydınlatma konseptleri ve görsel uyarının kişiler üzerindeki etkisini / kişilerin subjektif izlenimlerini değiştirmek için ışığın temel kavramları kullanılarak oluşturulmuş bir takım modeller açıklanmıştır.

Bölüm, 5. *Günüşiği ve Yapay Işığın Bütünleştirildiği Mekanların Algısı*, mekansal algının dört farklı bina tipolojisi üzerinden araştırılmasını içermektedir. Işık ve algılanan mekan arasındaki ilişki *İşlev odaklı* ve *Atmosfer odaklı* mekanlar alt başlıkları altında özetlenmiştir. Tüm mekanlar ziyaret edilmiş ve bölüm 3. *Günüşiği ile Aydınlatılmış İç Mekanların Algısı* ve bölüm 4. *Yapay Aydınlatma ile Aydınlatılmış İç Mekanların Algısı* bölümlerinde açıklanan özelliklere göre incelenmiştir.

6. *Ruhani Bir Tefekkür (düşünceye dalma) Odasının Aydınlatma Önerileri Üzerine Deneyler* bölümünde, önceki bölümlerde açıklanmış, teorik bilgiler deneyler yapılarak test edilmiştir. Teorik araştırmanın uygulamasının bir ruhani tefekkür odası üzerinden yapılma sebebi araştırma sırasında incelenen mekanların büyük çoğunluğunun spiritüel mekanlar olmasıdır. Tez çalışması Nimbus Group GmbH gözetiminde Stuttgart, Almanya’da yapılmıştır. Deneylerin gerçekleştirildiği mekan şirketin gözetiminde seçilmiştir. Deneylerin sonuçları *Günüşiği deneyleri* ve *Yapay ışık deneyleri* olarak iki başlık altında açıklanmıştır.

Bölüm 7 . Sonuç bölümünde, bütün çalışmadan türetilmiş sonuçlar açıklanmıştır.

Anahtar Kelimeler : Algı, Işık, Günüşiği, Yapay Aydınlatma, Subjektif İzlenimler

1. INTRODUCTION

1.1. Problem definition

Distribution of light values spatial qualities of the spaces such as shape texture and color which are vital for spatial experience. However, most of the lighting research in interiors is based on quantities of light such as illuminance and colour temperature while there are few studies on relationship between light and spatial perception of people.

Light and perception are the main focus of this research. Perception is both a visual and a psychological process strongly associated with seeing and giving meaning to a space. Interior space is experienced by people visually and psychologically. First, people see and perceive the space visually. Then, visually perceived information is interpreted psychologically by being correlated with past experiences, social and cultural values.

In this study term of perception is related to perception of people in interiors. In the light of information derived from the research on space and perception, the concept of perception is divided into three main sections. The main questions of the research are defined as :

- How light affects the visual perception of an interior?
- How light affects the visually perceived qualities of an interior (such as size, shape, depth and distance etc.) and spatial qualities (such as materials, color etc) of interiors?
- How light affects people's psychological perception of interiors?

1.2. Aim and development

The questions that the thesis research deals with are derived from both practical experience in a lighting design company and from the observations of different building typologies during the research. It was realised that most of the lighting design scenarios are based on physical qualities of light such as illuminance and colour temperature while there are few studies on relationship between light and spatial perception of people. The aim of the thesis is observing light's

impact on visual and psychological perception of people in interiors. Figure 1.1 explains development process of the thesis research step by step.

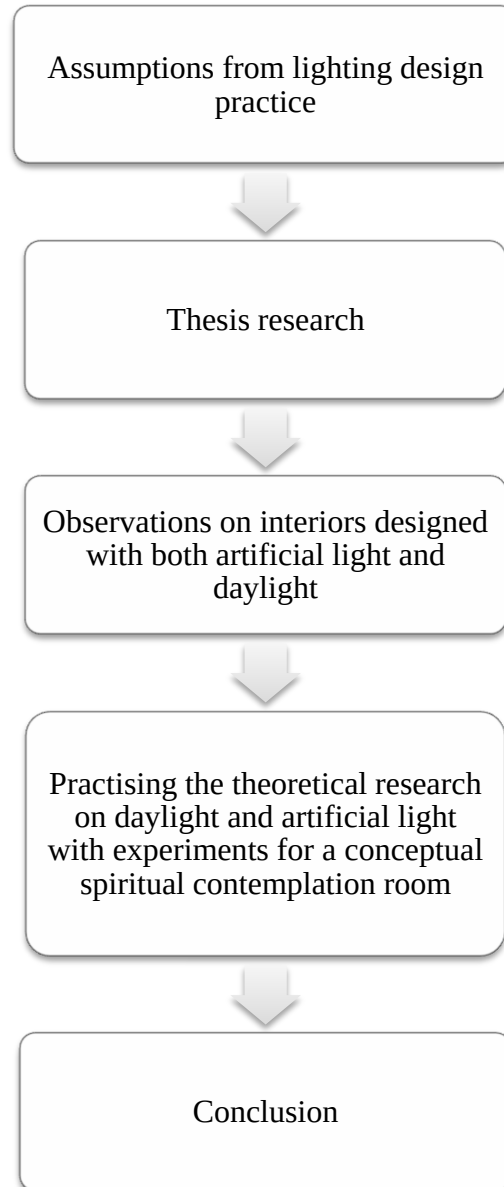


Figure 1.1 : Analysis process (Gültekin, 2014).

1.3. Content

The thesis is composed of seven sections. On the first four sections, research related to the topic is explained. First section is composed of introduction. On second section, affect of light and perception on people and space are investigated through definitions. On section three and four, impact of light on perception is observed separately for daylight and artificial light through examples.

On fifth section four interiors designed with both artificial light and daylight are investigated under two subtitles : Function oriented interiors and Atmosphere oriented interiors. For each building, relationships between light and perceived spatial qualities and experienced spatial atmosphere is observed.

On sixth section, in order to practice the theoretical information, possible lighting situations of a Spiritual Contemplation Room is experimented according to the assumptions derived from research. Choice of observing lighting situations of a Spiritual Contemplation Room is preferred because of numerous spiritual interiors observed through examples on theoretical sections. As mentioned before, the thesis is written under supervision of Nimbus Group GmbH , located in Stuttgart, Germany. Location of the room in which the experiments are done is located in showroom of the company. The conceptual Spiritual Contemplation Room was supposed to be used by the employee of the company. Experiments are collected under two subtitles as *Daylight experiments* and *Artificial light experiments*.

On the seventh section, conclusion and outcomes derived from the whole study is explained.

1.4. Methodology

For the research, visual, digital and analog information were used. Literature have been investigated through written books, papers, journals, lighting design magazines, previous thesis studies written about related topics and webpages related to architecture. Also, theoretical information learned and the information concluded from the lighting design projects worked on during office work have been noteworthy on problem definition.

For the experiments on section five, a 1/10 physical scaled model is made manually. Several LED product, lenses and converters are used to create scenes. Technical support have been provided by the company employees.

2. PERCEPTION of SPACE and LIGHT

2.1. Space - place and perceptual space:

Perception is the understanding of the data acquisition process which include stimulation of senses and mental processes. In other words, it is the process of obtaining information about the environment at the point where the mind and the truth meet (Lang, 1974). Visual perception is the conclusion of the complex interaction of physical and social factors. Perception affects behavior and later behavior affects perception. A simple model of the human visual perception process is explained on Figure 2.1.

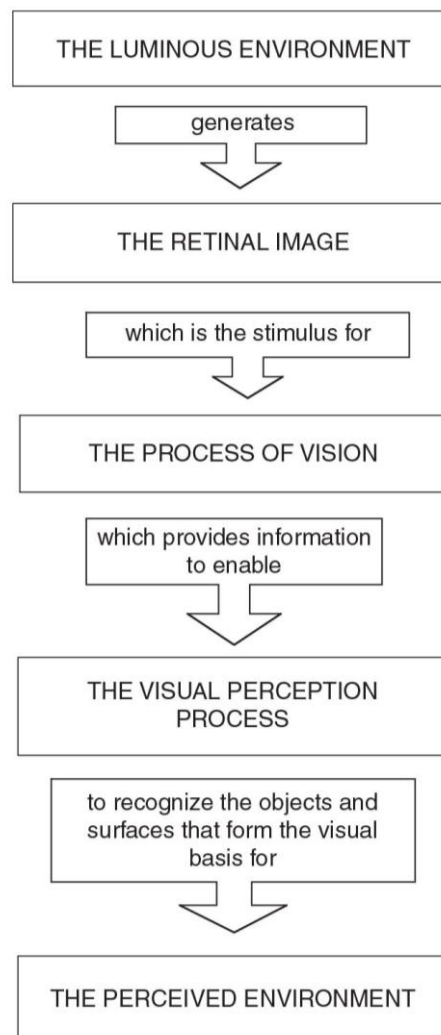


Figure 2.1 : A simple model of the human visual perception process
(Cuttle, C., 2003, p.18).

Space can be described in several ways. It represents the physical space, which is a spatial unit restricted by walls and ceiling. It can also represent an experienced space which is not restricted by walls or ceiling, but still can be perceived as a substantial spatial unit.

Differences in the elements that restrict space create a distinction between architectural space and natural space. When these elements are ; walls, ceilings, floors, columns, beams, the space is called "architectural space". If these elements are ; earth, sky, horizon, bushes, trees and clouds, the space is called "natural space" (Altan, I. , 1993). To be able to define interior space properly, architectural space should be defined, because interior space is a part of architectural space. On the basis of these two different approaches of Altan, it can be concluded that definition of the interior space takes part in definition of architectural space.

According to Schulz, space definitions can be divided into two main groups. The first group is related to three dimensional geometrical space while the other group is related to perceptual space which is based on observation and personal experience (Schulz, C. N., 1971). In other words, space and perception are strongly related to each other.

Geometric space is objective. It can be measured and determined through the geometric concepts. Moreover, it integrates the person with the nature and completes the person with the natural organic environment. Geometric space which determines the person's physical activity, is strengthened by light and movement (Schulz, C. N., 1971).

Perceptual space is subjective. It can be observed and detected by the person who lives in it. These spaces vary according to the person covered by the senses and they are detected in the mind of the person depending on the time. Component of light which gives the third dimension to the spaces, is an element of the perceptual space. The perception of the space varies according to the quality, direction and quantity of light (Schulz, C. N., 1971).

Schulz also mentions a term called "genious loci" (spirit of the place) which is the space beyond the notion of the term "place". The term "genious loci", corresponds the unique spatial properties of space which reflects its spirit. In other words, the

space becomes “place” with the "soul" the space has (G. Jive'n & P. J. Larkham, 2003).

Trancik defines space as “ a place which has several physical connections for a limited purpose”. According to him, when a cultural or a regional context is added to the space, it becomes “place”. Place includes location, physical, cultural and humanitarian character of the space. Place should also include spatial qualities such as material, shape, texture, color and light as well as the cultural characteristics (Trancik, R., 1986).

According to Joedicke space can be described by two opposing concepts: mass and space. Thus, if elements limiting a space are walls, ceiling, flooring etc. the space is called as interior space-closed space. If elements limiting a space are trees, clouds and horizon, this place could be called the outer space-open space. Full items and hollow blocks are distinctive features while seperating exteriors and interiors. Joedicke also states that the most important contrast between interior and exterior is light (Joedicke, J. 1985).

Concept of space includes more than geometric and perceptual space. Geometric space is objective, but it reflects the spirit of the space to people. Perceptual space is subjective. Therefore, it varies depending on time and person. With the consideration of these two spaces as a whole, we can reach to the existential space. When the person interacts with the space, the perceptible spaces become discrete spaces. The process that began with the perception of architectural space can be re-configured in the minds of the person and reached the existential space that contains political, social, cultural, symbolic and semantic experiences. Architectural space is a state of existential space (Schulz, C. N., 1971).

Kuban supports Schulz`s definitions of space in his book ; "Mimarlık Kavramları, Tarihsel Perspektif İçinde Mimarlığın Kuramsal Sözlüğüne Giriş". According to him, an architectural space must contain the formal and the characteristics of human life together and a space can exist with action and light. Therefore, the space needs to be addressed with this definition states (Kuban, D., 2010).

Based on these lines, the space could not be taken as just one physical space without light and people. Human factor is converting a space into a place. Man, senses the space, communicates with it and gives a meaning to it. So, place can be defined as a

social space formed with human interaction while the space / interior space has a more architectural meaning. Man's perception and interpretation of space is an important part of the space and interior space definitions. That's why how the spatial perception occurs and affects occupants' experience of the space/place should be examined.

2.2. Spatial Perception - Spatial Experience:

When the question of how one feels in a space and how it affects him, the question of 'how do people perceive the space' comes into the mind. Cüceloğlu states that the relationship between space and human is established by perception (Cüceloğlu, D., 2000). The relationship between architectural environment and human takes place by sending messages from environmental components to the person. Then, the person receives these messages perceives them (Erkman, 1973).

Perception occurs by receiving information from the environment. The information, the person receives helps him to transform it correctly to the action. And also, it helps for the interpretation and evaluation process. In other words, spatial experience can be thought as interpretations of perception. According to Lindh, spatial experience includes, " issues related to space as in spatiality, spatial enclosure, the quality of being surrounded by spatial boundaries, as in the case of vertical walls in a space, the experience of a tangible, clearly defined space". Spatial enclosure addresses to " the experience of a spatial extension and the feeling of being surrounded, like being inside a spatial unit and, as a result, safety " (Lindh, 2012).

In the light of these definitions it can be claimed that the concept of spatial perception is used to describe:

- How we see or visually perceive spaces,
- Understand the physical qualities (such as size, shape, depth and distance etc.) and spatial qualities (such as materials, color etc) of spaces,
- Give a meaning or psychologically perceive spaces.

Spatial perception is shaped by the perceived characteristics of the space. Perceived contents change in different places. People have different value systems for the space depending on the content as every space have different spatial effects (Aydınlı, S., 1986). Spatial effects let the actions be meaningful, affect the choices and reflect the

values. Besides, even if it is possible to meet on a common ground of experiences and impacts that a spatial enclosure creates on people, they are dependent on culture (Boyce, 1981).

Cuttle defines the aim of lighting designer as controlling the luminous space in order to affect the perceived space. He also adds that past experiences have impacts on individual visual perceptions of their environment. So that the luminous environment and the perceived environment are different things (Cuttle, C., 2003). Lynch defines "a good place" as an appropriate space for; the person and his culture and the history of the society in which he lives (Lynch, 1981). Statements of Cuttle and Lynch supports the opinion of the subjectivity of spatial perception. Spatial perception is subjective.

According to the function of the emerging space spatial effects vary according to different cultures. For example, a function may have a religious interior. However, religious places create different spatial effects on people from each unique religion. In other words, the spatial experience of a church or a mosque on a Christian and a Muslim are different. Spatial perception is subjective, effected by experience and closely related to the emotional states of individuals.

Whatever the light source is, the perception of architecture is influenced by light because, light defines spatial boundaries and functional zones, light expands and highlights rooms, separates or relates areas, enhances architectural elements.

While describing the experience of being inside a substantial space feelings are involved in the process of perception so the situation is related to experience rather than perception. "Experience of a substantial space" also addresses to qualities which creates a room's atmosphere such as intensity of the light contrast, or lighting patterns being cold, warm or active (Boyce, 1981).

Lighting design should focus on people and their needs instead of taking only quantitative terms such as illuminance and the distribution of luminance into account. Ganslandt & Hofman, define man as "an active factor in the perceptual process.... who can construct an image of a visual environment based on a wide variety of expectations and needs " (Ganslandt & Hofmann, 1992). So that, first of all people's perceptual requirements of a luminous space will be explained.

2.3. Perceptual requirements of a luminous space

Effects of light on people's perception in interiors is not only related to physical qualities of the space, but also strongly related to psychological dimensions. Perception of interiors is a complex process including visual perception, spatial experience, human emotions and behaviors. However, traditional lighting design concepts are generally focused on quantitative data, necessary attention is not given to perceptual requirements of humans as explained in the previous chapter. On 1977, William Lam was one of the first lighting designers to ask the question : How one can describe the needs expected from a lighting arrangement?

Stating that designers should define more accurate environmental goals than “ create a mood “ or “create an attractive space”, he made a division between requirements of people from a lighting system as *Biological Needs* and *Activity Needs* (Figure 2.2).

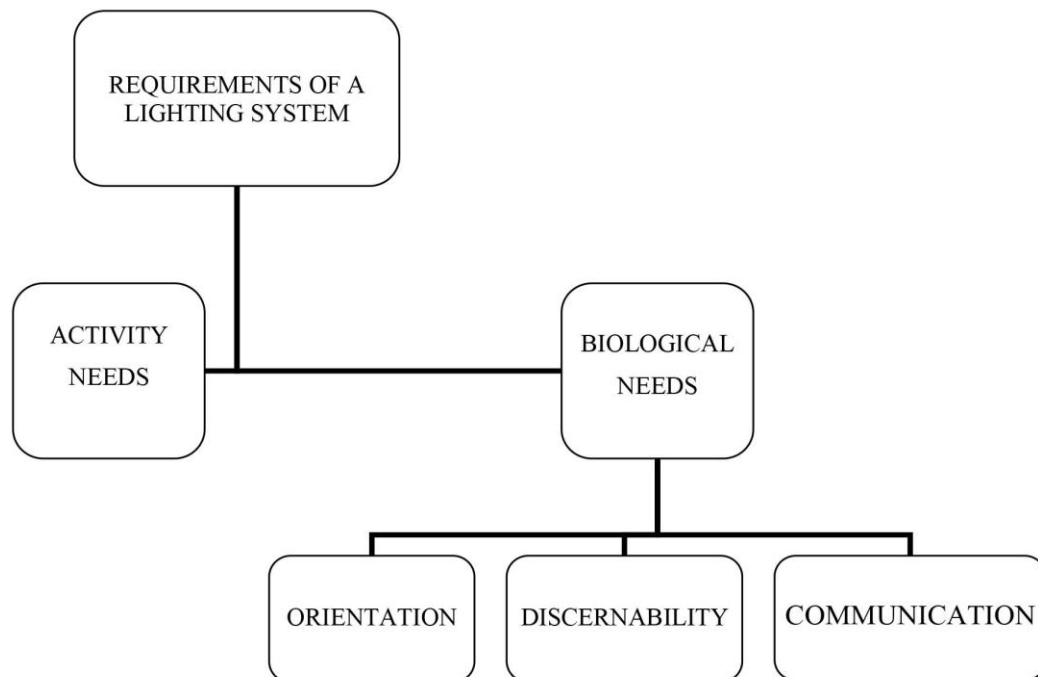


Figure 2.2 : William M. C. Lam's qualitative lighting design criteria
(Lam, W. M. C. , 1977).

Biological needs are the psychological expectations from a visual environment. The need for feeling emotionally and physically well in a surrounding is the main concern of this system (Gansfald & Hoffmann, 1992).

People have tendency to give more prominence to biological factors in their surroundings than other sensory information. These factors are related to physical, emotional and intellectual health. Unclear or missing information from the environment makes people feel uncomfortable and even in danger (Lam, W. M. C., 1977). So, in a luminous space, a person's emotional state in a visual environment depends on if the biologically necessary information is clearly distinguished or not. Walking down an empty street, for example, if it is dark and very late at night, people feel in danger and even defensive.

The most important biological needs for environmental data are listed as in the following by Lam:

***Location**, with regard to water, heat, food, sunlight, escape routes, destination etc.*

***Time**, and environmental conditions which relate to our innate body clocks*

***Weather**, as it relates to the need for clothing and heating or cooling, the need for shelter, opportunities to bask in the beneficial rays of the sun, etc.*

***Enclosure**, the safety of the structure, the location and nature of environmental controls, protection from cold, heat and rain, etc.*

***The presence of other living things**, plants, animals and people,*

***Territory**, its boundaries and the means available within a given environment for the personalization of space,*

*Opportunities for **relaxation and stimulation** of the mind, body and senses,*

***Places of refuge**, shelter in time of perceived danger (Lam, W. M. C., 1977).*

Lam (1977) states that human beings always observe the environment and realise immediately when there is a change. Respectively, they adjust themselves quickly to the new situation.

In the light of this information, as an example, when people are performing a task, they pay less attention to other stimuli around them. If they are interrupted by irrelevant data which is not their concern, they feel uncomfortable and their concentration is disrupted. Whenever the concentration is completely lost, the focus of perception shifts and they start looking for other information to fulfill their biological needs. They turn around and look for the source of interruption or look outside from the window to check the weather or time outside.

Lam states this situation is because of the fact that need for clear orientation is the basic psychological need for human beings (Lam, W. M. C., 1986).

During the day people expect to see bright interiors just like outside and during the night they expect a darker outside and lower brightness levels than they had during the day. Having windows in a room for example satisfy the need for orientation . People need to have information about time, weather conditions and the environment surrounding them. Similarly, sensation of gloom when there is an overcast sky outside is caused because of the same reason. Which means people expect to see a brighter exterior outside during the day. However, when there is an overcast sky, illumination of outside is darker than we expect it to be. So, people feel uncomfortable (W. M. C., Lam, 1977).

Different views of interiors change perception of spaces each time of the day continuously. Boundaries between the inner and outer world is blurred. So that, the natural cycle of the day is perceived. Strohmaier's study on the same spot exposed to daylight shows naturally changing quality of daylight through the day (Figure 2.3).

Orientation need is affected by expectations and previous experiences. Process of perception in interiors is negatively affected by unclear messages. People are attacked by several stimuli consequently and they have several impressions. The interpretation of informations from the surrounding space depends on the meaning they give to the situations. ” The brain acts according to the basic principle that similar causes will produce similar effects” says Lam. He also states that people are able to survive and function because of this principle. In other words, the world acts as people expect from it (W. M. C., Lam, 1977).



Figure 2.3 : Passenger (stills) by Jutta Strohmaier, 2004 (Url - 1).

When the world does not act the way they expect from it, people's biological balance is negatively affected. There are many studies to manipulate people's perceptions to satisfy biological need for daylight even when it is not possible to have daylight. In Sweden for example there are several days without sun. However, to maintain psychological and physical well being people need to feel the presence of sun Rybakken's design targets to provide impression of daylight transmission from the window. The experiment is made in a dark room without daylight. By painting the room white and adding parallelogram-shaped LED light fixtures which give off the natural color of sunlight are mounted into the walls and the positive sensation of daylight is replicated. There are no windows and it is not possible have daylight on in the room, but still presence of imitated daylight reflection on the wall affects people's psychology positively (Figure 2.4).

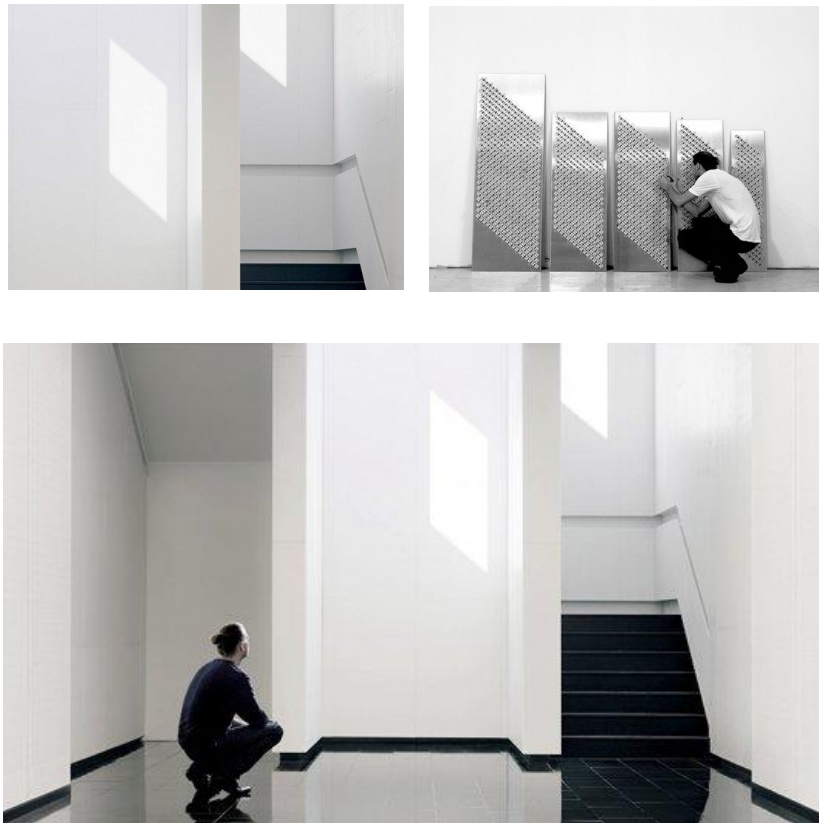


Figure 2.4 : Daylight Window, , Daniel Rybakken (Url - 2).

Distinguishing and perceiving the surrounding environment, in other words, *discernability* forms the second group of biological needs. To be able to feel safe, the space people occupy should be visible. Too dark or too bright spaces make people feel insecure. However, visibility is not the only criterion, structuring is also important. As Lam suggests on the list above, “the need for a clearly structured and ordered environment” is one of the utmost important biological needs (W. M. C., Lam, 1977). In addition to sufficient visibility, luminous environment should fit to our expectations. Which means, not everything should definitely be visible, but luminous interior should make sense as a clearly structured space (Gansfald & Hoffmann, 1999). For example, lighting flat walls in a room would be unnatural and confusing, but if there is a grazed wall in the same room, lighting that wall would emphasise the surface quality of the walls and would be attractive as in Figure 2.5.

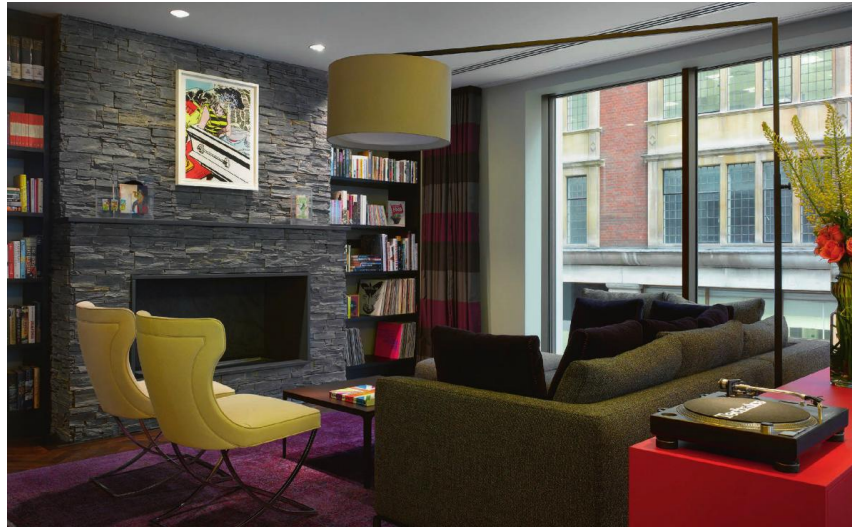


Figure 2.5 : Exposing the original stone construction for a striking effect, South Place Hotel, London, UK (Url - 3).

Communication, the third group of biological needs is related to people's need to interact with other people and themselves. Being exposed to too many visual information inside a given interior can be destructive and even unhealthy for human psychology. In an opposite situation, being too isolated is also not beneficial for people's emotional situation. To maintain the balance, definition and personalization of private areas are essential needs (Gansfald & Hoffmann, 1999).

A light zone above a seating area in a brightly lighted large room can define a private area. Der Spiegel, HQ Canteen is a vast open space for communication of the employees of the company. The tables are placed around the space with a loose arrangement (Figure 2.6). Light hanged filters are dividing but not blocking the space. Large yellow circle dishes on the ceiling are zoning the space with hanged luminaires directed to the tables (Braun, Z., 2012).

Activity needs define the requirements of data to do several activities. First, type and needs of the specific visual task should be known and analyzed. On one side, activity needs resemble quantitative lighting. Because to perform each visual activity there are some physical criteria like level and intensity of light or luminance distribution within the interior space. Optimum visual conditions should be provided to accomplish a specific task for functional lighting. However, traditional lighting is concentrated on choosing the most difficult visual task which will be done in an

interior space and apply uniform lighting all over the space. Lam (1977) suggests a more detailed analyze considering the location, type and the time interval of the activity for a perception oriented lighting setting (W. M. C., Lam, 1977).



Figure 2.6 : Der Spiegel, HQ Canteen, Hamburg, Germany (Braun, Z., May 2012).

Generally in office spaces, because of the task lighting requirements cool white light temperature is preferred as it improves concentration during worktime. Detailed information on colour temperature of artificial light sources will be given in following chapters.



Figure 2.7 : Neuehouse, Manhattan, New York, US (Url - 4, Url - 5).

As an example; Neuehouse is a company with an extremely different interior than an ordinary office space because of their activity needs. The company is constantly working in collaboration with other entrepreneurial companies, so they needed a warm, welcoming, and open environment to give the message of hospitality. Ambient glowing pendants with warmer colours on the center of each lounge are able to be lowered down at night to strengthen the intimate atmosphere (Figure 2.7). Indirect fluorescent lights hidden on the top of the rails provide the required lighting conditions for an office space. According to the example and the fact that each

specific interior lighting design case need a specific scenario, it can be said that right and detailed analyze of activity needs give better results in interiors.

2.4. Resume on perception of space and light

Light is an integral impact of both physical space and perceptual space. Light adds third dimension to an interior. Spatial qualities of a space such as illumination level has impact on perception and individual experiences within an interior. So, light is an element of perceptual space. Besides, light makes it possible to see, comprehend and move in geometrical space. Spatial perception/experience is a broad issue which contains physical and sensual perceptions of humans. Social, cultural and psychological factors are involved in the perceptual process creating different spatial experiences on each person.

Spatial perception is subjective, affected by experience and closely related to the emotional states of individuals. However, traditional lighting concepts does not have a physiologically oriented view of human perception. People are usually thought as machines seeing and processing objects or images. Human visual environment is much more complex than just processing visual tasks. It is impossible to analyse the process of perception of people truly in an interior space, when people's abstract comprehension of the environment surrounding them is oversimplified.

People are in need of clearly distinguished information in a luminous surrounding, to be able to sustain their biological well being. Being informed about environmental data such as location, time and weather conditions improves sense of being safe. Psychological expectations from a surrounding environment defines Biological Needs.

Human beings are highly capable in adapting to new visual situations. Adaptation to cycles of nature creates expectations. It is expected to be dark at night and bright during the day. Even human body adapts to this cycles evolving biological clock of the body. In order to feel psychologically well, people need to have clearly distinguished information from their surroundings. Task lighting requirements to visually percieve and process information are defined as Activity Needs. However, task lighting still needs to be analysed according to the type of activity, time, interval and location to satisfy psychological perceptual requirements of people.

3. PERCEPTION OF DAYLIT INTERIORS

“Light is a powerful substance, we have a primal connection to it”

James Turell

In ancient times, human beings used to spend most of their time of a day outside, working in the fields. Today, we are spending more time inside, under artificial light working in the offices or at home. It has been questioned if we are able to get enough amount of daylight for our physical and emotional well being.

Light is a physical variable as well as being a perceptual variable. So that, light has both psychological and physiological effects on people. People's feelings, moods and emotions are involved in the process of experiencing the space. According to Vogels mood and perception are different. “In contrast to mood, the perceived atmosphere of an environment is expected to be a more stable concept. Atmosphere differs from mood in the sense that it is not an affective state or feeling but an affective evaluation of the environment. It is a subjective impression of the environment related to the expected effect on mood, but it does not necessarily correspond to the actual effect on mood” (Vogels, 2008; Vogels, et al., 2008).

Daylight meets the space creating several moods and emotions on people during spatial perception/experience of an interior. So that, in order to understand daylight's effect on spatial perception of humans, first, the unique qualities of daylight and its interaction with spatial design elements of a space need to be investigated.

3.1. Relationship between daylight qualities and perception

The amount of light penetration to the interiors depends on the amount of daylight entry to the spaces from outside. This availability differs with climatic conditions, the time of day, and different seasons of the year. On sunny days of summers, daylight availability is in its maximum level while on winters daylight intervals are shorter. On such dark days, less daylight is available. Daylight is the consequence of primal energy source of the world: sun. So, it is significant to understand the different qualities of daylight and the impacts of them on people's visual and

psychological perception process. These unique qualities of daylight can be listed as variation, orientation, colour , shadow and darkness.

3.1.1. Percieving variation

Daylight is rapidly on change, varying in different times of the day, year and weather conditions. This situation is not a disadvantage, as this variability results in more dynamic interior spaces. Natural conditions need to be adapted to interior architecture.

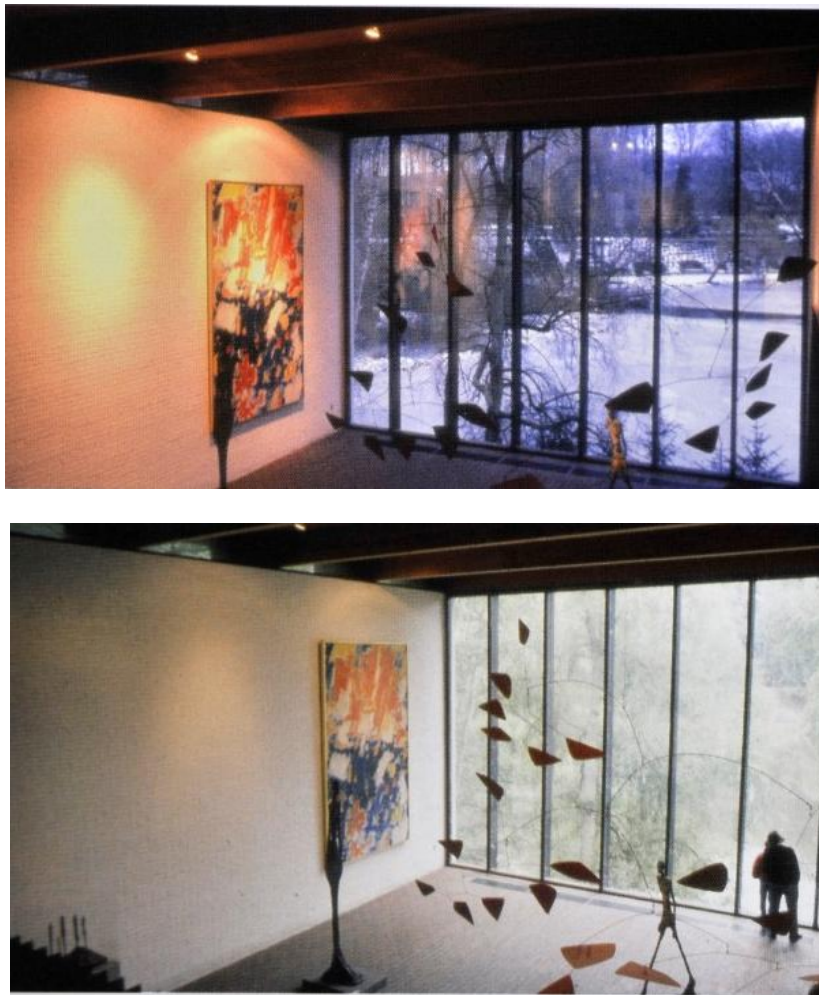


Figure 3.1: Different views from a room on winter and summer, Louisiana Modern Art Museum, Humelbaek, Denmark (Cuttle, C., 2009).

Variation of daylight differs according to the geographic location. In a country close to Equator sun is very strong and harsh in at noon while it is soft and weak in a country far from Equator. Similarly, seasons have variety. Each season has its own

character. Winter snows and summer sun effect sensation of people in interiors. Different atmospheres from the same room in Louisiana Modern Art Museum on summer and winter are shown in Figure 3.1.

Indirect light and direct light are also two basic elements of variation. Direct light is the light with a clear sky. Indirect light is created by both direct light and diffuse light reflected from the floor, walls, ceilings or environment.

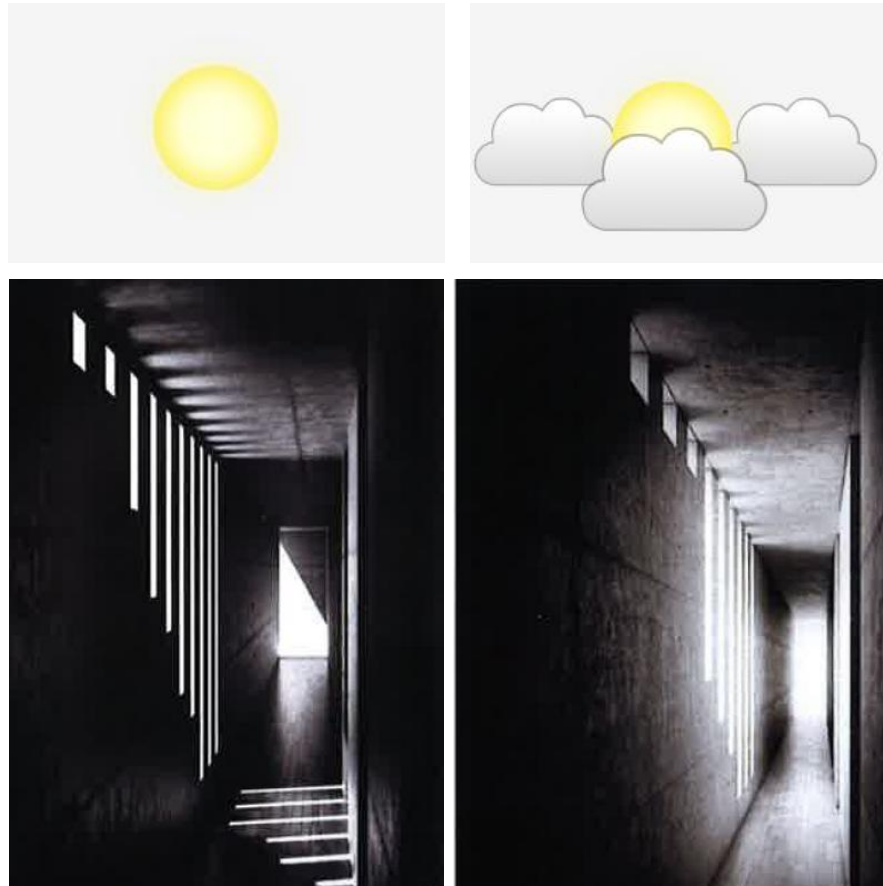


Figure 3.2: Koshino House by Tadao Ando, different views under clear sky with direct sun and cloudy sky with diffuse sun (Url - 6).

Distribution of light under clear sky and cloudy sky is different. Daylight under cloudy sky with diffuse sun creates calmer visual perception as the space has low intensity and the interior is lit more evenly. Cloudy skies provide diffuse light with low intensity and create calming sensations in interiors. In Tadao Ando's Koshino House, two different visual perceptions are achieved with changing quality of daylight. In contradiction to cloudy sky with diffuse sun, clear sky with direct sun shines through the interior creating sharp shadows and intense feelings (Figure 3.2).

Specific sky conditions occur around different countries around the world. Lack of variation of sun causes psychological problems on people. When people can not get enough daylight, they feel physically and psychologically sick. Some continents have imbalanced rhythms of light- dark and many countries are suffering from the lack of sufficient sun. The outcomes of having continuous dark days on people will be explained in the chapter 3.1.5. Manipulating darkness - light coherency.

3.1.2. Providing orientation

People enjoy a day with sunlight and feel disappointment when this need is not met. This quality of sun is not measurable or formalized. The optimization of sunlight entry to a building is provided by orientation of the building which also optimize efficient daylight entry to the space. Feeling the changes of natural light levels outside is vital to protect body balance and psychological health.

Sunlight is generally a positive architectural element which has visually and therapeutically positive effect on people. However, side effects such as glare, and heat gain should be controlled (M. S. Millet and Barrett, C. , 1996). Bartenbach gives the example of PC near window to this situation. Difficulty of adjusting the eyes to the light causes mental strain and results in tension and sweating. People have tendency to lose concentration, have difficulty in accomplishing given tasks and feel tired. He states that all their studies showed illuminated space should be in suitable dimensions as well as providing protection to prevent glare caused by sun. Also surface textures should be chosen from non - reflective materials. Desks should be lighter tints of gray or wood-tone while the ceiling, walls and floors are white or light coloured to prevent undesired reflections (E., Tsakiridou, 2003).

Sunlight has direction because of the movement of the sun during the day, so daylight has different brightness levels at different locations. Behavioral reaction of people to sun also differs in different continents. In cold countries located in Middle Europe people have limited sunny days. They perceive those days as a gift .People from countries close to Equator however react oppositely, try to run away from harmless effects of sun orienting themselves under heavy blocks of stones (Figure 3.3).



Figure 3.3: Different reaction of people to sun in a cold country versus in a country close to equator (Ungrungseesapon, 2012).

Perception of space and time changes because of modelling and orientation. Another quality of daylight is enabling orientation by giving information about the time of the day and the weather conditions.

Humans have inherent biological rhythms working like a clock. When the night becomes the day or when the days get shorter or longer due to seasonal changes body adjust itself to these changes. The weather expected to be dark or bright according to the time orientation of the clock. If this information is missing, as may be the case in closed spaces such as department stores or a windowless room of a building, the surrounding space is perceived as unnatural and disturbing.

An artificially lit closed space without openings such as windowless department stores can make us lose our sense of time. Daylight modelling is provided by the direction and flow of natural light which is strictly related to orientation of the building and openings. Bentalls Centre is an example of a shopping mall as it lets daylight in with rooflights, providing a pleasant shopping experience under differing shades of daylight. On the other side, artificially lit Singapore Iluma Mall is a bad example to this situation as there are not any openings letting daylight in. In addition, choice of colors and complex patterns is increasing the depressing feelings (Figure 3.4).

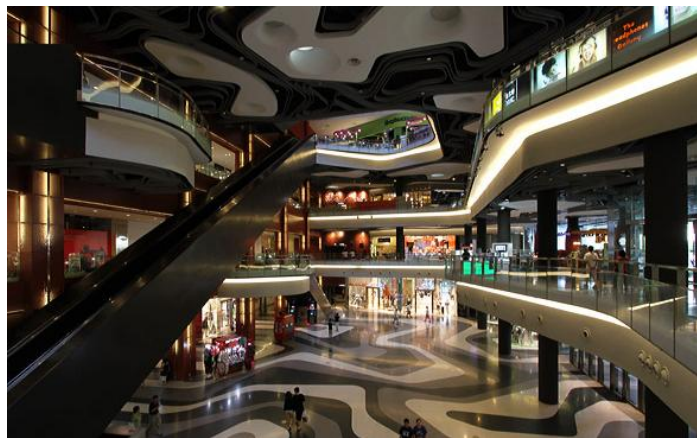


Figure 3.4: Bentalls Centre and Singapore Iluma Mall lighting design of interiors
(Url- 7, Url -8)

3.1.3. Sensing colours

“ The appearance of the interior space is determined by the physical surfaces, edges and textures when acted upon by the light falling on them”

Marietta S. Millet

The visible light (simply light) is the part of the electromagnetic spectrum that is visible to the human eye which corresponds to a wavelength range of 380 - 760 nanometers (nm) and a color range of violet through red. The human eye is not capable of "seeing" radiation with wavelengths outside the visible spectrum. The spectral distribution of daylight enables perfect colour perception.

Visible spectrum could be thought as a rainbow. Sunlight is refracted as all the colors of a rainbow when it shines through a prism. In reality, all the colors of nature come

from light. It can be said that maybe because of this reason, when the natural light meets the space, it effects our psychological health and emotional well-being.

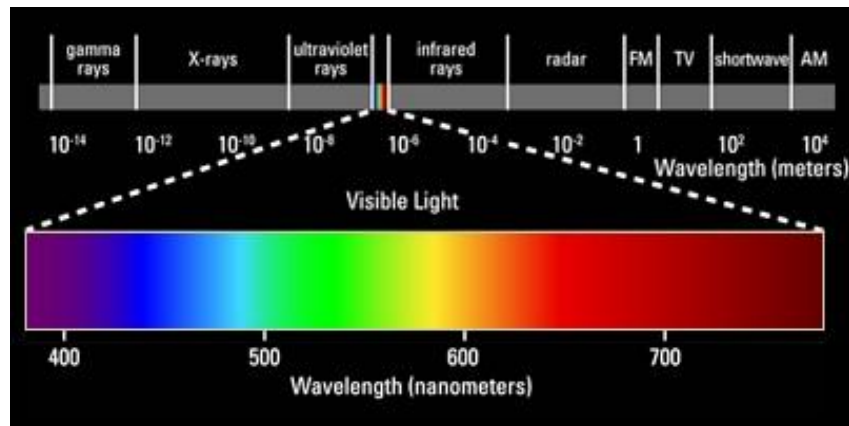


Figure 3.5: Light spectrum (Url -9).

Spectral changes of daylight throughout the day affect the interior atmosphere of a room. Colour of daylight changes from morning till evening. So, colors of materials in a space are perceived differently on different times of the day. Gordon states that when color vision is related to hues rather than colors. Actually, light is not coloured it creates sensation of brightness and color. Colors are described as psychological sensations that are named by people. According to him, color as a sensation and color as a *wavelength* are different. So, it is more accurate to talk about spectral hues instead of spectral colours (Gordon, 2003).

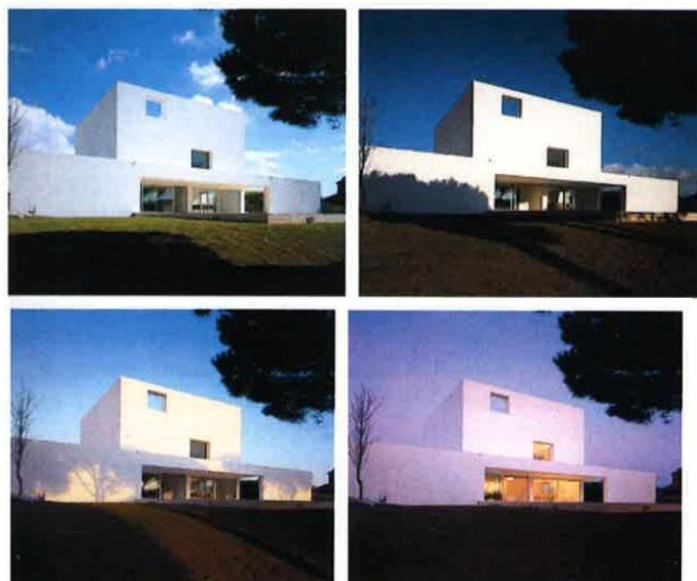


Figure 3.6: Different colors of daylight on different times of the day (midday, early afternoon, dusk and sunset) (Ungrungseesapon, 2012).

Also, rendering of colors is better under daylight. Transformation of colors is different under daylight than artificial light, because daylight has a changing quality, while artificial light sources are static. Another reason to this is distribution of daylight's being different than artificial light. Daylight's tendency to illuminate surfaces is better than any artificial light source as artificial light sources distribute light only in certain directions.

A room at night, with a wall lit by an artificial light source, wall surface looks brighter than the rest of the room. The same room under daylight however looks more evenly lit. Because daylight illuminates both horizontal and vertical surfaces evenly. Thus, the roof, the walls and the floor look more evenly lit as in Figure 3.7. Therefore, daylight offers better sense of space.

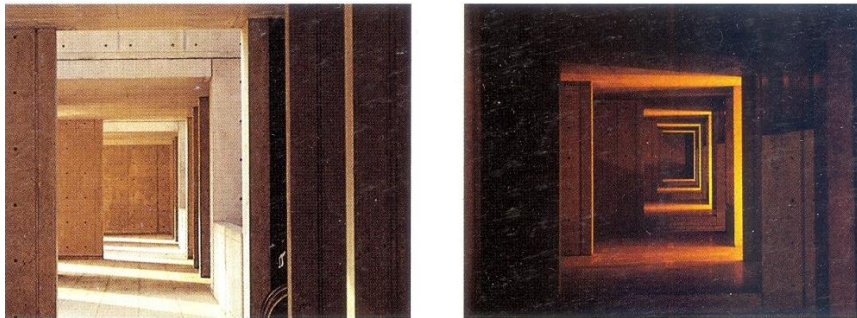


Figure 3.7: Distribution of light in arcade at the lower level of the Salk Research Institute day and night, California (M. S. Millet and Barrett, C. , 1996, p.120).

Secondly, changing colors of natural light effects emotions. When people imagine themselves outside at dawn, they feel calm and relaxed as the dark night becomes the light day. It can be said that these unconsciously perceived colors of the day changing from black over blue-violet, blue and blue-green to white creates relaxing and calming effects on people.

Changing colours of light have also been the muse for architecture. The idea of bringing changing colours of light into the space to increase positive feelings of people is forming the design concept of The Dwan Light Sanctuary, located on the campus of UWC-USA. The space was designed in 1996 as a meditative space. Large prisms are placed on the façade of the circular apsis and the ceiling. The prisms refract and spread the light into the space like rainbows. The interior is enabling the

visitors to experience full spectrum of colors of the sun while relaxing their mind and soul. Students and other visitors are able to attend or organise weekly yoga classes, memorials, religious celebrations (Jewish, Muslim, Buddhist, Native American etc.), classical and meditative concerts and poetry readings (Url - 10).



Figure 3.8: Dwan Light Sanctuary, UWC-USA in Montezuma, New Mexico
(Url - 10)

As reported by the students of the university, perception of a spiritual , calming atmosphere without boundaries is created:

“I use the Sanctuary for prayer, reflection, a place of meditation and yoga, and a place for truly private conversations”

Anjali Sulochana Appadurai, Canada

“I used it mainly for relaxation and for a place to come and think to myself (escaping from the overwhelming environment of UWC”

Ido Grossman, Israel

“I’ve used the Sanctuary as a space for meditation, body movement exercises, a place to just think quietly or decompress. When others have not been around, I’ve also used it as a place to sing, (the acoustics are unbelievable), or to hold specific, important conversations, always of a harmonious nature”
Arielle Hawney, USA-Washington (Url - 10).

3.1.4. Experiencing shadow creation

There would not be light without shadow. Shadow is a partial darkness or obscurity within a part of space where direct light coming from a source of light are cut off by an interposed opaque object. The shadow covers the space behind the opaque object with the light source in front of it (Figure 3.9).

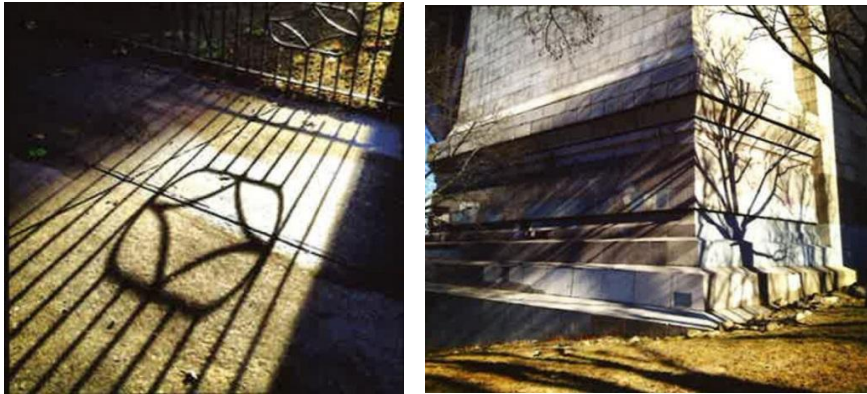


Figure 3.9: Shadows from everyday life (Url - 11).

Under daylight, length of the shadows differs at different times of the day according to the height of sun. Shadow provides information about the direction of light, the angle of the sun, the time as well as defining an object, a shape or a space (Figure 3.10). Direct and diffuse sun have different shadow qualities. Under direct sunlight shadows are sharp and contrast with light is harsh. However, under skylight shadows are softer and dimmer.



Figure 3.10: Museum of Glasgow, Burrell Collection (Philips, D., 2000, p.89).

Continuous shadows define spatial impressions. For example, shadow can define spaces help them explore interiors. Also, the degree of contrast between dark and light spaces can create a hierarchy or separate spaces. In the example of Museum of Glasgow, contrast between shadow and light is defining the exhibition areas (Figure 3.10).

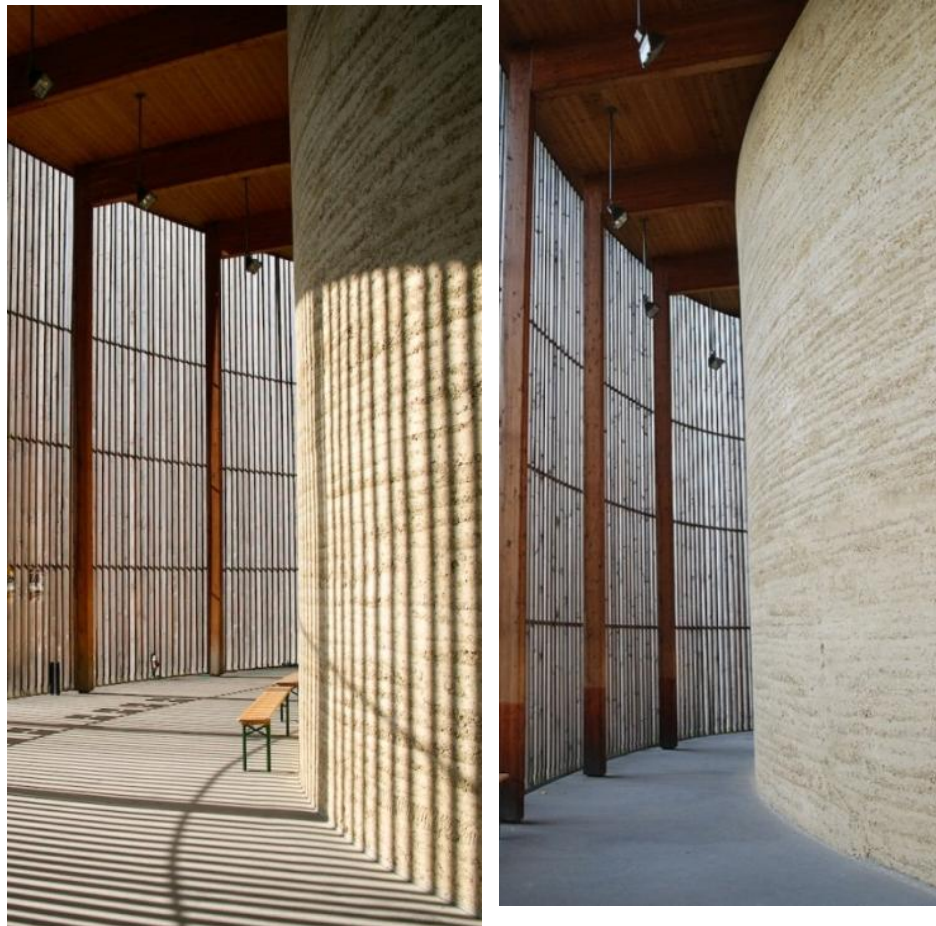


Figure 3.11: Direct sunlight with harsh shadows versus diffuse sunlight with soft shadows, Berlin Chapel of Reconciliation, Germany (Url - 12).

Daylight and shadow have a significant role to create an impact in interior space. In an interior space designed with daylight sunlight penetrates through the glazing material of the opening meets the surface materials and furnishing elements. Perceived atmosphere is lively with shadows moving and changing according to the light changing outside (Figure 3.11). Shadow can give information about the direction of light, time, sun angle as well as the outline of an object. For example a church having a facade made of patterns diffuse daylight forming shadows, affecting the atmosphere inside creating a sensorial impression. Church in Tre Kroner,

Denmark can be given as an example to this situation. Unique design of the facade is enhancing the feelings of faith within the interior space. The church is also an example of light-shadow plays enhancing religious feelings (Brandi, U., 2005).



Figure 3.12: Church in Trekroner, Denmark (Brandi, U., 2005, p. 56).

Timber construction of the church is acting like a perforated screen reflecting changes of daylight into the space. At different times of the day and the year, different appealing views emerge in interior. In other words, shadow is adding liveliness to the space (Figure 3.12). Vivid shadow animation is offering a variety of colour effects to the interior. Here, shadow improves the design of an interior space creating variation, improving the design quality as well as creating a pleasant atmosphere (Figure 3.13). On winter and summer times of the year sharpness of shadows and light alters differently. Religious feelings such as holliness, being close to god are magnified. Figure 3.14 shows the change of shadows in interior space during different times of the year.

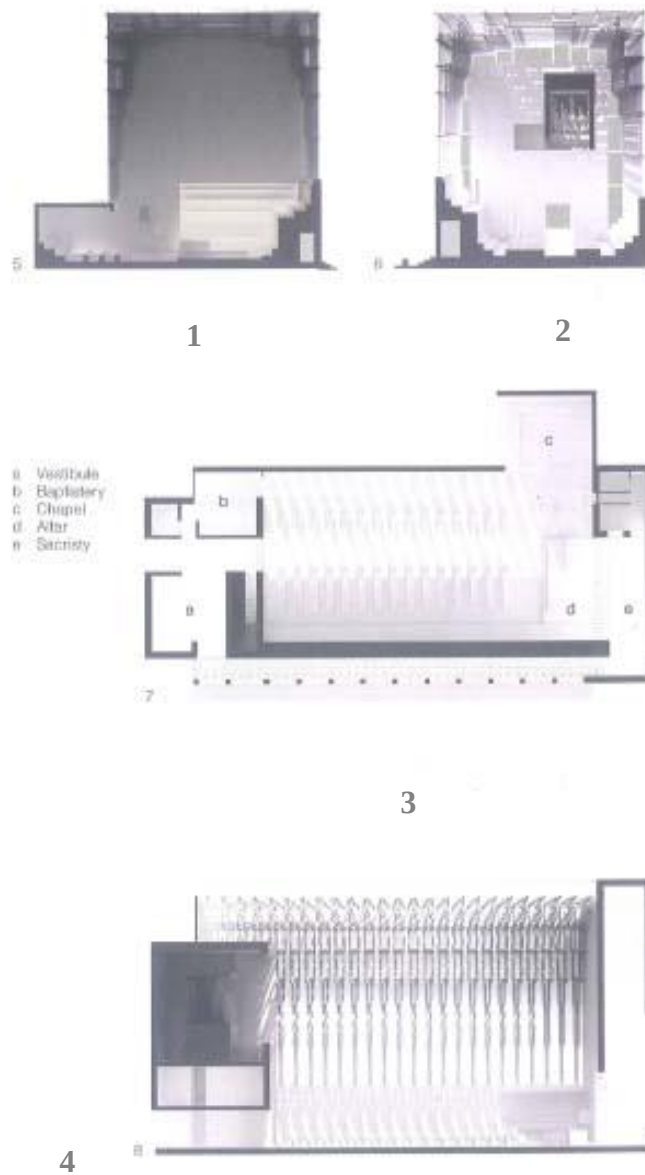


Figure 3.13. Plans, sections, lighting studies of church in Trekroner, Denmark
(Brandi, U., 2005, p. 53).

1. Sectional elevation facing altar
2. Sectional elevation facing organ
3. Floor plan
4. Longitudinal section

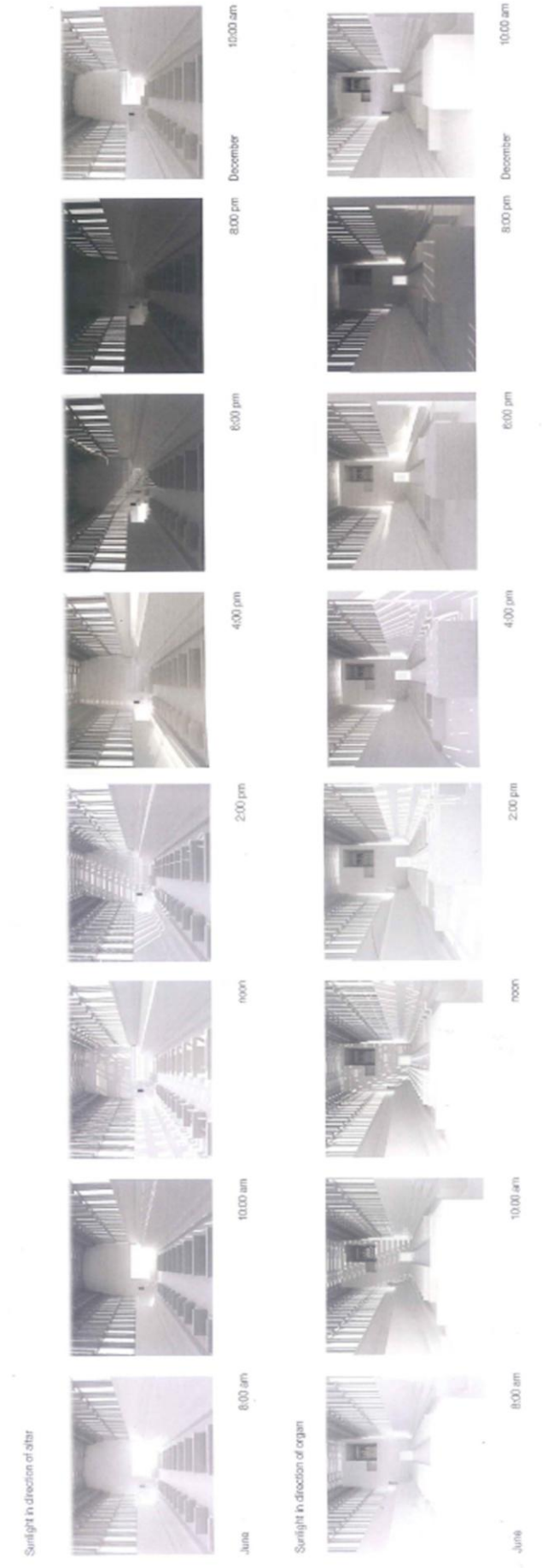


Figure 3.14: Sunlight in the direction of Altar and Sunlight in the direction of Organ, Church, Trecroner, Denmark
(Brandi, U., 2005, p. 54- 55).

Daylight's combination with spirituality and communicating with one's soul have positive affects on healing. The prayer and meditation pavilion is located at Cardiac surgery centre in Sudan, built by the Italian humanitarian organization, EMERGENCY NGO. Various Inter-ethnic and Inter-religious wars have taken place in the country for a decade. Spiritual diversity of the country is reflected to the design of the space. A space that could host praying activities of all faiths was the main idea (Url - 13).

The Arab Ethnic group constitutes 39% of the population and 61% of Africans; and in terms of religion, 70% of people in Sudan are Muslim, while the remaining 30% are Christian or belonging to other religious faiths ("Human Rights Watch": Q&A: Crisis in Darfur 05/05/2004).

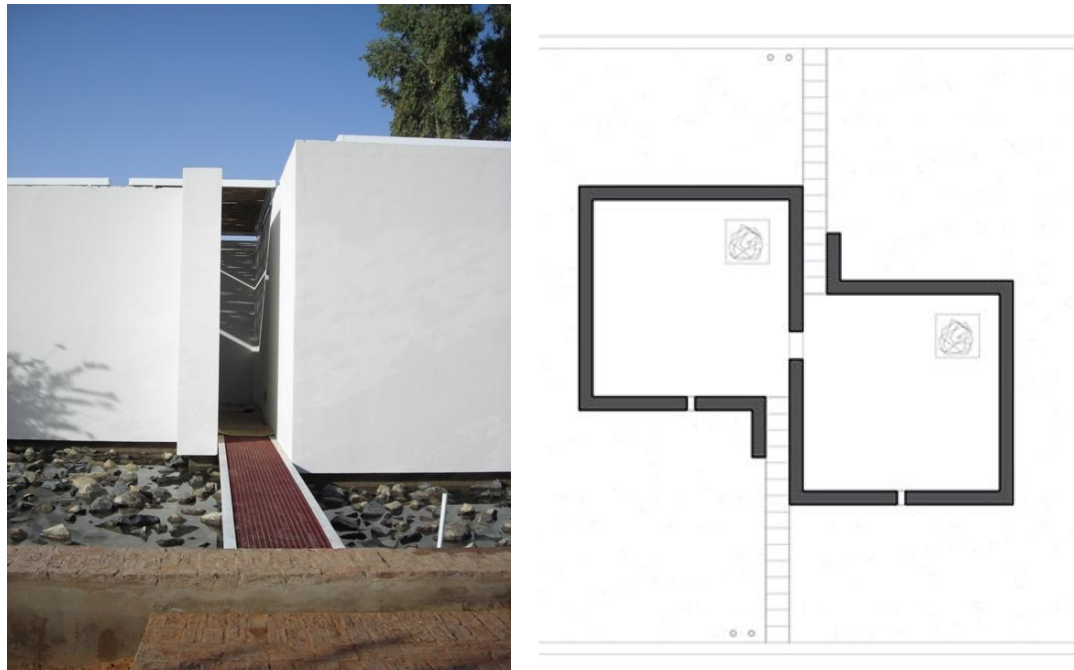


Figure 3.15 : Prayer & Meditation Pavillion, Khartoum, Popular Republic of Sudan
(Url - 13).

Any religious symbols are avoided to appeal all religions. As natural light has power on enhancing faith in all religions, the only symbolic message is the light itself. Large water pool seperates the two white cube shaped structures from the real world and created spiritual seperation between outside world and inside. Muslim faith had

to be considered as they are forming the highest percent of population. Separation of man and women is achieved with two cubes (Figure 3.15).



Figure 3.16 : Shadow interplays on the walls and floors, Prayer & Meditation Pavillion, Khartoum, Popular Republic of Sudan (Url - 14).

Bamboo leaf frames are forming ceilings allowing sunlight penetrate inside. Gaps between leaves of the bamboo frames are creating interplay of shadows in interiors enhancing faith. Moreover, shadow interplays are giving information about direction of the sun creating zones for the occupants to orient themselves in space (Figure 3.16).



Figure 3.17 : People orient themselves according to shadow interplays (Url - 14).

In Muslim faith for example people orient themselves according to qibla before ritual worship (performing salaah). For this unique space direction of sun helps people to

arrange their position as patterned shadow play of reflections is the only connection to outside (Figure 3.17).

3.1.5. Manipulating darkness - light coherency

“When you sit inside of a dark room and you look out at the garden that is naturally illuminated, you can begin to feel the fundamental relationship between light and darkness, the reason they need each other to express themselves”

Tadao Ando

The perception of the interior space and light could not be thought separately. If there is a light in the space, people see, feel and perceive the space. Light is the basic element for perception of a space. Darkness is opposite of light. In other words, one can not exist without the other.

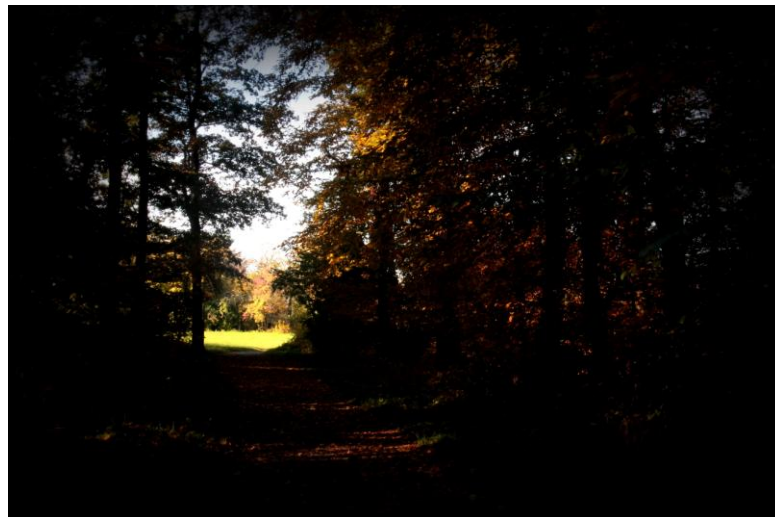


Figure 3.18 : Light and darkness in a forest (Eygi, 2014).

Light - darkness is a part of the nature. Bright daytime end with sunset, becomes dark night. In a dark forest for example, people seek for light and orient themselves according to light (Figure 3.18). Spiritual meaning of light is another point of view. Light has been related to being safe, gods and holiness while darkness is related to evil and death in the legends. During the centuries this contradiction has been the muse for stories, legends and for designers. Contradiction between dark and light adds value to space. Desired meaning or design idea can be implemented to space via contrast between light and dark. This contradiction can form the atmosphere a space.

A single opening from the sky in a dark space has power to enhance religious or sacred emotions.

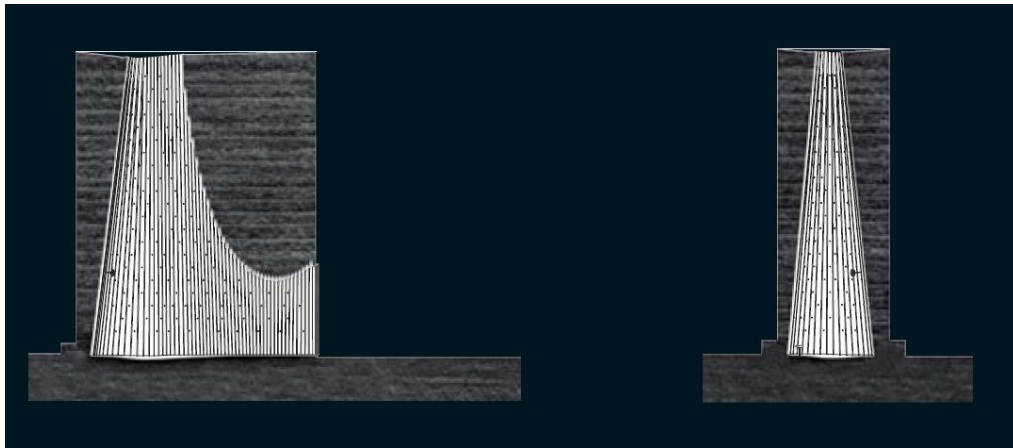


Figure 3.19 : Sections of Bruder Klaus Chapel, Germany (Url - 15).

In Peter Zumthor's Brude Klaus Chapel, the oculus provides the only light for the small dark space. The roof is open to the sky, sun of the day and stars of the night. The oculus is the focal point of the space (Figure 3.19). Rain, snow and daylight penetrate to the space through the single opening and create unique perceptions on people on each specific time of day and year. The perception is strengthened with use of material. The chapel was fired, within the 112 tree trunks forming the interior construction are burned and left behind a black-brown concrete shell inside (Figure 3.20).

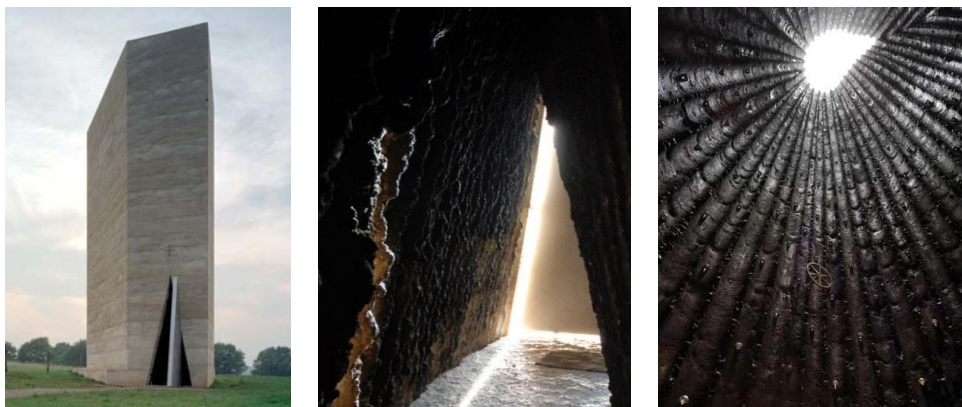


Figure 3.20 : Concrete structure of the chapel (from the outside), interior (Url - 16).

Contrast between light and dark can convey messages. Some visual informations are interpreted as socio-cultural or religious traditions via symbols. For example, a Christian cross or the Star of David resemble different religions. Also, some visual symbols create a sense of space on people. For example, white lines on a pavement

define a space. These visual patterns effect the way people act and our experience of a space. The same idea can be implemented to light. Light can transfer messeges.

Tadao Ando Church of Light can be given as an example to this situation. Light is an important symbolic element of faith. It can be observed that the light creates a spiritual feeling in the church. The cross is placed on the central focus of the interior. Even though light comes from a small cross pattern, darkness-light contrast form reflections to illuminate the whole interior space (Figure 3.21).

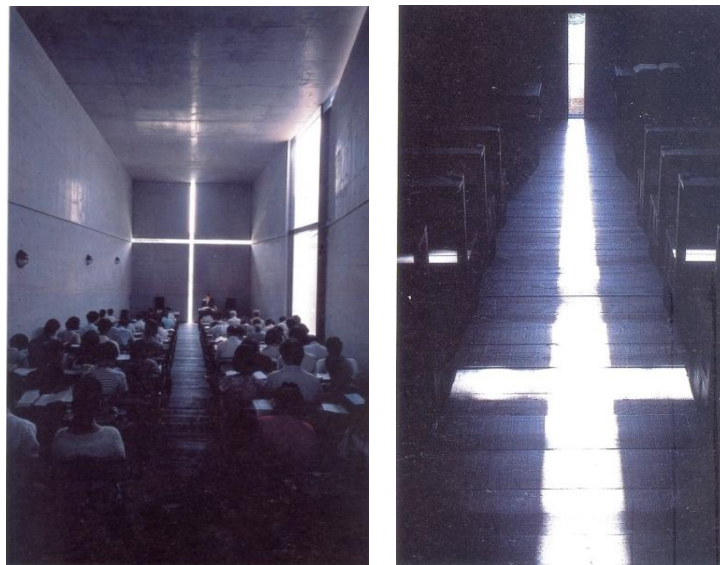


Figure 3.21: Symbolic use of light-darkness contrast, Tadao Ando, Church of the Light (Philips, D., 2000,p.89).

Messages can be conveyed or religious feelings can be enhanced with darkness as it is explained in the previous examples. Absence of light in daily life, has various negative impacts on people's health and behaviours. When people can not get enough daylight, they feel physically and psychologically sick.

A description of the psychological effects of absence of daylight on people was described by Wechsberg on the article in New Yorker. The city of Tromsø in Northern Norway is located in Arctic Cycle. People living in Tromsø have 59 sunless days during winter because of the location of the city in Arctic Cycle. He reported that people felt tired had difficulty in waking up and finishing given tasks at work. In addition, they suffered from sleeping disorders, low energy levels and depression. He also states vice versa is an other fact. As people in Tromsø, changed their behaviour

in summer completely, they did not feel tired, being active even at night and it was hard to convince them to work (The New Yorker, 1972). According to this article, it can be said that natural light has a significant effect on human psychology. An other example to this situation would be light therapies in Arctic Cycle. As in the example of Tromso, because of their geographic location some countries are not able to get enough daylight. As a result, there is a significant amount of people suffering from psychological problems due to disruption of their biological clock.

Biological clock is responsible for regulating sleeping intervals. Movements of sun outside; day becoming night and night becoming day effects our body signals. When the balance of this cycle is interrupted, the signals from the brain are interrupted and the biological clock is damaged. If biological clock is disrupted, body functions, physical and mental health is affected. “Circadian rhythms also respond primarily to light and darkness and causes physical, mental and behavioral changes during a roughly 24-hour cycle. Light therapy is used to treat a variety of depressive disorders” (e.g. Dalglish et al., 1996; Lam et al., 1989). People who have a circadian rhythm disorder are cured with bright light therapies. Daylight is much more effective than artificial lighting at sustaining the circadian system as it responds only to high levels of blue light, which daylight has naturally (Rea, MS, Figueiro, MG, Bullough, JD, 177-190).

3.2. Interrrelation between daylight and design elements

Relationship and interaction between light and spatial elements of an interior space such as color and texture are more important than the elements themselves in perception of a daylit interior space. Daylight affects moods, sensations and perception of an interior space in correlation with some spatial elements of an interior space. First, light penetrated through openings. Then, it changes the perceived spatial qualities by affecting materials, surface finishes and their colours.

3.2.1. Penetration through openings

Openings are not only significant to make an interior space brighter but also they are essential to form special atmospheres within an interior space. Norberg Schulz underlines the significance of windows in description of the spirit of the space as it

reveals the unique structure of an architectural space and relating it with light (M. S. Millet and Barrett, C. , 1996). Size, position, type and material of the openings is important in this regard openings can be divided into three different groups: *Facade Openings*, *Ceiling/Roof Openings* and *Perforated Openings* (Figure 3.22).

Organising and designing openings are the main criteria for successful daylight design. Designing the openings requires more than adding windows and rooflights to an interior space. Heat gain and glare should be controlled and balanced. Shading devices should be used to reduce glare and keep level of contrast at acceptable levels.

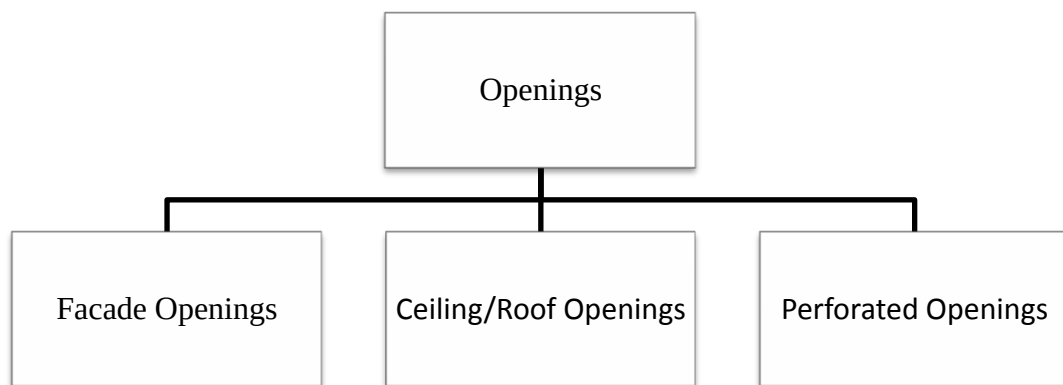


Figure 3.22 : List of possible opening types in an interior space (Gültekin, 2014).

According to the architectural qualities of a building such as size, shape, location etc. Various different types of Facade Openings (Windows) are designed to support atmospherical needs of interiors.

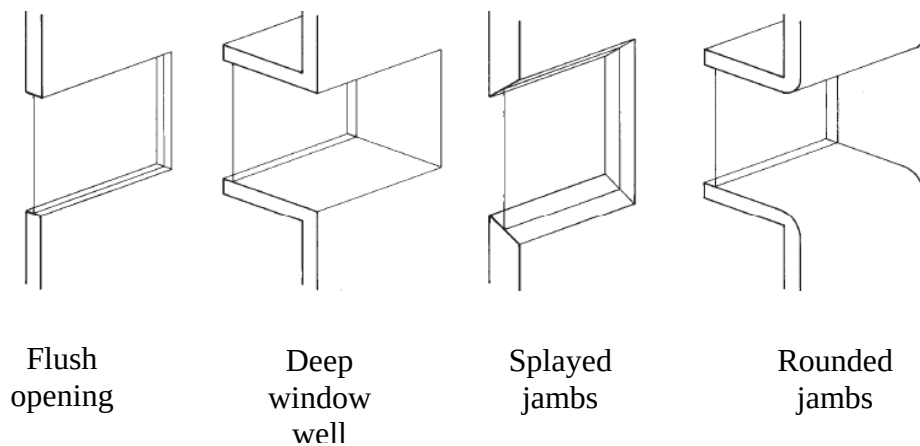


Figure 3.23: Splayed and rounded window jambs soften contrasts
(Gordon, G. , 2003).

Facade Openings can be divided into four as *Small Openings*, *Large Openings*, *Long Horizontal Openings*, *Long Vertical Openings*. *Small openings* provide a directional beam, highlighting the shape/object or the space to orientate the eye and provide hierarchy. Splayed jambs, rounded jambs, and deep window wells provide a soft transition. Adjacent surfaces create sharp contrast while splayed openings provide intermediately illuminated zones (Figure 3.23).



Figure 3.24 : RoomRoom by Takahashi Hosaka Architects (Url - 17).

The family house is designed by Takahashi Hosaka Architects for a deaf couple and their children is an example of how replication of small openings can effect perception and communication. The box-shaped house has many small square openings. Deep window wells on the façade and flush openings on the ceiling are scattered on surfaces. The openings are also used as a communication tool for sign language between deaf parents and children with capability of hearing. Here, perception of seeing is filling the missing sense of hearing. Sharp reflections of light on the floor and location of the openings on the ceiling are shown on Figure 3.24 (Url - 17).



Figure 3.25: Different views from the passenger's waiting room and corridors, Copenhagen Airport, Denmark (Giladi, G, p.33, 35).

During different times of the day the space changes creating various sensations. As it can be observed in Copenhagen Airport, daylight openings that are set built on the walls cause harsh contrast between exterior and interior space. Replication of the small opening on the façade of the airport creates a distinction between dark and bright areas via harsh light zones as can be seen in Figure 3.25 (Giladi, G, p.33- 35).



Figure 3.26 : Large opening in a house interior, Caviano, Switzerland (Url - 18).

Large openings distribute daylight equally to the interior space. In an interior space with a large opening, people have the chance to feel sun inside their house and to experience the outside world such as seasons and variation of natural light (Figure 3.26).

Long horizontal openings let the sunlight diffuse inside. They also serve as an element dividing the interior space as well as providing panoramic views. Vertical

openings on the facades of Villa Savoye can be an example to this situation (Figure 3.27). Light is able to diffuse through large windows performing a lively interior space with pleasant views. Also, division between first and second floors are achieved with long horizontal openings.



Figure 3.27 : Interior of Villa Savoye, Le Corbusier, Poissy, France (Url - 19).

Locating long horizontal openings on the lower parts of the facade, interiors are highlighted on sunsets. During the day daylight flows into the space, bouncing from the ground like a wave made of light. Sunrays hit the facade with a relatively inclined angle when the sun goes down. So, variation of daylight changing colours, is reflected to the interior.



Figure 3.28 : St. Franziskus Church, Austria (Url - 20).

Interior of St. Franziskus Church can be given as an example to this situation. Daylight penetration from the horizontal opening located close to the ground, is

strengthening spirituality (Figure 3.28). *Long Vertical Openings* strengthen the expression of in interior space by enhancing other vertical elements as walls or columns. For example using vertical openings in a church with high walls affect perception of people by evoking their religious emotions of holliness and spirituality. This effect is strengthened with combination of high vertical openings with colored glass (Figure 3.29).



Figure 3.29 : Long Vertical Openings of Santuário Dom Bosco, Brasil (Url - 21).

In Santa Maria Church, the vertical slith on the facade brings daylight into the room. Because of the fact that the slith is the only opening on facade, the adjacent walls of the opening are sloped in order to wide spread and distribute light more uniformly (Figure 3.30).



Figure 3.30 : Santa Maria Church : Marco de Canavezes, Portugal, 1997 by Alvaro Siza (Url - 22).

Ceiling Openings are also known as skylights or rooflights. They are developed to bring light into interior spaces which can not take daylight from windows. Skylights can highlight the space as well as creating new experiences by changing atmosphere of an interior space. Skylights transmit diffuse light of clear, cloudy or overcast skies to interiors reflecting the changes of the day inside. With proper controlling systems, they can be used in exhibition areas. Also, spaces which require less daylighting control (areas where visual activity is not critical) such as restaurants or waiting rooms can be designed with skylights (Url - 23).

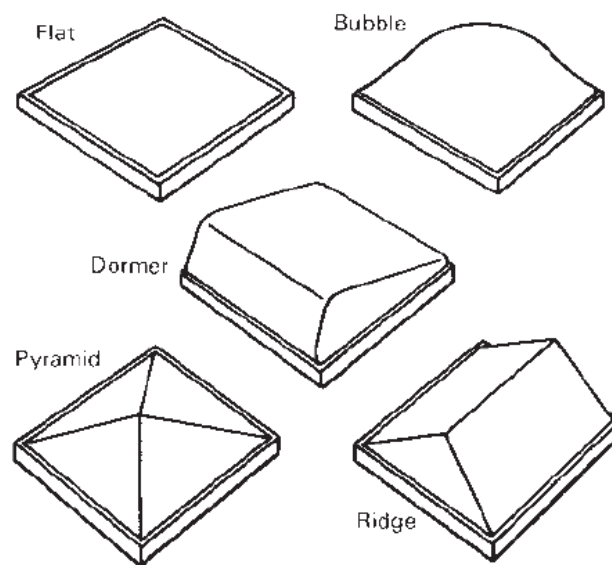


Figure 3.31 : Skylight shapes (Url - 23).

The shape of a skylight affects the amount of daylight diffused in on different times of the day, which effects spatial perception. When a skylight is angled or in the shape of a bubble, dormer, pyramid or a ridge, relatively more daylight is able to be taken in (Figure 3.31). Therefore, illumination achieved inside is better than a flat roof skylight (Url - 23). Typical rooflight configurations are shown in Figure 3.32.

Deep interiors can be daylit by using rooflights. Light wells are the most important components of skylights in this regard. A light well brings the light through the rooflight structure as well as controlling the daylight distribution. Light wells also serve as a shield against disturbing brightness for the occupants. Section of a typical skylight is given in Figure 3.33.

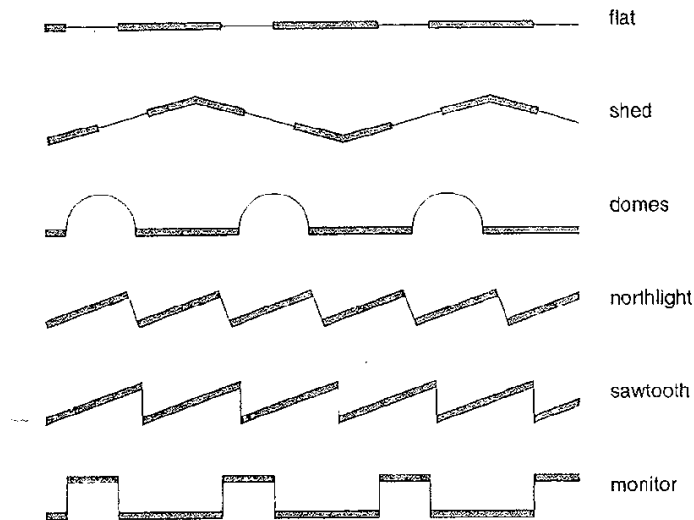


Figure 3.32: Typical rooflight configurations according to the CIBSE nomenclature (Baker & Steemers, p. 70, 2008)

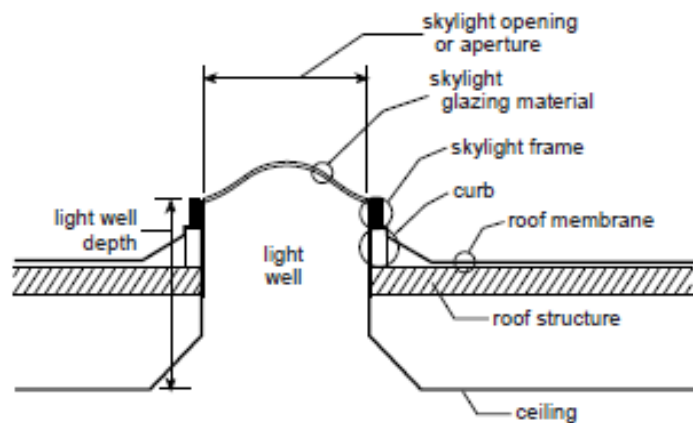


Figure 3.33: Section of a typical skylight (Url - 23).

Light wells can have various shapes such as vertical sides (in the same size with rooflight structure) or splayed sides that distribute the light with a wider angle to the space (Figure 3.34).

Sometimes several rooflights need to be positioned continuously to sustain the uniformity of illuminance within an interior. However, if they are located too far away from each other, daylighting will not be even inside. A spacing to height ratio is used to design roof lighting situations. Also, height and size of the ceiling may cause discomfort. Eyes try to adapt to very bright skylight and less bright interior. If

the ceiling height is low and the ceiling is large, glare possibility increases. Higher ceilings prevent this as the skylight will not be in the field of view (Figure 3.35).

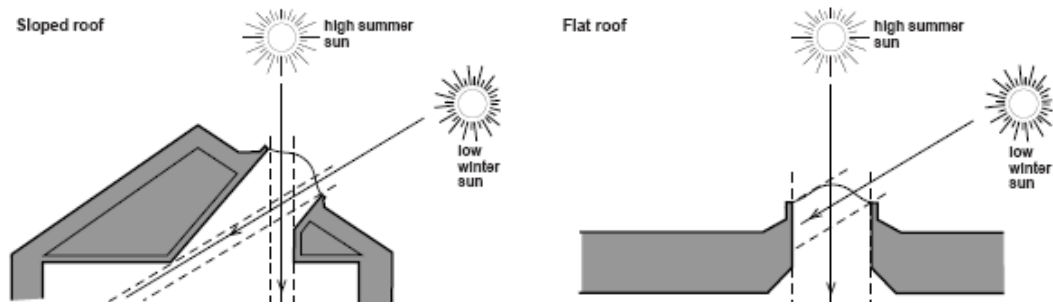


Figure 3.34: Sun penetration on flat versus sloped roofs (Url - 23).

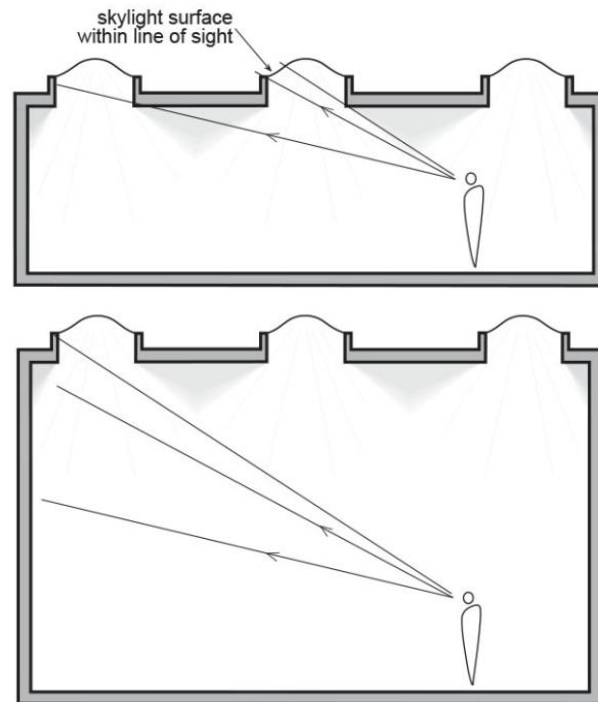


Figure 3.35: Visual Comfort Effect of High versus Low Ceilings (Url - 23).

In the example of La Tourette a dark interior space is lit by several sloped skylights to create a mystique atmosphere in the church (Figure 3.36). Giant domes pour light over coloured surfaces creating a powerful image and a unique experience. Different visual sensations created inside are perceived while praying enhancing the holy feelings of faith and spiritualism (M. S. Millet and Barrett, C., 1996).



Figure 3.36: Interior and exterior view of rooflights of Corbusier's La Tourette
(M. S. Millet and Barrett, C. , 1996).

In contradiction with La Tourette, in Pantheon, giant oculus in the center of the dome is the only opening providing light inside. The amount of daylight falling from a small opening is sufficient to provide necessary daylight levels in an interior space, but Pantheon is a pagan temple. Architectural design idea is also based on taking light in from one gigantic opening to create a holy atmosphere and enhance religious feelings of spirituality via play of daylight. Pantheon is also an example of using light symbolically. Interior space and design of dome is focused on the oculus of the Pantheon (Figure 3.37). Feeling of greatness is created in the spherical space with the change of daylight as well as creating a connection to outside. It also creates a holy light that resembles the light from the gods (Url - 25).



Figure 3.37 : Great oculus enhancing feeling of faith and greatness (Url - 25).

Today, it is possible to model interior atmosphere which will be achieved with daylight effect by using computer programs. Visualisations in the figure are created with Dialux, for 21 March with a clear sky in Rome, Italy. As it can be seen rendering of colours of materials are different each time of the day because of the changing quality of natural light. On different times of the day, the sensations of place is different and unique (Figure 3.38).



Figure 3.38 : Dialux visualisation of Pantheon showing the relationship with natural light under clear sky conditions (Uyan, F. , p.57).

Kimbell Art Museum in Texas is an example of carrying daylight experience into interior space. The daylight changes outside are reflected to inside with the special design of the ceiling of the exhibition rooms. The natural light planning in the museum is a consequence of Louis Kahn and lighting designer Richard Kelly's collaboration (Figure 3.39). Louis Kahn says : “ I can't define a space as a space unless i have natural light....natural light gives mood to space by nuances of light in the time of day and the season of the year, as it enters and modifies the space”. Rooflights may need special construction to provide heat control and visual comfort.

Kelly designed a daylight reflector system made of aluminium plates for North-South oriented galleries with vaulted ceilings of skylights. Perforations let the daylight diffuse inside passing through this plate (Figure 3.40).

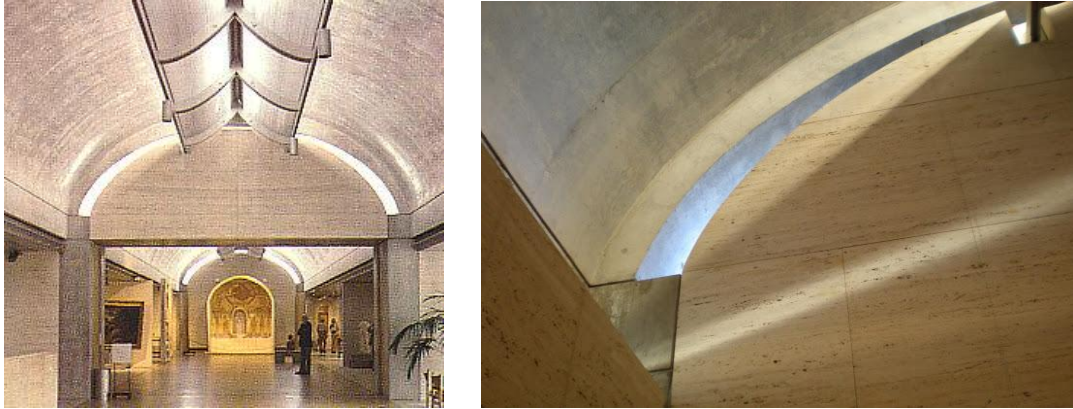


Figure 3.39 : Kimbel Art Museum, Texas, Louis Kahn , roof reflector system and slith on vaulted ceilings (Url - 26).

Plate's central section does not have any perforations in order to prevent direct daylight to inside. To soften harsh daylight , plants are placed in interiors. This unique design idea creates a feeling of entering/ exploring a daylit space on visitors as well as providing the possibility to experience works of art under daylight (Figure 3.40). Expected lighting scenerios and reflector properties are calculated with computer programmes. Besides, under the reflector systems, when necessary, tracks and spots are placed (Url - 29).



Figure 3.40 : Kimbel Art Museum, Texas, Louis Kahn plants in inner courtyards to prevent harsh sunlight (Url - 29).

Perforated Openings may convey a symbolic meaning, a message of a culture. Shadows created under light form various atmospheres. If the interior space is exposed to daylight, shadows of perforations differ in shape and size creating a variety of lighting expression during different times of the day. These changes alter the perception of people in the space changing their emotions. The Louvre Abu Dhabi can be given as an example to this situation. The dome of the museum has a special roof with perforations, creating a game of shadow and light during the day creating changing atmospheres. The museum is also providing its visitors to explore exhibition under a rain of light during the day forming a spiritual atmosphere (Figure 3.41).



Figure 3.41 : Interior view of dome of The Louvre Abu Dhabi (Url - 30).

In interiors, patterned screens tend to blur the distinction between interior and exterior space. Screens mediate the direct sunlight by casting intricate shadow patterns in the interior space. In other words, the patterns serve as a projector reflecting the screen.

Spirituality of Kaust Mosque is enhanced with calligraphy tradition. Artwork placed inside the window is interacting with sun creating a patterned interplay of shadows in interior. Under daylight, patterned openings can create patterned shadow plays and convey a cultural meaning (Figure 3.42).



Figure 3.42 : Kaust Mosque, Patterns serving as a reflecting screen (Url - 31).

Another quality of perforated openings is reflecting changing colours of the day to interiors. Reflecting this quality to interiors enhance spirituality in places related to related to faith and religion as in the example of Saiyyed Mosque, India. Variation of daylight is correlating with patterned openings re-creating spiritual atmospheres during the day. Each opening on facade is made of perforated artworks (Figure 3.43, Figure 3.44).



Figure 3.43 : View of the perforated openings on facade, Sidi Saiyyed Mosque, India (Url - 32).

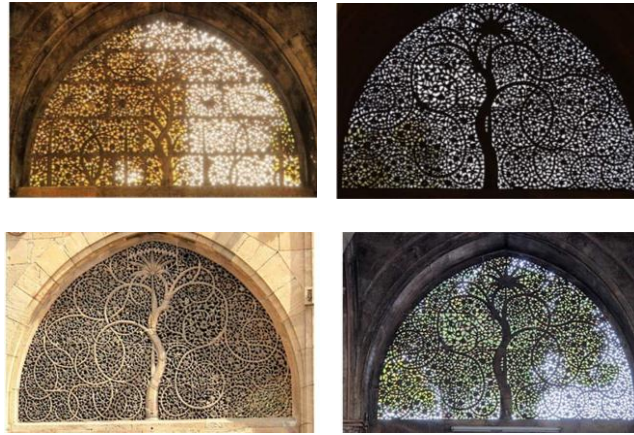


Figure 3.44 : Perception of the lattice facade opening under different shades of daylight, Sidi Saiyyed Mosque, India (Url - 33).

In the example of see-through church in Belgium patterns are acting as a projector reflecting the screen as well as being a part of it. Depending on where the viewer stands, the perspective of the viewer changes. It is perceived as a massive structure, or dissolves into the landscape. When look from the inside to the outside, an abstract play of lines is experienced (Figure 3.44). In this way, landscape also serves as the material of the building. The church makes the subjective experience of the landscape visible, and vice versa. Horizontal plates are providing transparency (Figure 3.45).



Figure 3.45: See-through church, Looz, Limburg, Belgium, by Gijs Van Vaerenbergh (Url -34).

Perforated openings can also be used together with artificial light to create specific atmospheres. On the example of The Optical Wall for CREA light, the aim was to create a dreamy interior with interplay of light and shadows. Perforated external

facade is diffusing sun forming various shadow plays. The main idea is creating a relaxing atmosphere with only light, so that other design elements like furnitures are even fussy or transparent. For the night atmosphere, an artificial light installation mounted on the dividing wall is applied to complete and maintain continuity of the pure, relaxing affect achieved during daytime. Perforated openings of interior and exterior are forming a bond between daylight and night atmosphere. Perception of people in the interior is directed with light to achieve a pleasant and relaxing atmosphere (Figure 3.46).

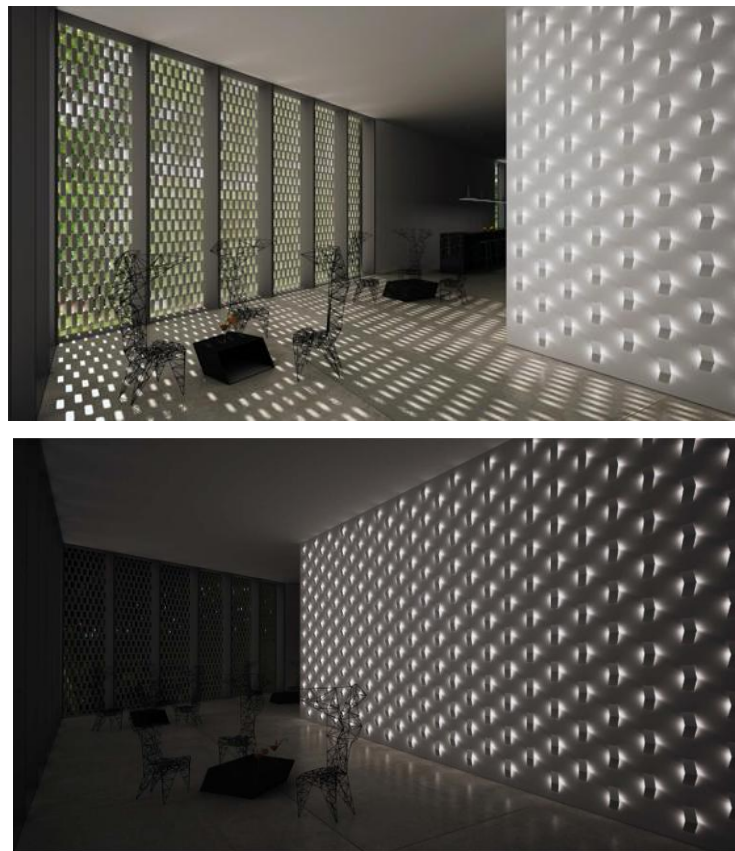


Figure 3.46: Space concept for CREA light application, daytime versus nighttime, Poland (Url - 35).

3.2.2. Perception of materials, surface finishes and colors

Materials are key to understand light in architecture. Emphasis on material is grounded by the interaction between light and material. Two qualities : colour & their finish are the most important in this regard. Colours have an impact on people

altering their emotions, decisions and judgements. Colour has three aspects: hue, value and intensity as a material. Value determines how much light is absorbed and how much is reflected (M. S. Millet and Barrett, C. , 1996). Various materials have different reflection levels. This fact affects the visualisation and brightness levels of an interior. Reflective properties of the surface being illuminated is a necessary information in daylight interiors.

Table 3.1: Different reflection levels of some materials , IESNA Catalogue
(Url -36).

Room Surface	Reflectance Value
white acoustic-tiled ceilings	70 to 80%
light-colored walls	40 to 60%
Carpeting	15 to 30%

If light hits an opaque surface some of the light is absorbed and some of it is reflected. Example of surfaces as fabric, paper etc. cause diffuse reflection which means the light reflected from the surface is diffused equally in all directions (M. S. Millet and Barrett, C. , 1996). Reflectance values of some materials are given (Table 3.1).

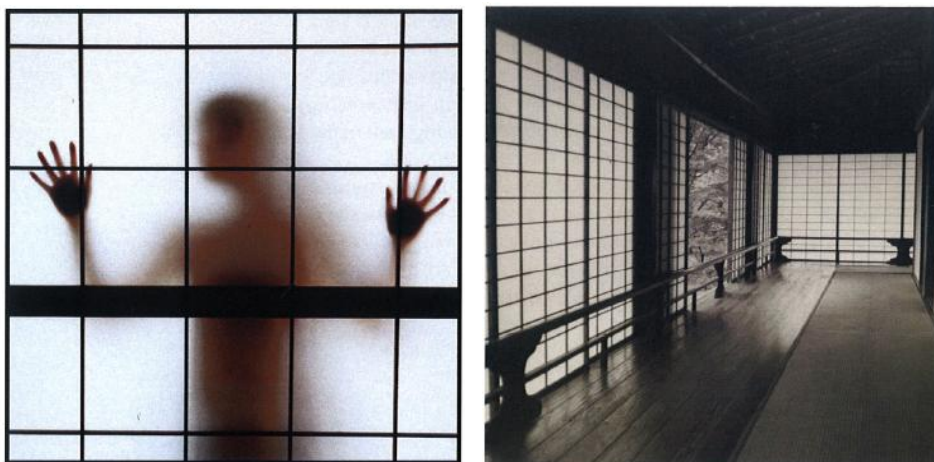


Figure 3.47 : Shoji screens.of Japan houses (Ungrungseesapon, 2012).

Shoji screens of Japan houses are an example of materials with diffuse reflection. Shoji paper is made of fibers of a tree called kozo. The paper has a specific transmittance that allows just the right amount of light to diffuse through the space. Sunlight is diffused evenly to the interiors softening the harsh light rays. Shoji's paper surface scatters sunlight evenly, making it soft to the eye and allowing light to distribute evenly. At night, the material also helps lighting the rooms reflecting the artificial light and increasing overall brightness. Another quality achieved is privacy as it is translucent not transparent like glass. Also, possible glare problems that may disturb the eye is prevented. In the example Shoji screens are used as room divider and light diffuser (Figure 3.47).



Figure 3.48: Memu Meadows Experimental House under overcast sky versus under clear sky, by Kengo Kuma, Hokkaido, Japan, all images Courtesy of Kengo Kuma (Url - 37).

The house of Memu Meadows is another example of using materials with diffuse reflection. Project's aim was regenerating the traditional houses which used natural materials. Outside of the double skin membrane is made of a polyester fluorocarbon tarp while the interior is composed of a glass-fiber cloth membrane (from recycled PET bottles). The idea was saving the heat from the fireplace to maintain comfortable temperatures during winter by heat insulation. The design idea needed to have a barn house typology but, instead of a thick, solid insulation double skin membrane idea is implemented. The material properties are allowing light to create a diffuse day-lit atmosphere inside letting the occupants experience the changing weather conditions, seasons and different times of the day while maintaining a constant temperature. Figure 3.48/1 shows the interior under overcast sky. Gloomy outside atmosphere is reflected to the room. Weather condition is perceived without looking outside from the window. Figure 3.48/2 shows the perception of space under clear sky conditions. Liveliness of shining sun is perceived in interiors (Url - 37).



Figure 3.49 : Daylight House of Takeshi Hosaka (Url - 38).

Different materials create different moods. Under different light sources, a material can change color or texture. This quality is more obvious in interior spaces designed with daylight. During the day, lighting levels change outside, altering atmosphere of the interior space as in the Daylight House of Takeshi Hosaka (Figure 3.49). The atmosphere rapidly changes inside on different times of the day with daylight diffusing through a grid arced roof lighting system (Url - 38).

The house does not have any windows. Daylit atmosphere is achieved with use of a gridded ceiling light from above. The ceiling has a wooden structure and each skylight has a white translucent acrylic sheet below. The vertical daylight forms as "distorted squares". Between the roof and ceiling light, there is an air space, which distributes the light evenly. In the summer, the warm air is directed outwards, in winter, the air space serves as a heat buffer.

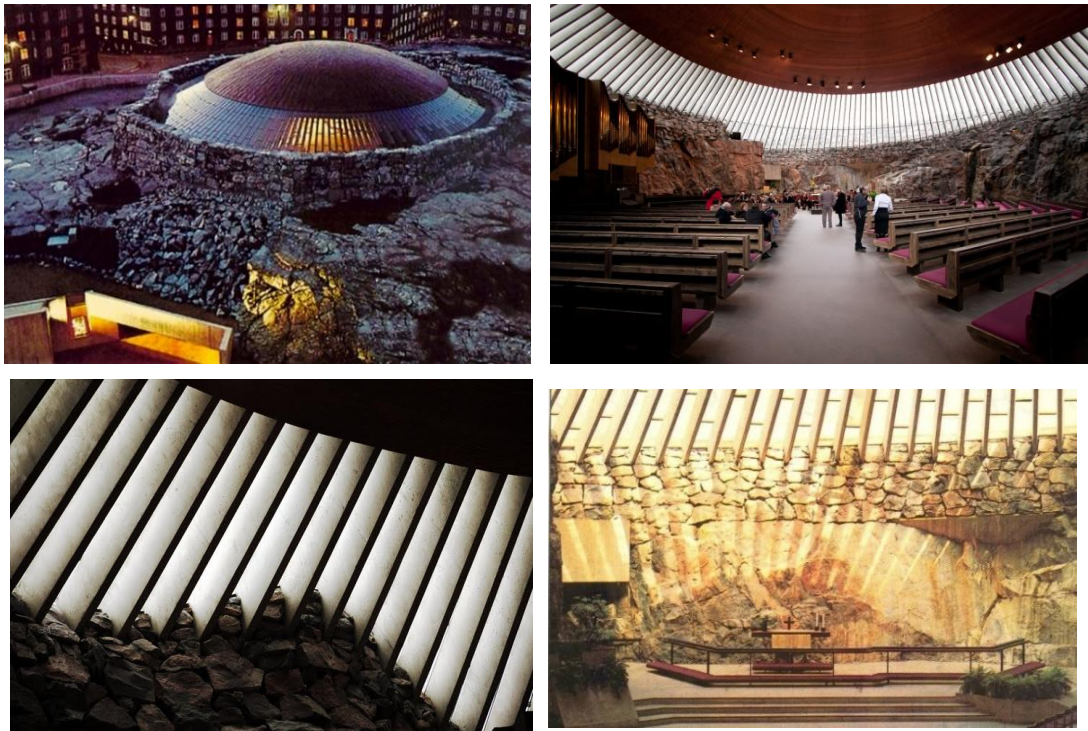


Figure 3.50: Temppeliaukio Church, Finland, Helsinki, Timo and Tuomo Suomalainen, 1968-69 (M. S. Millet and Barrett, C. , 1996, p.68) .

Various materials react to daylight differently, creating a wide variety of sensations. Shiny metal surfaces such as chrome or silver cause specular reflection. The visualisation and brightness levels of an interior space is affected by specular reflection. In Temppeliaukio Church, for example, combination of materials with

different reflection levels is creating a spiritual atmosphere. Diffuse daylight enters the space through rectangular plates of metal grids forming reflections on natural stone walls of the altar, enhancing the holy feelings (Figure 3.50).

Specular materials which have glossy finishes reflect light like mirror so it is also named as mirror reflection. Matte surfaces like wood or natural stone reflect light and diffuse equally in all directions. When light passes from one transparent element to an other element with a different density refraction occurs. For example from air to glass the light refracts perpendicular to surface (Gordon, G. , 2003).

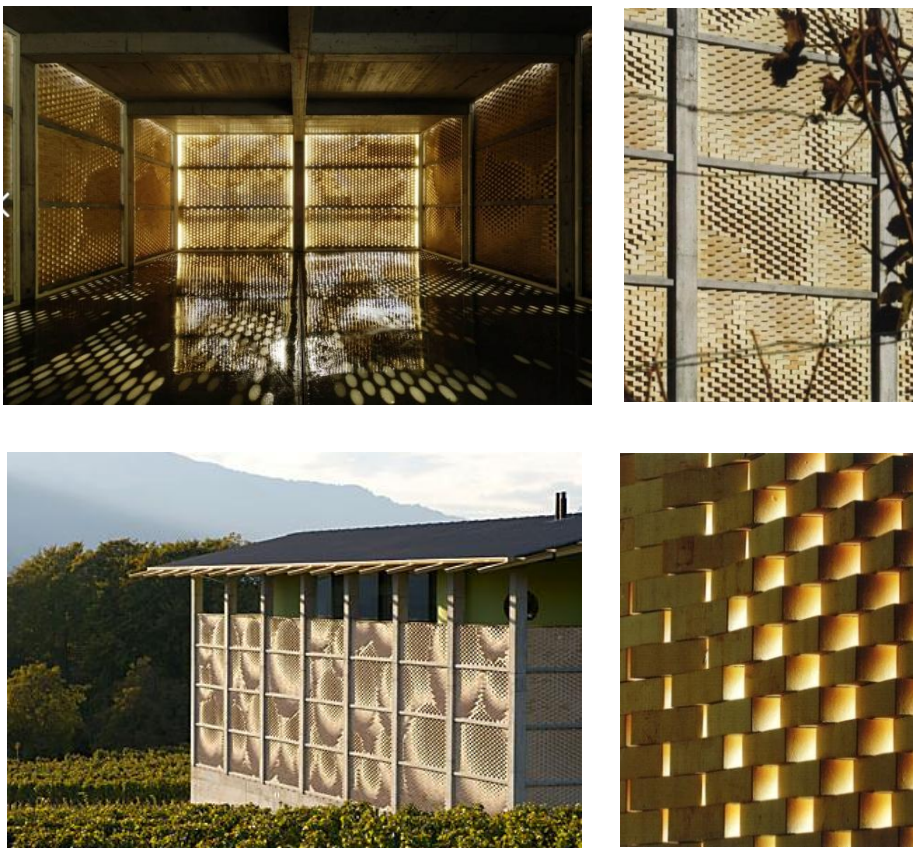


Figure 3.51: Gantenbein Vinery, Switzerland (Url - 39).

Stone is the most significant structural material of architecture. Thickness, safe and rigid appearance of stone has made it very popular for centuries. However, even stone can be very inviting and cozy when it is designed with daylight. Gantenbein vinery is a vine facility located in centre of Switzerland Alps (Figure 3.51). The architecture of the facility is shaped with daylight to use old conventional methods of vine production (Url - 40).

Location of the building is chosen according to the sun, rain, wind and temperature changes. Idea of building a facade made of stone but with perforated openings is implemented to plan temperature and lighting ideally for vine production. Bricks are placed within an order calculated in computer programmes. Also, the patterns changing on the facade are planned and calculated to resemble grapes, leaves and clouds to create a natural atmosphere. The view is changing constantly as the visitors move around the building. Because of the changing quality of the daylight atmosphere inside is also constantly in change (Lee Ga Young, A., 2009).

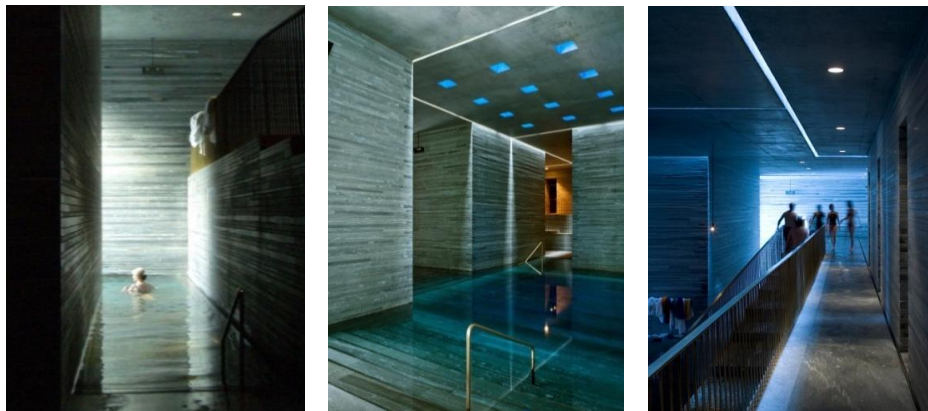


Figure 3.52 : The Vals Thermes by Peter Zumthor, Switzerland (Url - 40).

Use of natural materials like water, stone, glass are designed with daylight to shape relaxing interiors. The Vals Thermes by Peter Zumthor is a combination of natural elements light, water and color (Figure 3. 52). Stones and water reflect light in different colors from blue to green. The light is serving as a sensation tool creating a tranquil atmosphere inside. Light also provides directional beams for orientation of occupants well as differentiating inside from outside (Url - 40).



Figure 3.53 : Tadao Ando Meditation Space, UNESCO Paris, France (Url - 41).

Space For Meditation is a personal project by architect Tadao Ando. It was built for the 50th anniversary of United Nations. Simple use of water, light and air create an atmosphere for contemplation (Figure 3.53). The daylight is entering the space from a thin slit from the ceiling symbolising spiritual freedom. The stones on the ground are made of granite exposed to the atomic bomb in 1945 in Hiroshima and Nagasaki while the cylindrical structure is made of reinforced concrete (Url - 41).

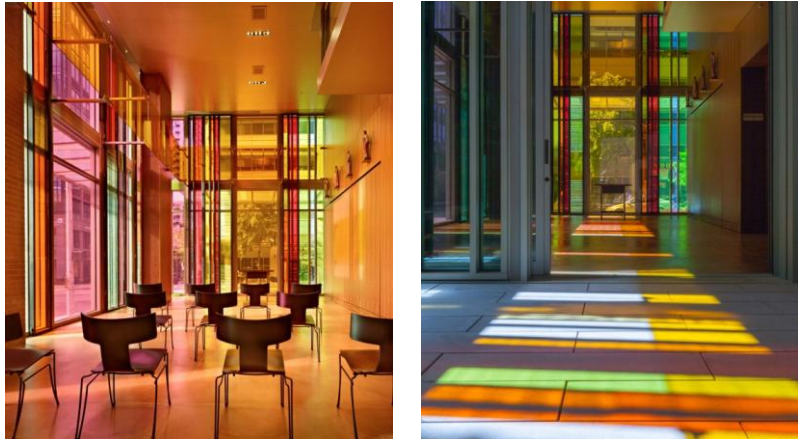


Figure 3.54 : The colors reflections are constantly changing (Url - 42).

Clear glass and coloured glass have also been used in churches, mosques and cathedrals to support spirituality. Interchanging interior of Gethsemane Lutheran Church on Figure 3.54, is enhancing faith and spirituality via multicoloured reflections.

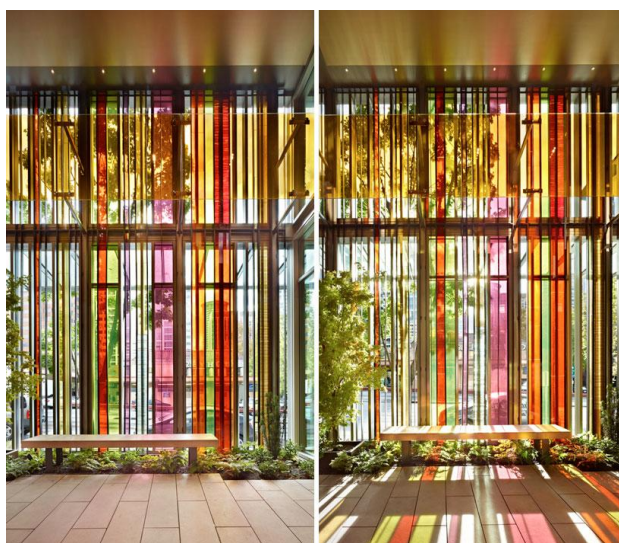


Figure 3.55 : Views of the sidewalk chapel at different times of day, Gethsemane Lutheran Church (Url - 43).

The chapel is made of a combination of reflections and refractions of colourful glass patterns are forming vivid reflections on the ground. Colours are chosen in warmer tints of colored, clear and translucent glass forming a rain of light. As it could be seen on Figure 3.55, perceived atmosphere differs on times of the day and days of the year according to the changing angles of penetrated sunrays (Url - 44, Url - 45).

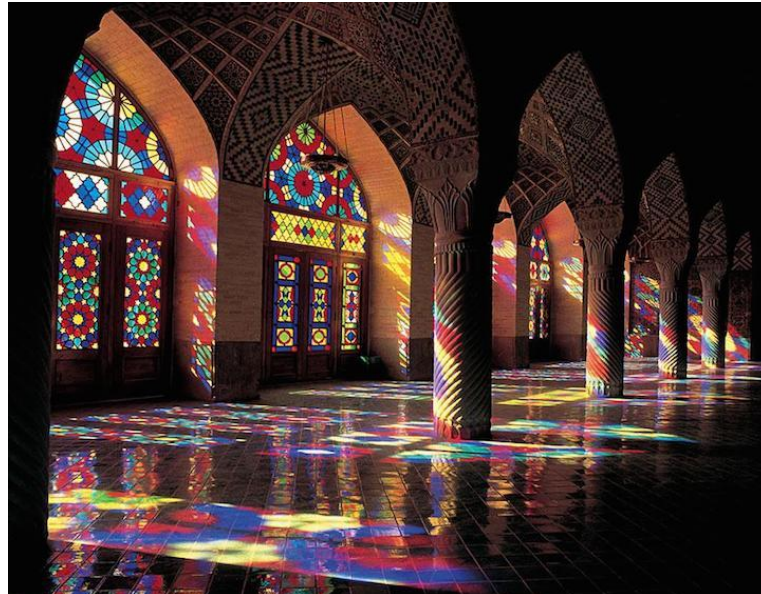


Figure 3.56 : Reflections of multi- coloured glass on ceramic tiles of the floor, Nasir Al Mulk Mosque, Iran (Url - 44).

Another example of coloured glass application's affect on perception in spiritual interiors is, Nasir Al-Mulk Mosque which was built from 1876 to 1888 in Shiraz, Iran and still has been used as an active worshipping space. In Islam pictures of profits or religious scenes is forbidden. So, Islamic architecture is focused on colour, and materials. The mosque is constructed out of wood and ornamented with ceramic tiles and coloured glass (Url - 45). Persian rugs on the floor are enabling comfortable praying as well as forming the base for colourful reflections from the windows. Ceramic tiles are reflecting the colours like a screen while reflections on the surface of carpets are more softer (Figure 3.56, Figure 3.57). With the changing angle of the sun rays and weather conditions interior is re-creating itself. Figure 3.57 shows the interior in the morning when the sun rays are vertical and in the late afternoon before the sunset when the angle of sunrays is inclined (Url - 45).

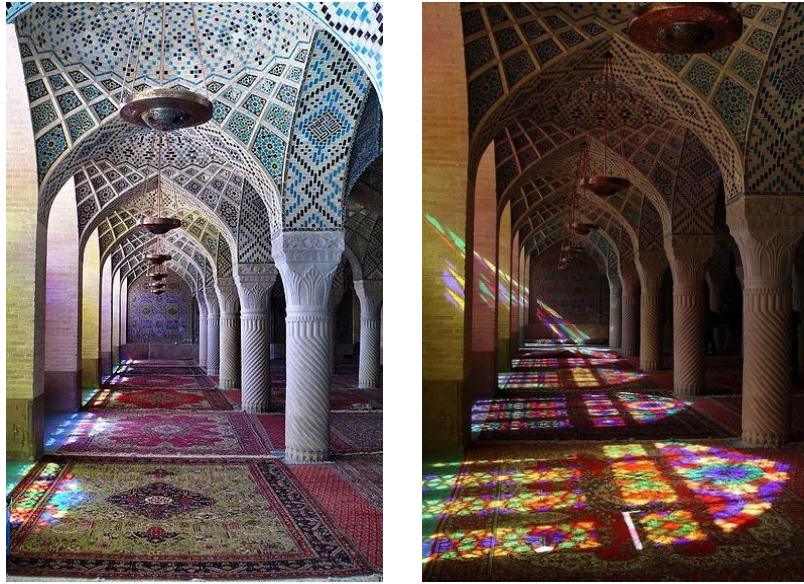


Figure 3.57 : Interior at different times of the day, Nasir Al Mulk Mosque, Iran
(Url - 45).

3.3. Resume on perception of daylit interiors

Sun is the only natural light source of the universe. Daylight is desired by people in every area of daily life as humans were alien to electrical light just a few centuries ago. Observations supplied with evidences on light's effect on human perception, health and behaviour can be found in research. Daylight qualities effect human and his perception of interior in which they live in. Variability, orientation, color of light, shadows and darkness- brightness have different dynamics of affecting people's perception. Variation of light enables different atmospheres. Daylight is rapidly on change. Variation let us experience, percept the same interiors from a diferent point of view. Different atmospheres lead to several sensations.

People orient themselves according to daylight as well as being informed about different times of the day, seasons of the year. Daylight in a room at 8.00 in the morning and at 12.00 in the afternoon are different. Simply, looking out of the window people estimate time. Color of daylight is unique as it involves all colors in it in contradiction to artificial light sources. So, its rendering quality and power of giving meaning to the space are fascinating. The same space provide different perceptions under different colors of daylight.

Shadows are vital for existence of light. When sunlight hits an object, a partial obscurity of shade occurs. People orient themselves according to light as well as to shadows. For example, on a hot summer day, under harsh sunlight, shade of a tree is a savor. Also, shadows are used as a design element for architecture by being manipulated via facade openings. Perception of space can be shaped by contradiction between light and darkness to create an aimed impact on people. Light and dark enhance religious feelings or give a specific message to people. In addition, imbalanced rhythms of darkness- brightness affect physical and psychological health of people unfavourably. Continuous darkness damage biological clock of people misleading secretion of needed hormones and cause circadian rhythm disorders.

Besides, daylight's interaction with spatial qualities of an interior space has consequences on perception of people in interiors: Openings admit daylight into the living spaces and are crucial to provide comfortable vision, view and perceptions. Also, they serve as a connection between indoors and outdoors. Penetration of daylight into interiors through various types, shapes and placement of openings form a variety of perceptions on people. Light diffuses into the space through an opening interact with materials that can change color or texture under different shades of daylight. This interaction differs according to unique reflectance levels and color properties in interiors. Diverse perceptions are achieved each time daylight interacts with space.

4. PERCEPTION OF ARTIFICIALLY LIT INTERIORS

Lighting design scenarios are generally focused on the idea of having enough light to perform a task which involves vision. Occupants' behavior or impressions are not as important. Nevertheless, there is enough evidence supporting the fact that light interferes with the visual experience of people within a space intentionally or unintentionally by guiding circulation, focusing attention and also affecting impression of a room or activity. On this section, first of all, artificial light qualities within interiors such as illumination level, direction and spatial distribution of light, degrees of brightness - contrast, colour of the light sources in relation to colours of the surface textures and intended activity are explained.

Then, perception oriented artificial lighting is investigated. Degrees of excitement, fundamental lighting concepts and their affect on atmosphere creation are explained with examples. Finally, subjective impressions achieved by manipulating lighting patterns to affect people's psychological assumptions of an interior space are explained according to John Flynn's theories. How to achieve five impressions, named as spaciousness, visual clarity, privacy, relaxation and pleasantness by Flynn is explained with drawings and observations on short examples (Flynn, 1988).

4.1. Artificial light properties within interior space

4.1.1 Illumination level

The first investigations on necessary lighting conditions were merely focused on establishing optimum visual performance. Visual performance requirements are different for each visual task. Generally, the required illumination level differs according to the size of the object and contrasts in the visual field. For example necessary lighting conditions to see and visually perceive objects for table tennis and backgammon are different. The lighting conditions could be thought as a combination of the quantity of light, luminance limits and luminance intensities required for each specific situation.

Table 4.1: Typical illuminance levels in interior spaces (IESNA,2000, p. 10 - 13).

Typical illuminance levels in interior spaces	Ranges of Illuminations (Lux)
Minimum value in interior spaces , excluding working areas Illuminance level required for recognizing facial features	20
Minimum illuminance for workplaces in continuous use	200
Maximum illuminance at standart workplaces	2 000
Illuminance levels for special visual tasks e.g. in operating theatres	20 000

Visual performance generally improves when the illuminance level is increased. However, extremely high illuminance decrease visual performance because of glare. When the degree of difficulty of the visual task increases, the recommended illuminance levels increase. Detailed visual tasks require even higher illuminance levels (Table 4.1). However, these standards concentrated on amounts of light are not enough to explain perception of people. Perception of interiors is more than the amount of light in the interior space. Light spreads within the space in several directions and is reflected by the surface finishes, furnitures, walls and ceilings. Here, direction and disribution of light should be taken into account. Then, luminance (brightness) contrast and possibilities of glare and sparkle needs to be examined (Table 4.2).

Table 4.2: Typical illuminance levels for various activities (IESNA,2000, p. 10 - 13).

Typical illuminance levels for various activities	Ranges of Illuminations (Lux)
Public spaces with dark surroundings	20-50
Simple orientation for short temporary visits	50-100
Working spaces where visual tasks are only occasionally performed	100-200
Performance of visual tasks of high contrast or large scale	200-500
Performance of visual tasks of medium contrast or small size	500-1000
Performance of visual tasks of low contrast or very small size	1000-2000
Performance of visual tasks of low contrast and very small size over a prolonged period	2000-5000
Performance of very prolonged and exacting visual tasks	5000-10000

4.1.2. Direction and spatial distribution of light

The lighting of a room can be designed in a a wide variety of ways in interiors with several directions , distributions and types of lighting. All these variables are unified under the name of luminance/lighting patterns. One of the most important criteria is

spatial distribution of light. Several lighting types are used to distribute light beams toward space. The two basic lighting types are downlighting and uplighting. Downlighting is actually managed by direct light sources and uplighting is managed by indirect light sources. Other specific lighting types can be classified as wall washing, grazing lighting (Figure 4.1).

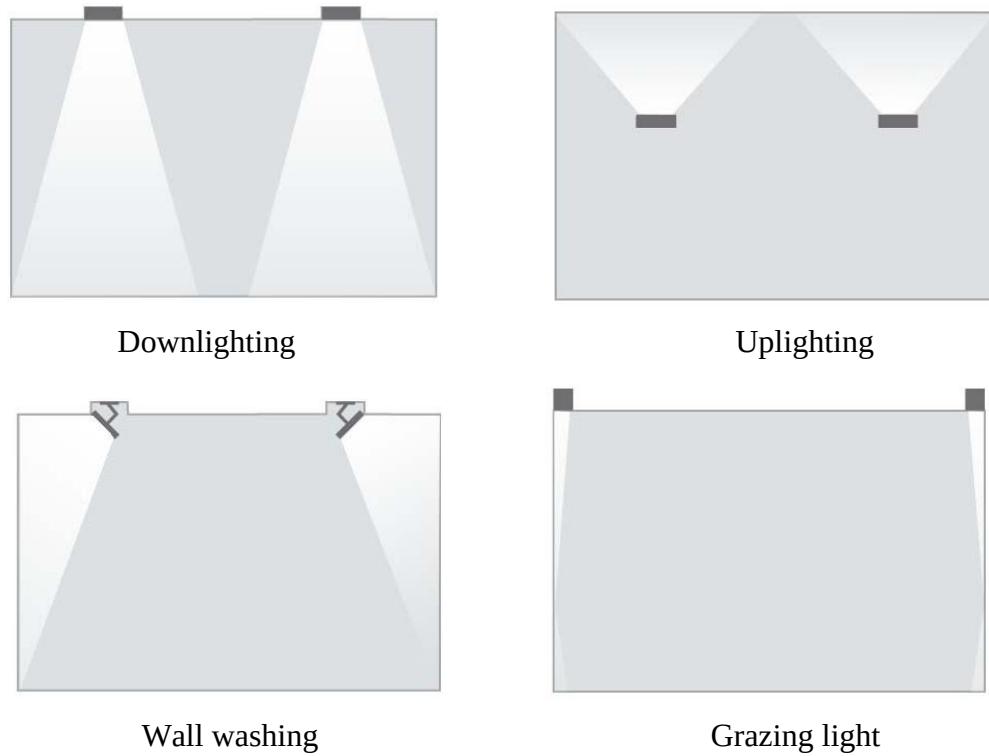


Figure 4.1 : Lighting types (Gültekin, 2014).

It is possible to manipulate people's perceptions by playing with these variables. For example direction and spatial distribution of light can change the sensational quality of an art work dramatically. Sculpture of Lincoln in the museum lit artificially by downlights to emphasise strong and confident character of the model (Figure 4.2). However, reflections of sunlight in interior causes reflections from the floor and he looks scared. This example is the proof of wrong planning of direction of light is able to change the intended expression and give an unintended perception. Architecture itself can be used to hide uplighting fixtures. In the example of department store uplights are hidden in the niches not to damage daylighting effect achieved with huge arced glass window (Figure 4.3).

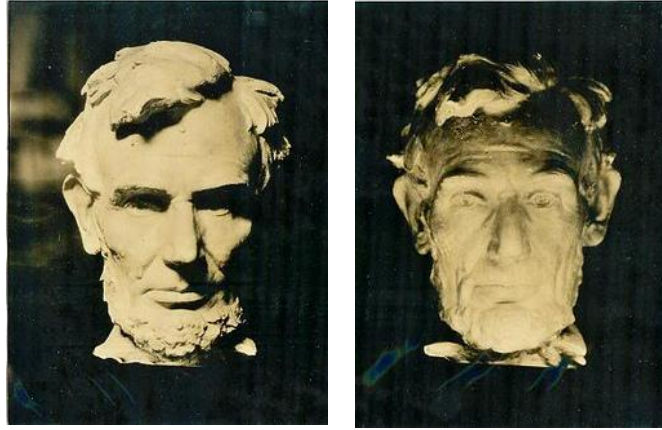


Figure 4.2 : Statue of Abraham Lincoln by Daniel Chester French, Washington (Gordon, G. , 2003).



Figure 4.3 : Uplighting hidden on the ceiling of a department store (Url - 46).

To decrease tension in an interior, uplighting fixtures can be used to create perception of a wider space. In Altes Museum of Berlin, ceiling height of the ground floor is extremely low.



Figure 4.4 : Altes Museum, Egypt Collection, Berlin, Germany (Gültekin, 2014).

The room is away from daylight and have proper climatic conditions to preserve exhibition objects. In order for visitors not to feel like being in a confined interior uplighting fixtures are directed to the ceiling to manipulate perception (Figure 4.4).

Uplighting can also be fixed to the ground level. In Vatican Museum on Figure 4.5, uplighting fixtures on the ground are making it possible to see the work of art on the ground and the ceiling (Cuttle, C., 2009).



Figure 4.5: Vatican Museum, Raphael Room, Rome, Italy (Cuttle, C., 2009, p. 73).

Interiors appear brighter and more spacious by lighting the walls. Wall washing and grazing light are two techniques that change perception of a space by differentiating the appearance of wall surfaces. Wall washing is applied on vertical surfaces in order to make an interior space to be perceived larger and more inviting. It is useful to hide the imperfections of wall surfaces. Also, the lighted wall appear as if it is a bright background. To create a soft wall washing, lighting fixtures should be distant from the wall. In museums, wall washing is applied on vertical surfaces in order to highlight paintings and artworks (Url - 47). Zhejiang Art Museum on Figure 4.6, is offering contemporary exhibitions to the visitors. Wall washers mounted on the ceiling are enabling the occupants to perceive the works of art under required lighting levels as well as creating the impression of being inside a larger interior space (Url - 47).



Figure 4.6: Wall washers, Zheijang Art Museum, China (Url - 47).

Grazing light accents texture quality of walls and provide dramatic effects by accentuating the details via forming shadows. On Figure 4.7, a living room with grazing light application on wooden shutters is shown. Here, grazing light is enhancing the surface quality of the wood strengthening the comfortable living room atmosphere.

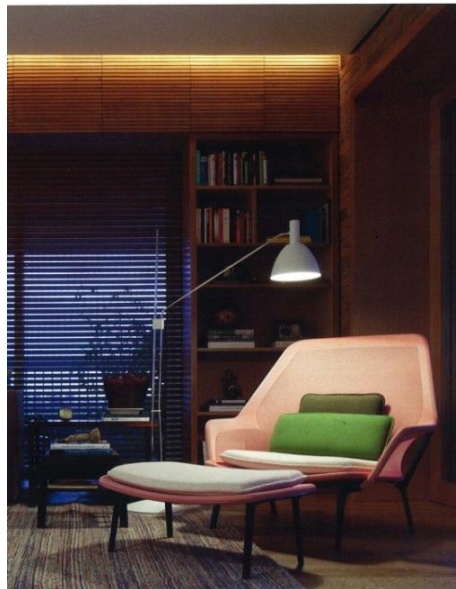
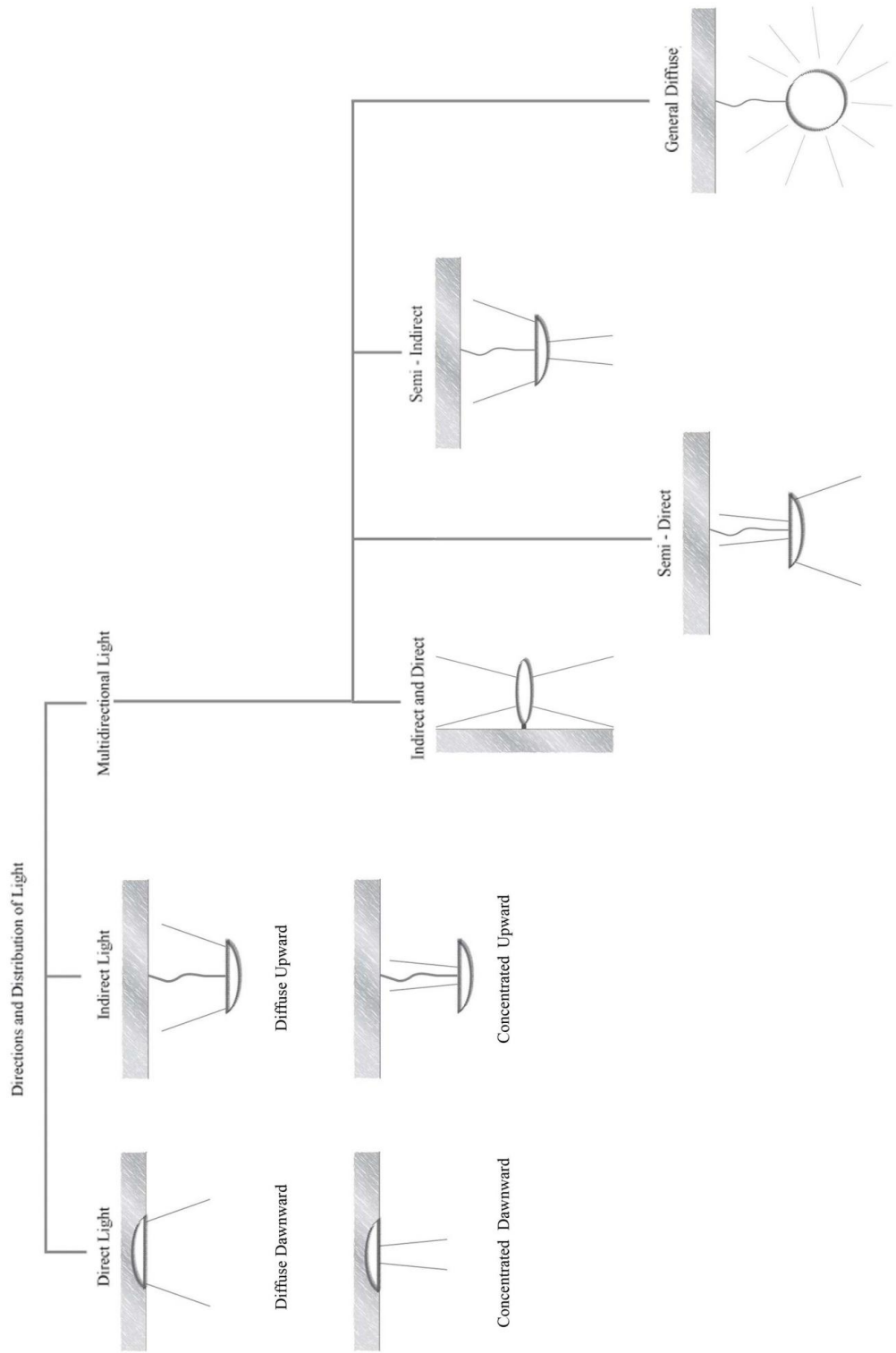


Figure 4.7: Grazing light application on wooden shutters (Lict + Wohnen, p.58).

An artificial light source spreads light in three different ways : Direct, indirect and multidirectional and two types of distribution ; concentrated or diffuse. Multidirectional light sources are grouped as Semi-Direct, Semi-Indirect, Direct-Indirect and General Diffuse. Table 4.3 summarises direction and distribution types of artificial light sources. Information on table is derived from Interior Lighting for Designers by Gary Gordon.

Table 4.3: Table of Directions and Distribution of light with explaining drawings (Gültekin, 2004).



Another classification is made according to the distribution of quantity of light. According to the total percentage of quantity of light distributed above and below the horizontal plane general indoor lighting equipments are classified by the C.I.E as in the Table 4.4.

Table 4.4: C.I.E. classification for indoor lighting luminaires (Url - 52).

Luminaire type	% Upward flux distribution	% Downward flux distribution
Direct	00 - 10	90 - 100
Semi-direct	10 - 40	60 - 90
Direct-indirect	40 - 60	40 - 60
General diffuse	40 - 60	40 - 60
Semi-indirect	60 - 90	10 - 40
Indirect	90 - 100	0 - 10

Direct light can be concentrated/focused downward or diffuse downward. Generally Diffuse light emission, does not cause direct glare because it has a wide angular spreading angle. Indirect light can be concentrated upward or diffuse upward. When the light rays are spread with narrow patterns from a luminaire, the distribution is called Concentrated Distribution. In opposition to this, when the light rays spread with a wide pattern from a luminaire, it is called Diffuse distribution (Gordon, G. , 2003).

Gordon states that low ceilings with concentrated downward light causes strongly illuminated light zones on the floors. So, the spaces in between form dark areas. To prevent this, luminaries should be located extremely close to each other. He also

states that interiors with low ceilings should have diffuse downward lighting equipments (Gordon, G. , 2003). On Figure 4.8. a hotel bath with a low ceiling is lit with concentrated downward downlights. The sapace between the light sources is kept very narrow to prevent undesirable dark areas.



Figure 4.8: Direct - concentrated downward, Hotel Risorgimento, Lecce, Italy
(Lightlife, 2011, p.18).

Indirect (upward) lights are directed to the ceiling, so a wide area of the ceiling is lit. Light is reflected from the ceiling , but reflected light has low luminance so it doesn't cause discomfort glare. Concentrated upward lighting directs light rays to the ceiling, so ceiling also acts like a secondary light source (Gordon, G. , 2003). On Figure 4.9 light is spread upward with a very narrow beam (concentrated upward).



Figure 4.9: Indirect – concentrated upward, Nhow Hotel, Milan, Italy (Lightlife, 2011, p.19)

Light reflected from the ceiling has very low reflection, so it doesn't cause any discomfort. Reflected light from the ceiling is serving as a second light source as Gordon says. Also, light spread upward and reflected light from the ceiling is highlighting the vertical walls, forming a pathway leading the occupants to the hotel lobby. So, it can also be said that distribution of light enables defining spatial borders and emphasising architectural elements in interiors.

The business space of Olympic Hall in München is shown in Figure 4.10. Indirect diffuse light application on the high ceiling spreads light on horizontal surfaces. So, there are no sharp differences between light and dark parts. Horizontal surfaces of the meeting tables are well lit. Low ambient brightness is achieved (Url - 48).



Figure 4.10: Indirect diffuse upward light application of the the business area of Olympic Hall in Munich, by Pfarré Lighting Design (Url - 48).

Diffuse Downward Distribution of Light (with spreading angle between 80° and 120°) provide more opportunities than concentrated downward lighting for various lighting requirements (Gordon, G. , 2003). The atmosphere achieved in the space has low contrast.

Staatsgalerie Stuttgart is an example of diffuse downward light distribution. The exhibition rooms have high ceilings. Distribution of diffuse light create an equal emphasis and low contrast all over the space (Figure 4.11).



Figure 4.11: Direct - diffuse downward light distribution, Staatsgalerie Stuttgart (Url - 49).

Direct-indirect light sources spread 50% of the light directed up and other 50% of the light directed down as in the example of Corte San Pietro Hotel rooms. Light sources look like as if they are a part of the walls. Low ambient luminance is achieved all over the room. Besides, daylight spread into the room from roof opening is supported (Figure 4.12).



Figure 4.12: Multidirectional light emission from Direct-Indirect light source, Corte San Pietro Hotel by Daniela Amoroso (Url - 50).

General – Diffuse light spreads light in all directions. Luminaires of Theodore – Cafe Bistro are spreading diffuse light into the space. The lighting fixtures are placed above the eye level so they are not creating discomfort glare (Figure 4.13).



Figure 4.13: Theodore – Cafe Bistro , Israel (Url - 51).

Enhancing the three dimensional effect is possible by playing with direction and distribution of light. According to distribution angle and direction of the light beams, distribution of light differs. Combination of light spreading from different directions (from top, below, back) enable various perceptions. On Figure 4.14, lighting situations of Statue of Aphrodite of Cnidus is given. Diffuse light distribution spreads light in all directions.

On Figure 4.14 / 1, diffuse front lighting forms no shadow at all. On Figure 4.14 / 2, light source is located on the right side; on Figure 4.14 / 3 light source is located on the right side and another light source behind; and on Figure 4.14 / 4 light source is located on the top and another light source is located behind. On each lighting situation perception of the statue is different, but the shadows are always soft and the details of the statue are not clearly distinguished. The perceived impact is fussy. On Figure 4.14 /5 however, light is diffusing from the top and also to the front of the statue. The perceived impact is dramatic with clearly distinguished face details. On the last image Figure 4.14 / 6, the statue is lighted only from the back. On his setting, shape of the object is emphasised, but details are hidden.

Each lighting scenario creates a unique perception and this process is achieved by playing with physical variables of light. Figure 4.14 shows how the perception of the same object is changed with different lighting patterns and consequently different spatial distributions of light.

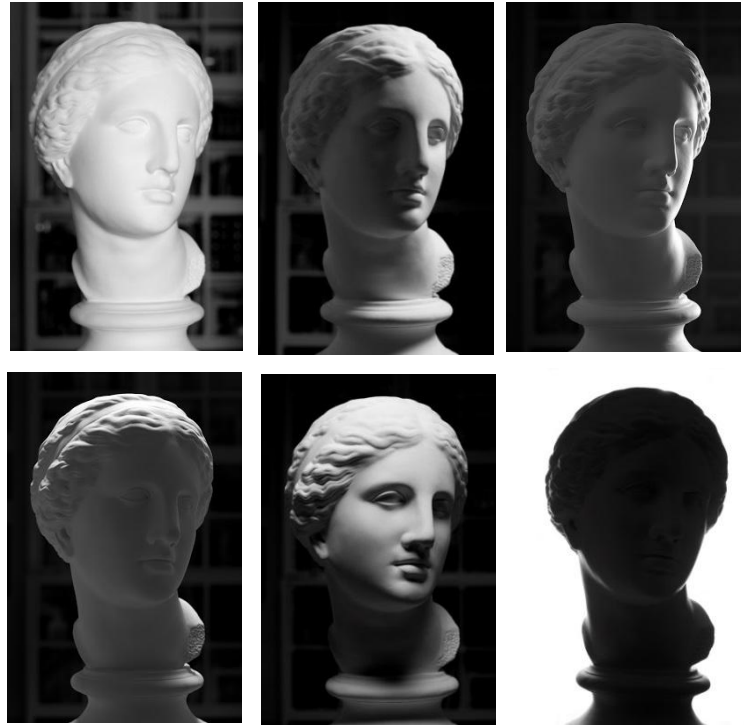


Figure 4.14: Different perceptions achieved with different directions of diffuse and directed lighting, Statue of Aphrodite of Cnidus (Url - 53).

1. Diffused front lighting
2. Diffused vertical lighting from the right side
3. Diffuse lighting from behind and to the right side
4. Diffuse lighting from the top and behind
5. Diffuse lighting from the top and front
6. Diffuse lighting from the back

It is the fact that visual perception enables data from the surrounding environment with light, but this data aguisation process takes part between light, percieved object and human. As Gansfald and Hofmann states; designing lighting situations counting on only qualitative information will cause problems (Gansfald & Hofmann, 2009). People do not percieve illuminance, the visual environment that is lit is percieved. In other words, distribution of light is also affected by elements in the space. How light interacts with surface finishes, brightness contrast levels, reflectancy of the materials in the space will be explained in the following steps.

4.1.3. Brightness contrast, reflectance and glare:

Brightness is the light reflected from a surface toward the occupant's eye. Surface reflectance qualities and intensity of light falling on a surface change the visual perception of an interior. Gordon says perception is independent of the quantity of light entering the eye; it is based on the quantity of contrast: the differences between light and dark (Gordon, G. , 2003).

Since, sense of sight is sensitive to the brightness contrast of a space, brightness is used to create an emotional impact. Individual impressions of a space are a function of brightness contrast. The degree of brightness contrast affects emotional setting as well as encouraging the intended activity. A medium grey area will appear light grey if it is bordered in black, or dark grey if it is bordered in white (Figure 4.15). This can be explained by a scientific fact that the stimuli perceived is processed directly - brightness is perceived as a result of the lightness contrast between the grey area and the immediate surroundings (Gansfald & Hofmann, 2009).

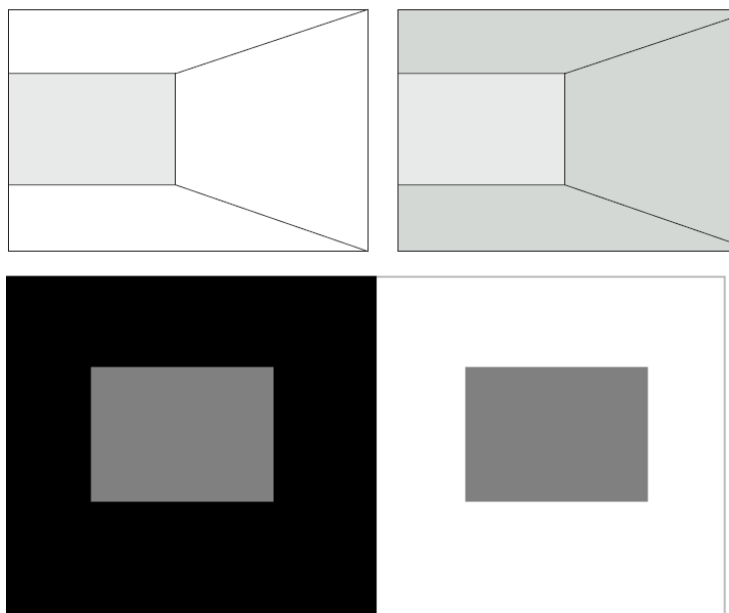


Figure 4.15: A medium grey area will appear light grey if it is bordered in black, or dark grey if it is bordered in white (Ganslandt & Hofmann, 2009, p.30).

Brightness contrast in tunnels can be given as example to this situation. Due to the dark surrounding, the exit of a tunnel looks even brighter than it really is. This is

caused by inability of eye's adaptation to two merely different luminance. Because of that drivers have difficulty in adapting to brightness. Due to this dangerous situation, to prevent harsh contrast changes, tunnels usually require site specific lighting scenarios. The longest tunnel in the world is 245 km and located between Bergen and Oslo. In order to prevent adaptation problem of the drivers, as well as overcoming the gloomy trip through the tunnel, a lighting design concept that imitates sunrise and sunset is applied. The setting is changing negative effects of perception caused by harsh brightness - contrast difference into positive (Figure 4.16).



Figure 4.16: Laandertal Tunnel between Bergen and Oslo (Url - 54).

For high enough lighting levels, the eye is colour sensitive, whereas for low lighting ones, objects are fundamentally perceived by luminance contrast which is present against the background. "The luminance difference between the observed object and its immediate space is known as *contrast*" (Url - 54). According to these lines it can be said that physical qualities such as degrees of brightness contrast in the environment have an impact on psychological impressions of a space. Brightness contrast is established by developing patterns of light. The luminance patterns of the perceived atmosphere create the physical image in the retina and an emotional message on people. In other words, eye sees, brain perceives.

As it is mentioned before, brightness/luminance is the only basic lighting parameter that is perceived by the eye. Interaction of light with finish and colour of a surface determines its luminance. Low brightness levels decrease ability of perception,

because we have difficulty in seeing physical qualities of objects or spaces. Like low brightness, high brightness might cause unbeneficial consequences on occupants. Negative side of excessive brightness is glare. Glare is described as an extreme luminance within the normal field of view (Ganslandt & Hofmann, 2009). When luminance levels created by a light source or reflection within the field of view is higher than the the brightness to which the eyes are adapted, glare occurs



Figure 4.17 : Brightness contrast difference
(Rouhana, A. & Bommel, W., 2011).

1. Luminance contrast: too low.
2. Luminance contrast: too high.
3. Luminance contrast: well balanced.

On Figure 4.17 for example, three different atmospheres of the same interior is given. The occupant possible has difficulty in reading the newspaper on the first picture, while suffering from glare on the second picture. On the third picture however, the brightness contrast is balanced.

Glare can cause annoyance, sharp differences between luminance levels which are uncomfortable for occupants. Excessive luminance in the visual field causes glare. Extreme levels of glare cause disruption of vision, because it decreases the seeing ability of the eye. As a result, continuous eyestrain and headaches may occur. A glare source can be imagined as a disturbing sound which weakens our perception. Disability glare occurs when there is excessive glare (Gansfeld & Hoffmann, 2009).

When the occupant is disturbed by high luminance levels in their visual field discomfort glare occurs. Discomfort glare doesn't prevent visual performance

completely. However, in a workplace, if people continuously try to adjust their eyes to various brightness levels while performing a task, they feel uncomfortable , even painful and eventually their performance will be disrupted (Gordon G. , 2003).

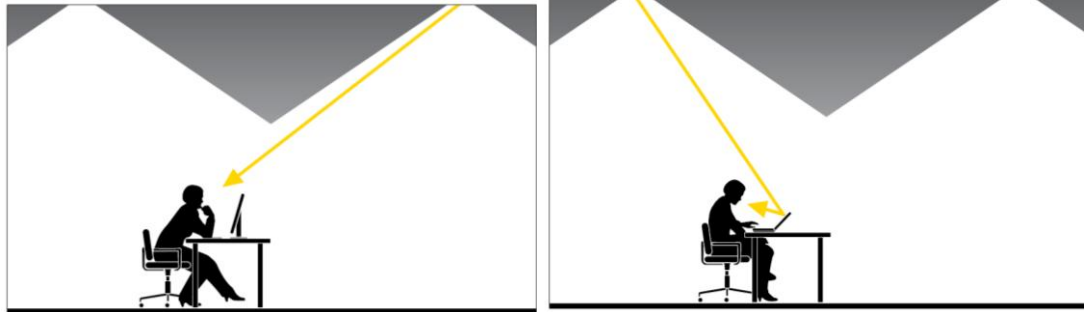


Figure 4.18 : Direct glare and reflected glare (Zumtobel, 2013, p. 12).

If glare prevents access to information such as preventing to see the computer screen in the office or to read the page of a book, it is very destructive. Both disability and discomfort glare may cause direct glare and reflected glare. Direct glare is caused when the bright light source is visible in the visual field of the visual task. Balanced luminance and proper location of the light source to the visual task is very important in this regard. Very bright light from a light source without reflectors or wrong positioned light fixtures may cause direct glare . For example it is inevitable to have direct glare in a room lit with bare light bulbs. Reflected glare occurs when location and specularity of the materials reflect the glare source. In offices or study rooms, especially when the light source is located behind the person reflected glare occurs (Figure 4.18).



Figure 4.19: The weather Project by Olafur Eliasson, London, UK (Url - 55).

On the other hand, there are also situations when direct glare is perceived as attractive. Normally, when people look at an artificial light source directly it disturbs them. However, if difference of luminance levels convey a message or provide a pleasant sensation it is agreeable and desirable. In the example of sun installation the huge light source is symbolising sun and the visitors are enjoying looking at this direct source of glare and are even leaning under the light source (Figure 4.19).

To avoid glare in offices light sources should be located between the workplaces with the proper geometry. Also, it is possible to decrease brightness contrast by increasing the ambient luminance level or decreasing the luminance of the source of glare (Zumtobel, 2013). When reflected light interrupts occupants while performing a task such as reading or working on computer, glare type is called discomfort glare. In this type of glare, the eye constantly strains to concentrate on the task and to overcome the distraction caused by the source of glare (Url - 56).



Figure 4.20: Canadian Centre for Occupational Health and Safety : Lighting Ergonomics - Survey and Solutions (Url - 56).

Reflected glare is caused predominantly by luminaires located on the ceiling area, so the height and location of the light source should be carefully arranged. Right choice of luminaires and reflectors can also prevent glare. Luminaires that spread minimal direct light to downwards can also help limiting reflected glare (Figure 4.20). Qualities of surface finishes of the interior space are also as predominant as the required lighting level in the space. Surface reflectance percentages of some materials are given on Figure 4.21.

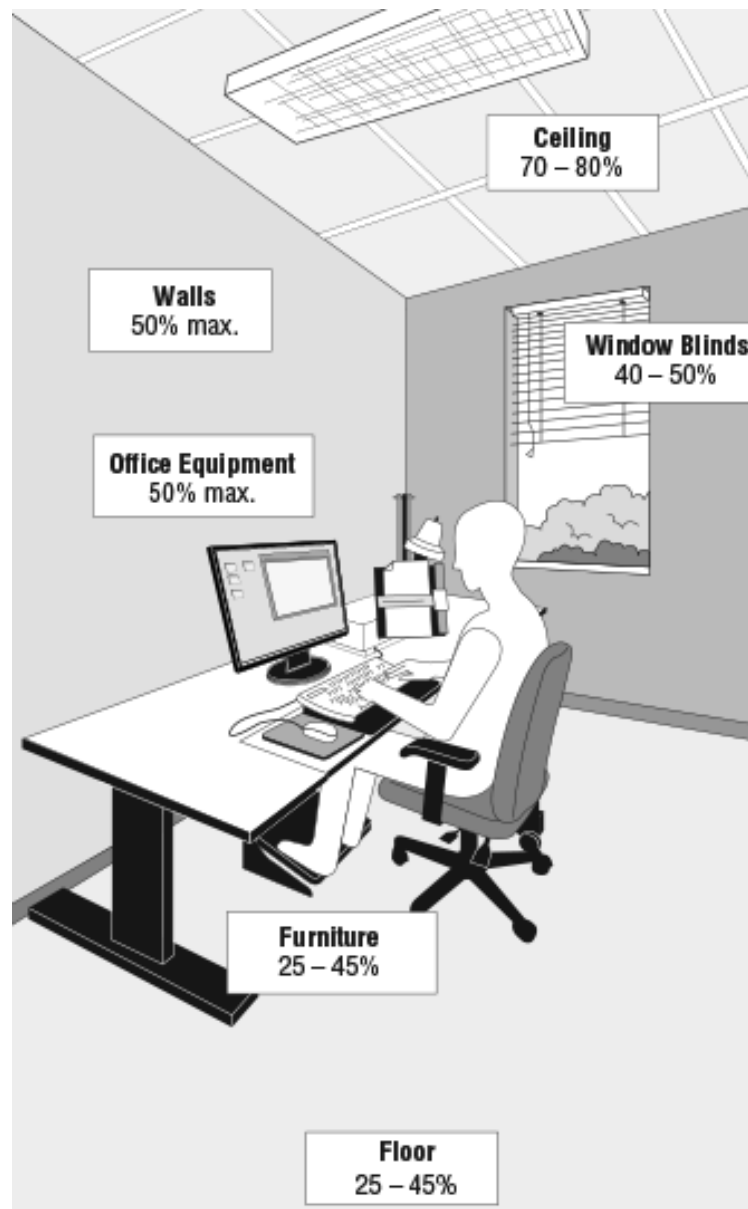


Figure 4.21: Surface reflectance percentages of an office, Lighting Ergonomics - Survey and Solutions: Canadian Centre for Occupational Health and Safety (Url - 56).

In interiors, polished surfaces should be avoided if not necessary. In a classroom, for example, instead of a shiny polished board, black boards can be used to prevent discomfort glare. Semi polished surfaces should be preferred and lighting fixtures should be arranged according to the discomfort glare possibility by using reflectors and diffusers. Some typical reflectance values for luminaire reflectors are given on Table 4.5.

Table 4.5: Surface reflectance percentages of an office, Lighting Research Center
(Url - 57).

Luminaire Reflector	Reflectance Value
high-quality white paint	90%
silver film	95%
highly reflective aluminum	85%
enhanced reflective aluminum	95%

4.1.4. Colours and colour rendering

Colour aspect of perception is a broad issue. Colour rendering ability of the light source and as a result, perceived colors of surface materials of the interior influence perception in interiors. Colour is not a characteristic of surfaces or objects. It is the sensation caused by qualities of light. So, light and color can not be separated.

Colour contrast affects perception. A red surface looks more saturated with a background. Butchers use this method to display meat with a green background of lettuce leaves to attract customers. It is only possible to see the colors of a surface that are present in the light source. A red apple, for example is lit with a green source and appear gray. White materials reflect all wavelengths almost equally.

There are various associations of colors. General impressions of major hues are associated with many areas of life. Sensation created by colors on humans are different for every different culture as everyone perceives the sensitive impression

of colours in individual ways. These experiences are caused by “unconsciously perceived and non-measurable” colour perceptions (Koos & Richter, 2004). Cultural influences are significant in this regard. For example, turquoise has a special meaning for Persian people. It is believed that this colour protects them from the evil eye. In Islam green is related to religion and is perceived as a symbol of hope (Mahnke, F., 1996).

There are also universal acceptance of same interpretations of some colors. Red is associated with blood and connection with life. It is the colour of love and passion grabbing the whole attention among all other colors. Yellow represents sun and giving life. Also, it symbolises communication as in several countries post boxes are yellow. Blue represents sky resembling calmness and serenity. Black represents evil while white is goodness. Even in fairy tales black magic hurts while white magic heals. As a consequence of associative power of colour, an interior space can be perceived as cozy, cold or inviting. Red range is popularly used for restaurant interiors as it is an appetite increasing color. It also has an impact on increasing blood pressure and stomach activities (Mahnke, F., 1996).

The location of the colored surface in the room is also significant to influence the atmosphere of an interior space. Each color evokes a different perception on different locations of a room. A specific color, for example, can create a pleasant atmosphere when it is used on the floor but might be disturbing when it is used on the ceiling. It is extremely important to consider the acceptance of the use of colours according to cultural and geographical background of people while choosing the proper colour of light in interiors. Table 4.6 shows perception of colours when applied on different locations in a room (Mahnke, F., 1996).

Sense of space can also be altered by choosing proper colours. Changing color of an interior space can alter the perception of a room and illumination levels. The most economical way to increase the amount of the light in a dark room is to paint it white. Painting the ceiling and upper parts of the walls of a room white, the room is perceived higher and brighter (Koos & Richter, 2004).

Table 4.6: Perception of colors on ceiling, wall and floor , information on table is derived from Colour , Environment and Human Response (Mahnke, F., 1996, p. 67).

***	Ceiling	Walls	Floor
Red	Intruding, disturbing, heavy	Aggressive, advancing	Conscious, alert, perhaps pompous
Pink	Delicate, comforting	Aggression-inhibiting, intimate, too sweet if not grayed down	Perhaps too delicate, unfamiliar in this location
Orange	Stimulating, attention seeking	Warm, luminous	Activating, motion oriented
Brown	Oppressive and heavy (if dark)	Secure and assuring (if wood) ; much less so if paint	Steady, stable
Yellow	Light (if toward lemon), luminous, stimulating	Warm (if toward orange), exciting or irritating (if highly saturated)	Elevating, diverting
Green	Protective	Cool, secure, calm, reliable, passive, irritating if glaring (electric green), muddy if toward olive	Natural (up to a certain saturation point), soft, relaxing, cold (if toward blue – green)
Blue	Celestial, cool, less tangibly advancing (if light), heavy and oppressive (if dark)	Cool and distant(if light), encouraging and space deepening (if dark)	Inspiring feeling of effortless movement, substantial (if dark)
Gray	Shadowy	Neutral to boring	Neutral
White	Empty, no design objections – helps to reduce shadows and diffuse light sources	Neutral to empty, sterile, without energy	Touch inhibiting (not to be walked upon)
Black	Hollow to oppressive	Ominous, dungeonlike	Odd, abstract



Figure 4.22: Björn Borg Headquarters, Stockholm, Sweden (Url - 58).

By changing colours of the interior walls of a room, different perceptions can be achieved under the same light conditions. On Figure 4.22, interiors of two meeting rooms of the same company are shown. Both rooms are designed with a broad colour scheme. The same light source with the same light distribution creates different impacts in the room with pink +blue tiles than yellow+blue tiles. Yellowish space is perceived as wider with high intensity of light . Under the same intensity of light, pinkish space looks smaller and lighting level is perceived as if it is dimmer (Url - 59).The same idea can be implemented to the furnishing elements of an interior. Visual perception simultaneously the perceived atmosphere of the room changes with white and dark seating (Figure 4.23).



Figure 4.23 : Changes of visual perception with white seating and dark seating (Url - 59).

White light is a mixture of colours. The sun includes the whole spectrum of colours and appears in white. However, all light sources do not need to include all spectral colours. Even if they do, they might be in different amounts.

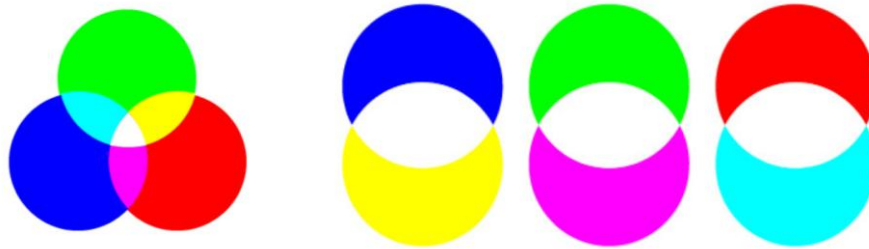


Figure 4.24 : Mixing colours of light (Rouhana, A. & Bommel, W., 2011, p.38).

1. Additive colour mixing of light.
2. Additive mixing of a complementary colour with the appropriate primary colour gives white.

Red, green and blue are called as primary colours, while yellow, magenta and cyan are called secondary or complementary colours. Mixing coloured light sources is called additive colour mixing (Rouhana, A. & Bommel, W., 2011). If complementary colours of light are mixed with the missing primary colour of light , the new colour created will be white light again (Figure 4.24). An object reflects only part of the colour of the light falling on it. Color rendering describes how a light source enables the color of the perceived object appear to occupant's eye. In other words, it describes how good the light source renders colors of objects.

Colour temperature is the color of light emitted from the light source. Some sources of light render colors better than other sources. Colour temperature is important in this regard. A light source's spectral composition is indicated according to its colour temperature. For example a white light source having a high amount of red colour in it will look warmer while another light source with a high amount of blue colour in it will look cooler (Rouhana, A. & Bommel, W., 2011). For an interior space, judgement of colours should be made under the final lighting conditions which will be applied to the area. An evening dress for example should be chosen under

incandescent lighting, because light with warm colour temperature is generally used for lighting of evening functions (Figure 4.25).



Figure 4.25: Evening dress under warm light versus cool light (Rouhana, A. & Bommel, W., 2011, p.43).

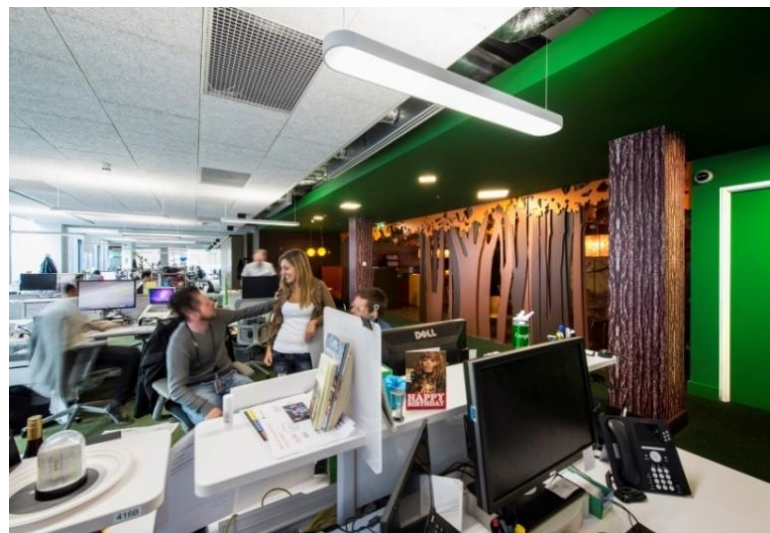


Figure 4.26: Office with cold white light, Google Campus Dublin, photo by Peter Wurmli (Url - 60).



Figure 4.27: Cafe with warm white light, Google Campus Dublin,
photo by Peter Wurmli (Url - 61).

Effects of light on psychology of people is strongly related to colour temperature of the lighting setting. Observations of Kruithof show that people prefer cool color temperatures when illumination is intense and warmer color temperature when the illumination is low (Kruithof, A., 1941). When concentration on a task or an activity is the case, cold colours of light is required. Figure 4.26 shows one of the office spaces at Google Campus in Dublin. In the office lighting level is relatively high and cold white light temperature is preferred. In contradiction to this, to spend leisure time or relax most people would like to have a lower level of light with warm tints of light (low colour temperature). Figure 4.27 shows the café space isolated with partition walls from the office. The atmosphere achieved is relatively informal and relaxing with the choice of warm light. In addition to choice of colour of light, it can also be added that neutral colour choice of the office space is enhancing the feeling of a formal atmosphere while the café space is relatively much more warmer and inviting with color choice of surfaces (Figure 4.27).

The perceived object is not only the retinal image. Evaluation of the perceived atmospheres carry our expectations. In early 1942, K. Goldstein had an experiment on a group of subjects. During the observation the subjects reacted to red excitedly and to green calmly. His observations showed that red light is found arousing, caused

blood pressure disorders and created unpleasant feelings on people. Yellow light was found as sunlike and mighty. Blue was found to be pleasant and restful. Green light was also found pleasant, agreeable and calming than red (Goldstein, K., 1942).

In restaurants lighting should be allowing occupants to enjoy their food in their natural colours. Bright overhead lights destroy sense of personal space – managed with tables and seating in this case. As the restaurants are also places for socialising, table surfaces should be lit well (Mahnke, F., 1996). The lighting in an interior should also enable objects look natural.



Figure 4.28: Food under different colours of light (Ekerbiçer, 2007)

1. Green Filter Metal Halide lamp

Comments: The food looks brownish, coloured light is not proper for eating, depressive, not natural, annoying, cold, like street lights, better than white

2. Blue filter Fluorescent Tubes

Comments : Only the blue plates are good, too dark, I am hungry

3. Red Filter Fluoresan Tubes

Comments : No problem after adaptation, looks artificial, meats looks good

4. Fluorescent Tubes

Comments : Food looks like food, too cold, feels natural, secure, better than all of them

In a restaurant; food should appear in their natural colors as people have expectations of what colour food should have. A study made in Germany, University of Wismar

aimed to find out if temperature and colour of light had an impact on choice of food. Different situations of lighting settings were tested on a group with a dinner experiment (Figure 4.28). People were asked under which colour of light they would like to eat. They answered that they wouldn't choose to eat under coloured light. Among all options, fluorescent tube without filter is preferred by the occupants of the experiment, because it created natural perception of colours and tastes. As a result, it was reported that the colour of light is a significant component on people's food choice (Ekerbiçer, 2007).

Right choice of light colour is essential for physical health. Especially in bedrooms, blue wavelengths should be avoided. Blue light is positive during daytime as it increases attention and mood of people. However, at night time, these qualities are disruptive. Secretion of melatonin – a hormone supports sleeping- takes place in darkness. All kinds of light disrupts melatonin secretion but blue light is much more powerful. Using dim red lights for night lights is suggested as red light has the least power to suppress melatonin secretion.

Table 4.7: Classification of colour temperature / colour appearance groups (Rouhana, A. & Bommel, W., 2011, p.41)

Colour temperature	Colour appearance
less than 3300K	warm (yellowish) white
3300K – 5000K	neutral / intermediate white
more than 5000K	cool (bluish) white

As it explained above, thermal radiators like sun and incandescent lamps the term colour temperature is used as they have continuous spectral energy distributions. However, for light sources with discontinuous spectrums such as gas discharge lamps or solid state lamps the term correlated colour temperature is used with the same purpose. So, even if the light sources include a limited amount of colours, they can emit white light which means a light source does not need to contain full

spectrum of colours to produce white light. Colour temperature is also used to create colour appearance groups (Table 4.7).

Coloured light applications has been popular currently. Invention of LED lights made it possible to add liveliness to daily life. In addition to exterior lighting applications, interiors such as shop, hotel, café, night club interiors even office interiors have been using coloured light applications. Coloured light differentiate the overall atmosphere of an interior by changing how the objects look. Atmosphere differentiation can be achieved by changing colour temperature or using coloured light to accent objects. On Figure 4.29, the same museum interior is lit with cold light and the objects are emphasised with warm white light. On Figure 4.30, the same room is illuminated with neutral white color while the objects are accented with red light. Because of the colour contrast between red and white background and choice of a saturated colour like red the object itself is perceived as red.



Figure 4.29: Differentiation using colour temperature (Url - 62).

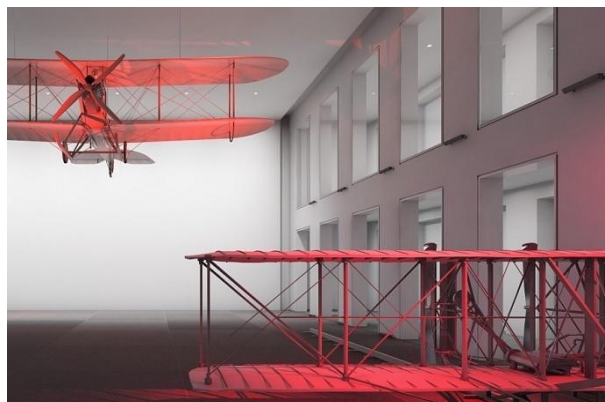


Figure 4.30: Differentiation using coloured accent lighting (Url - 62).

Differentiation using colour temperature is used in spiritual spaces to enhance faith. In Cathedral of Cremona for example, the lighting design is suggested to highlight pillars, lancet windows of the nave, vaults, altar, fresco fragments and the apse. On Figure 4.31/1 lancet windows are illuminated with warm white colour while the apse is suggested to be lighted with even a warmer tone of white as the fresco on the wall is the center of perception. The vaults are illuminated with a neutral white light. On Figure 4.31/2 however, the pillars and the longitudinal arches are accentuated with warm white (Url - 63).



Figure 4.31: Effects of two different colour temperatures onto the space (Url - 63).

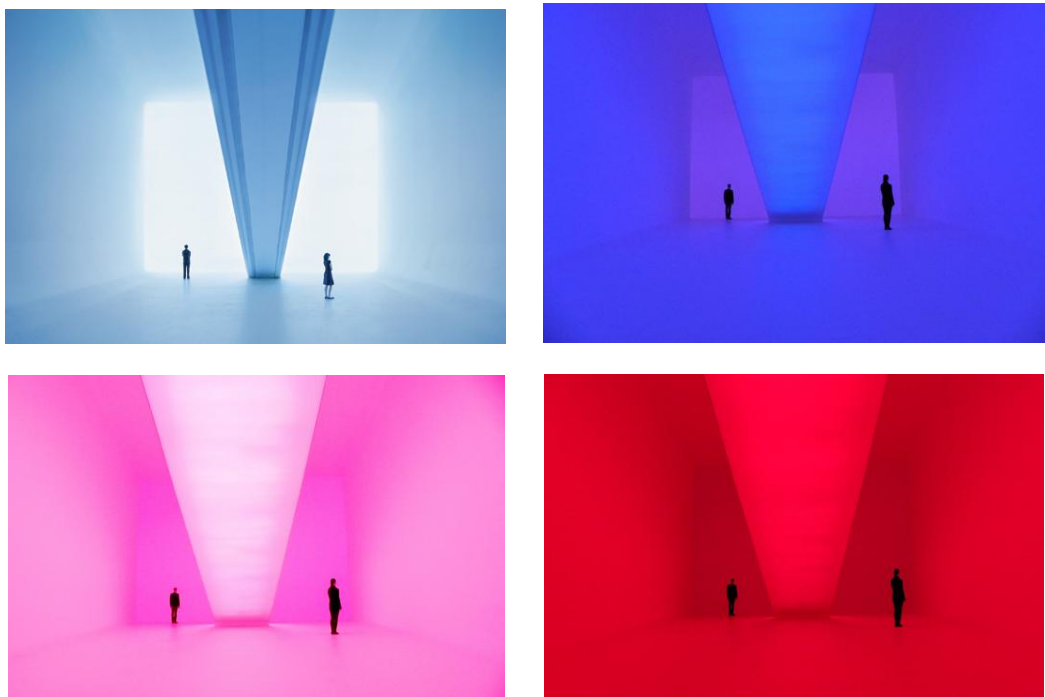


Figure 4.32: The Wolfsburg Project , Glangfield Space Art Installation by James Turrell, Kunstmuseum Wolfsburg, Germany (Url - 64).

Coloured light can be produced by RGB colour mixing light sources like LEDs or by using colour filters. It is possible to arrange LED luminaires to change colours with a changing sequence. In addition to visual perception, psychological perception is also affected by colours. Light installation on Figure 4.32 shows how it is possible to create different sensations in the same interior by playing with colour of light. Blue and purple are cold colors while pink and red are warm and comfortable. Also, the light reflected to the walls provide tints of colours creating a dynamic atmosphere.

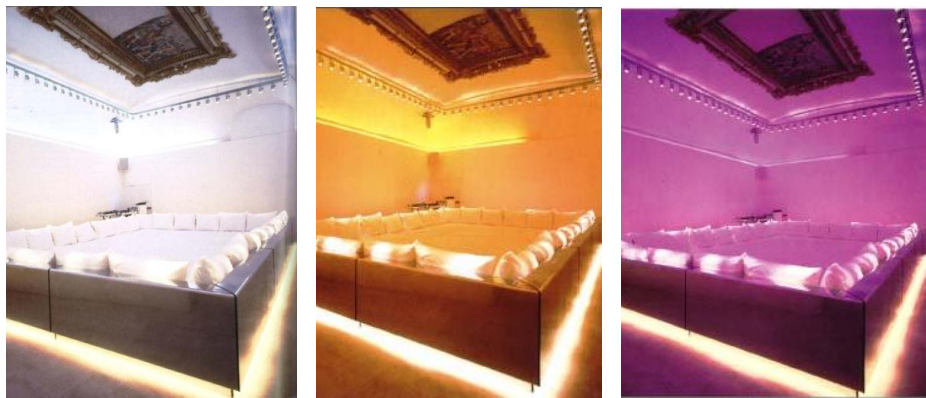


Figure 4.33: Salle Baroque, Superclub, Rome, Italy (Url - 65).

For example coloured light application in a white furnished baroque guest room of a night club increases excitement and energy. Hidden lighting points change the colour of the room creating a wide varetty of moods and sensations (Figure 4.33).



Figure 4.34 : LOFT MV, Brussels (Url - 66).

Another example to change of perception with the colour of light sources is LOFT MV. The loft space is converted from a factory space, abstracted by white curtains

and soft coloured LED light sources. The cube units are made of steel frames wrapped with white translucent PVC canvas. The atmosphere has a vivid expression of liveliness with coloured light (Figure 4.34).



Figure 4.35 : Atmosphere of interior space under purple light, The Prayer Pavilion of Light, Phoenix, USA (Url - 67).



Figure 4.36 : Atmosphere through coloured light, The Prayer Pavilion (Url - 68).

Multi - coloured light application can be used to enhance faith of a chapel. The Prayer Pavilion located in Phoenix, Arizona, USA designed as a ‘lantern on a hill,’ The chapel is suspended above the ground on four concrete walls. During the night the glass pavilion is highlighted with RGB LED fixtures transformed by light. Each color re-change transforms the glowing appearance Colour contrast of saturated

colours of red , green and blue create a strong composition. The focus of perception is the atmosphere created with play of colours (Figure 4.35, Figure 4.36).

An other example of intensifying spiritualism with colour of artificial light would be the Grand Mosque located in Abu Dhabi. The mosque is the third largest mosque in the world. The affect achieved was an interior glowing like naturally lit but actually dominated by artificial light sources. Vertical elements such as columns and glass mosaics on the walls are highlighted via wall washing to reveal the unique qualities of the textures. The lunar moon cycle represents the lighting sequence of the whole building in order to connect the mosque to the sky and to God. The mosque is copying the activity of the moon. When there is full moon, the lighting is a greyish light similar to the perceived light from the moon. As the moon's phases change, the building gets darker and darker and turns into blue. When it is time for the new moon, the mosque has the deepest blue colour (Figure 4.37).

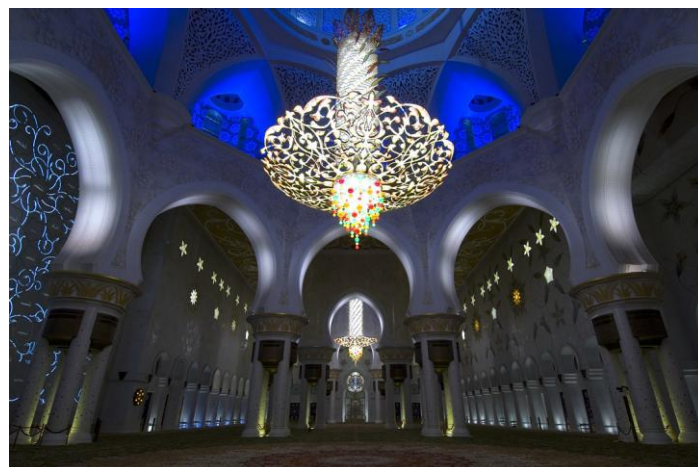


Figure 4.37: Interior changing colours according to lunar phases (Url - 69).

4.2. Perception oriented artificial lighting

For the seeing process or visual perception part of perception, level and distribution of luminance are the very first basic needs. Colour of light, brightness contrast and their correlation with objects and surface structures within the space are other significant qualities effecting perception. However, only these qualitative knowledge is not enough to plan subjective impressions of people. Becker mentions in his article published in PLD magazine that Prof. Dr. Heinrich states that there are many lighting designers and scientists from different fields who does not speak the same language. A group of people considers light as electromagnetic waves which can be measured physically. People with this point of view are not considering the emotional, aesthetical and psychological affects of light. Second group is composed of architects, artists and some lighting designers and is concentrated on perception of people (Becker, 2007). Perception is not only related to seeing an object, but also collecting information about the surrounding. On Figure 4.38, It is the lighting quality that makes it possible to visually percieve the room and the sculptures. Several shadows of the statues and the reflections are perceived as the part of the exhibited objects and the space. What makes it possible for the eye to see and perceive is the luminance pattern designed while planning the lighting situation of the room, but the very final picture created in minds is a result of the psychological process.



Figure 4.38 : Shadows of sculptures in an exhibition room (Url - 70).

Illimination levels has to be taken into account as a main part of the design of the environment, but it should be considered that illuminances alone are not enough, to achieve perceptual impressions. With this understanding, it is accepted that interaction of light with space and perception of people has to be considered. Then, perceptual psychology has been developed. In this chapter perception oriented artificial lighting will be explained.

As it is explained in the first chapter each person is an individual being and perception is a complex process affected by many social, cultural and personal variables. However, it is possible to control environmental load in an interior and play with basic lighting concepts to create the desired perception. Also, it is possible to create desired subjective impresssion on people by manipulating lighting patterns. Under the following subtitles how to achieve these steps will be explained.

4.2.1. Degrees of excitement /stimulation

Degrees of excitement created on people is explained with environmental load approach. Everything increasing people's sense of pressure is defined as an environmental load. When people have to deal with more stimuli, the load gets higher. The pressure has an influence on people's decision making. High Load Environments are complex and crowded while Low Load Environments are simple, uncrowded, symmetrical and conventional (Brousseau, R. K., p. 39).



Figure 4.39 : Low load environment, Turku City Library, Turku, Finland (Url - 71).

People react differently to the same interiors, but still their reactions are mostly similar in similar environments. Degrees of stimulation is important in this regard. According to the characteristics of an interior atmosphere, degrees of stimulation differs. Emotional impact is related to degrees of stimulation. All activities are influenced by kinds of visual stimulation (Gordon, G. , 2003).

In a library people expect to have a low load environment with cold temperatures of light as they need to concentrate and focus on the reading material and feel comfortable (Figure 4.39). Anything that may shift the focus of perception to another stimulus, distract concentration. Lighting with a changing colour setting would be very uncomfortable and create an unnecessary information load on people at a library. In opposition to this, in a bar lounge cold white temperature lighting would be dull, boring and very uncomfortable. At such a place, expectation of people is lighting levels that encourage participation and amusement supporting high levels of music and crowd. Interplay of shadows and light in a changing sequence would be proper applications as on Figure 4.40.



Figure 4.40 : High load environment, Nisha Bar-Lounge, Mexico City, Mexico
(Url - 72).

4.2. 2. Fundamental lighting concepts

The basics of fundamental lighting concepts are developed in 1950's. Perception psychology and theatrical lighting were combined together and established by Kelly. Before that, the main approach to lighting design was about quantity of light and

uniformly illuminated spaces. He changed this approach by focusing on the question of specific qualities of light. His study on a group of lighting functions were oriented on perception of occupants. Lighting concepts are separated into three basic parts as ambient luminescence (general/diffuse lighting), focal glow (task lighting) and play of brilliants (Figure 4.41). The desired atmosphere is achieved by playing with these three elements. The concepts established are composing the main structure of lighting design even today (Ganslandt & Hofmann, 1999).

Among these three principles, ambient- general - diffuse lighting is based the idea of washing surfaces with light. Wall-washers and downlights are the main equipments to achieve this kind of lighting atmosphere. This kind of lighting provides general illumination of the entire interior space. In general, maintaining efficient lighting levels for orientation and activity is the main purpose of general lighting. So, whole surrounding space and elements inside should be visible to the occupants. Everything in the room is in equal emphasis without any shadows (Url - 73).

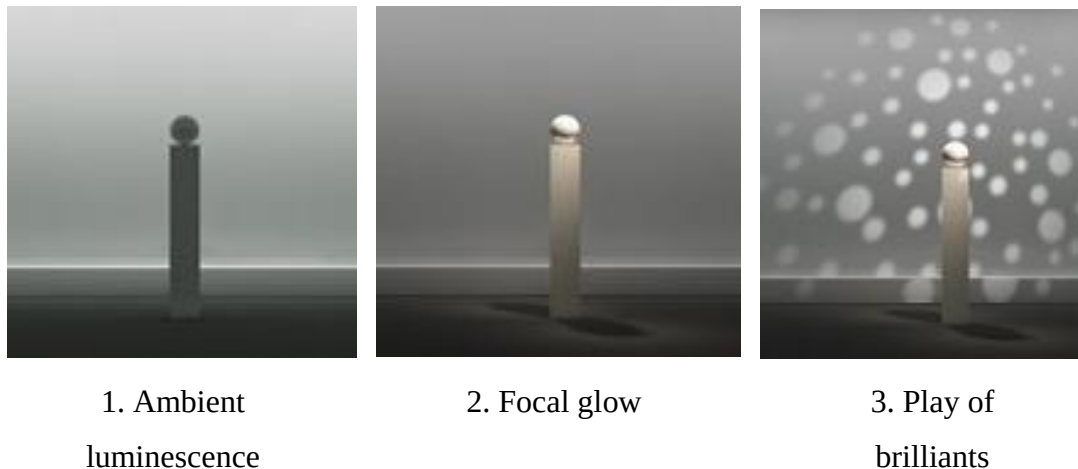


Figure 4.41 : Three basic principles of lighting (Url - 73).

Among these three principles, ambient- general - diffuse lighting is based on the idea of washing surfaces with light. Wall-washers and downlights are the main equipments to achieve this kind of lighting atmosphere. This kind of lighting provides general illumination of the entire interior space. In general, providing sufficient lighting levels for orientation and activity is the main purpose of general lighting. So, whole surrounding space and elements inside should be visible to the

occupants (Ganslandt & Hofmann, 1999). On Figure 4.42 , interior lighting of a cafe space is achieved with ambient lighting. Everything in the room is in equal emphasis without any destructive shadows.

According to Kelly, ambient or general lighting is,

a snowy morning in open country, twilight haze on a mountain top or a cloudy day on the ocean, the light in a white tent at noon, moonlight coming through the fog (Emerson, E. , 1967).



Figure 4.42 : Ambient (General) luminescence of a public space (Url - 74).

Focal glow's (task lighting) main purpose is to help transmitting a message. Task lighting is applied to highlight objects in relatively small areas. Relatively bright areas in an interior attract attention. This fact enables conveying important information within an interior. This kind of lighting is helpful for performing specific tasks such as reading, writing. Meeting room of a company is generally lit by task lighting with general lighting. This approach is applied because of the fact that using only task lighting and not illuminating other surfaces in the space may cause too much brightness contrast and discomfort (Ganslandt & Hofmann, 1999). When local lighting is applied together with general lighting it is called “supplementary lighting” as in the example of Google Tokyo Office meeting room shown on Figure 4.43.

Focal glow or task lighting for Kelly is,

the campfire of all time, the glowing embers around which stories are told, or the football rally bonfire. Focal glow is the limelight, the follow spot on the stage, and an aircraft beacon. . . . It is the light burning at the window or the welcoming gleam of the open door (Emerson, E. , 1967).



Figure 4.43 : Google Tokyo Office meeting room, supplementary lighting
(Url - 75).

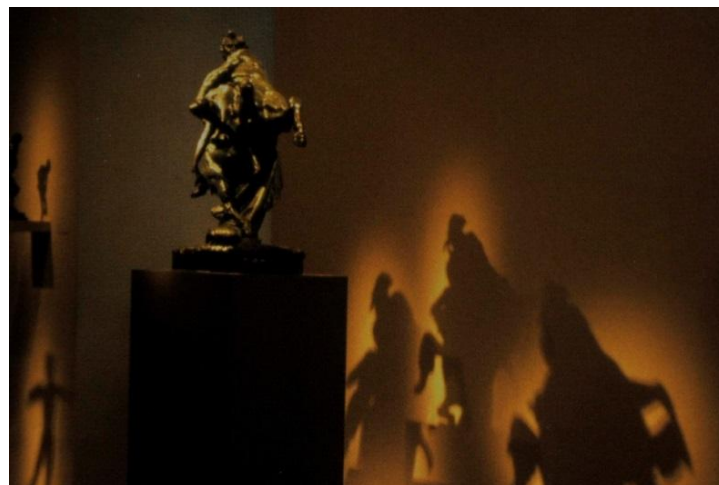


Figure 4.44 : Focal Glow, shadows formed by spotlights are a part of the exhibition of the statue, National Gallery of Art, West Building, Washington DC, USA
(Url - 76).

With focal glow the most significant sculpture in a museum or the core point of an interior can be highlighted. On Figure 4.44, task lighting achieved with directed

spots create multiple shadows and increase the intensity of the presentation. With a similar approach, unworthy information can be hidden with a lower task lighting level as in the example of Conga Room (Figure 4.45). Openings between ceiling pannels are left in dark to hide construction. A computer controlled multi – coloured LED lighting system emphasises the translucent columns composed of acrylic pannels (Figure 4.46). With the unique lighting system the ceiling changes color and atmosphere. The system reacts to the rythm changes of the music.



Figure 4.45 : The Conga Room , general view of interior, Los Angeles, USA, photo by Benny Chan (Url - 76).

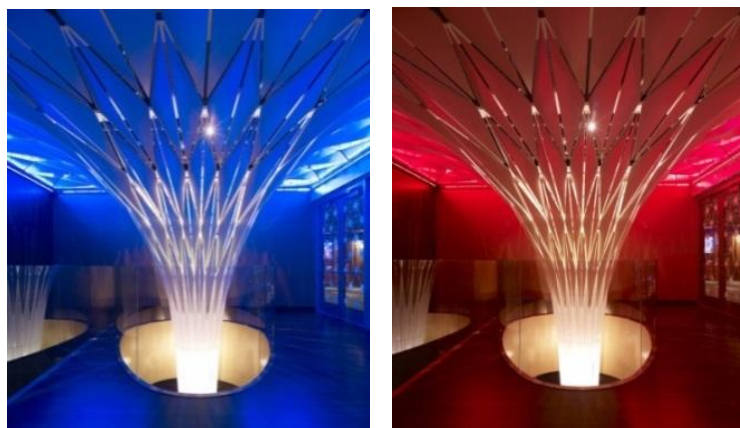


Figure 4.46 : The Conga Room , focal glow emphasizing columns with computer controlled multi – coloured LED lighting system, Los Angeles, USA, photo by Benny Chan (Url - 77).

Light conveys information and catches attention. The third element of light, play of brilliants is the form where the light becomes the source of information itself. It excites senses and mind, adds a magical atmosphere to the room (Gordon, G., 2003).

Chandliers of Süleymaniye Mosque can be given as an example to this effect. Here, the light source is the source of brilliance as well as being brilliant itself. The holly atmosphere is enhanced with the glimmers of light as well as reflections on surfaces within the interior (Figure 4.47).

To Kelly, play of brilliants (sparkle/glitter) is:

the sensation of a cache of diamonds in an opened cave or the Versailles Hall of Mirrors with its thousands of candle flames. . .a ballroom of crystal chandeliers. Play of brilliants is Times Square at night . . . sunlight on a tumbling brook . . . the heaven full of stars. . . birch trees interlaced by a motor car's headlights (Emerson, E. , 1967).

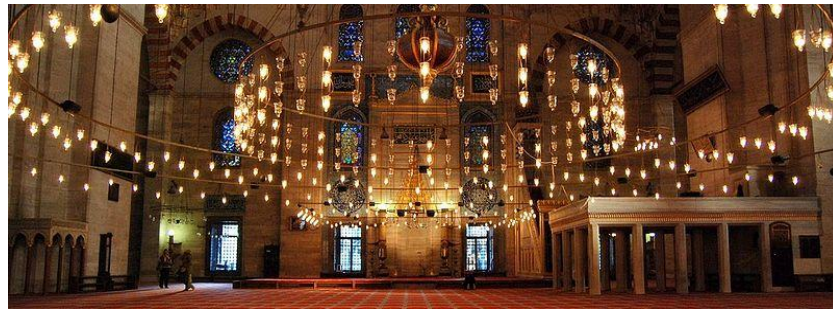


Figure 4.47 : Glitter of a chandelier , Süleymaniye Mosque, Turkey
(Url - 78).

Figure 4.48 shows glimmers of an artwork installed on the atrium of a company offering energy solutions. The surface is made of fiber-optic fabrics resembling variations of daylight. The installation on vertical surface shines adding life to the space creating a waterfall effect.

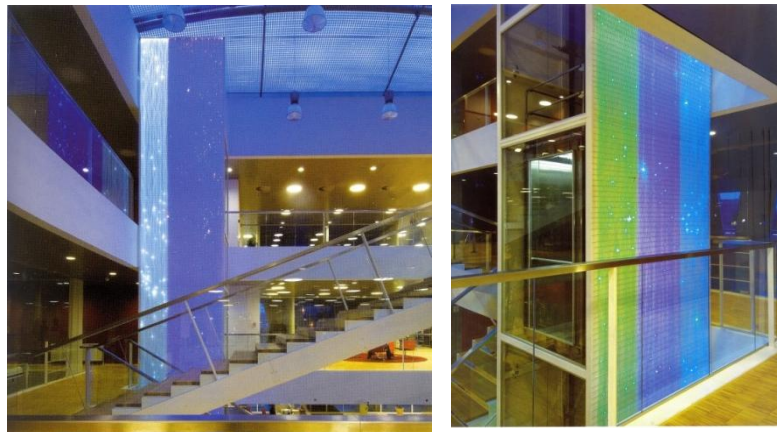


Figure 4.48 : Lightfall effect of glimmers, office building, Aarhus, Denmark
(Url - 79).

4.2.4 Subjective impressions

Lighting patterns caused by different distributions of light effect people's behavioral response or subjective impressions of a place. These lighting patterns can be grouped by uniformity, location and intensity of light. Uniformity of light describes if light is distributed uniformly or non-uniformly over the room. Location of light describes if the source of light is assigned to distribute light over horizontal surfaces (ceiling, floor, table surface) or vertical surfaces (walls). Intensity of light describes brightness and contrast levels of illumination on horizontal activity planes such as work planes or floor planes (Steffy, G, 2008).

These findings were established by John Flynn's profound research in 1970's. Following pictures on Figure 4.49 and Figure 4.50 are illustrating six lighting conditions that are tested in the same room by changing only lighting patterns. The outcomes of the observations show that when patterns of brightness contrast differs, the power of visual data on people changes. Thus, people have different impressions on each situation.

Especially on vertical surfaces lighting patterns have the power to effect these subjective impressions. Behavioral responses of many subjects to various room types under different light conditions are categorised to define luminance patterns causing these responses. To detect the subjects' behavioral responses opposing pair words (scalars) on Table 4.8 are chosen to describe their impressions of the room. As a consequence, five basic impressions are identified to be influenced by various lighting patterns:

- ✓ Spaciousness or confinement
- ✓ Visual clarity or haziness
- ✓ Relaxation or tension
- ✓ Privacy or publicity
- ✓ Pleasantness or unpleasantness

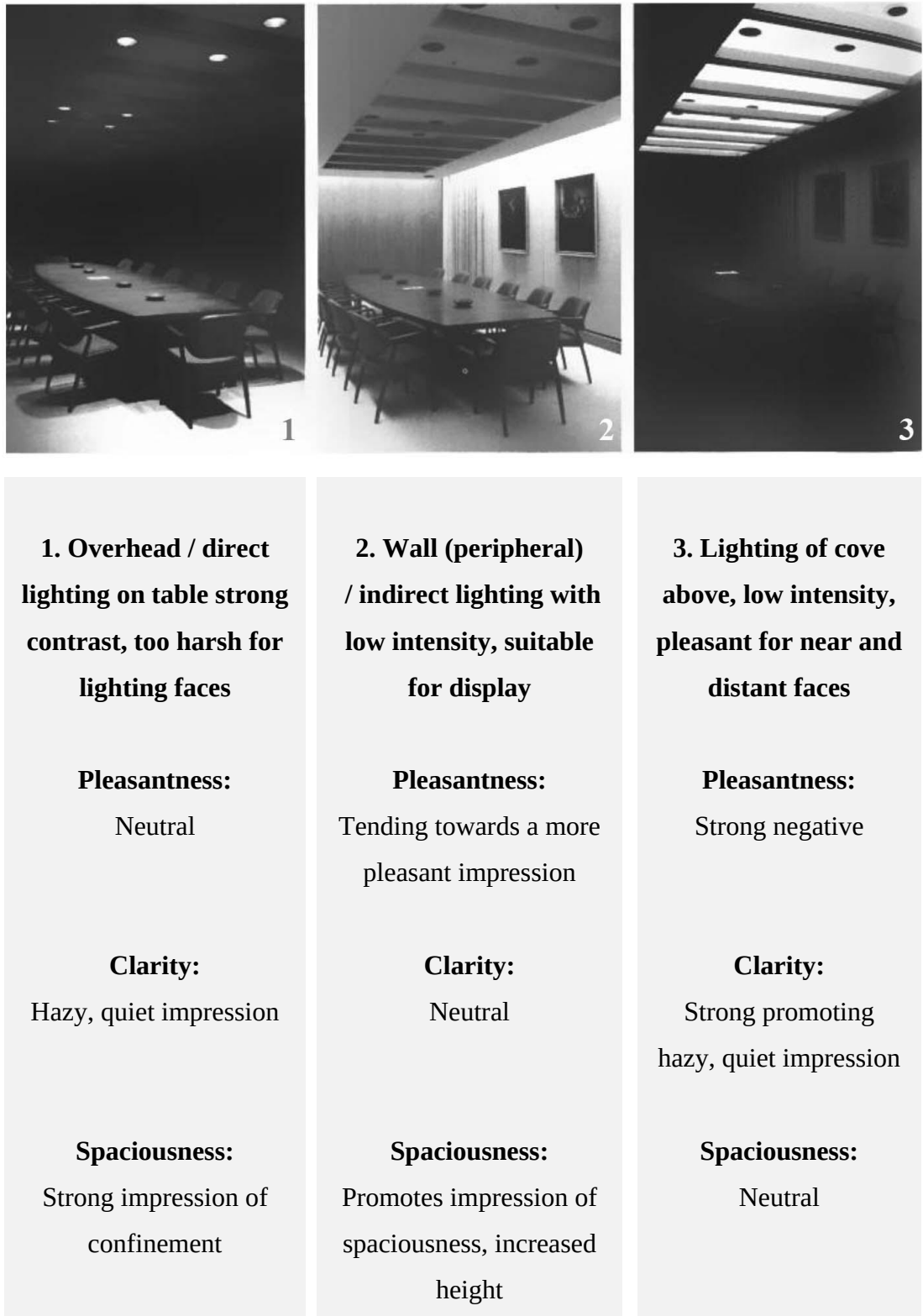


Figure 4.49 : Illustrations of six lighting conditions (Steffy, G, 2008, p.114, 115):



4. Direct lighting on table, Lighting of small wall

Pleasantness:
Relatively Strong positive

Clarity:
Neutral

Spaciousness:
Neutral with strength in impression of length



5. Direct lighting on table, Lighting of cove above soft subdued effect, pleasant for near faces

Pleasantness:
Relatively Strong negative

Clarity:
Strong

Spaciousness:
Somewhat



6. Lighting of cove above, Lighting of walls flat shadow free

Pleasantness:
Strong

Clarity:
Strong

Spaciousness:
Strong

Figure 4.50 : Illustrations of six lighting conditions (Steffy, G, 2008, p.114, 115)

Table 4.8 : Subjective impressions scalar descriptions
(Steffy, G, 2008, p. 115).

General Evaluative Scalars	Clarity Scalars	Spaciousness Scalars
Friendly vs. hostile	Clear vs. hazy	Large vs. small
Pleasant vs. unpleasant	Bright vs. dim	Long vs. short
Like vs. dislike	Faces clear vs. faces obscure	Spacious vs. cramped
Harmony vs. discord	Distinct vs. vague	
Satisfying vs. frustrating	Focused vs. unfocused	
Beautiful vs. ugly	Radiant vs. dull	
Sociable vs. unsociable	Noisy vs. quiet	
Relaxed vs. tense		
Interesting vs. monotonous		

In the light of observations derived from Flynn's study, to create the suitable impressions, an explanation of how to manipulate lighting conditions is given. Drawings of lighting situations are based on the implications derived from lecture notes of professional lighting designer Randy Sabedra (Url - 80).

Spaciousness is related to the perceived spatial volume. High occupancy areas and transition areas are needed to give impression of spaciousness. People have the impression of an interior to be large or small due to the uniform distribution and intensity of light. High and even levels of illumination on walls and uniform lighting on all surfaces create sense of spaciousness (Figure 4.51).

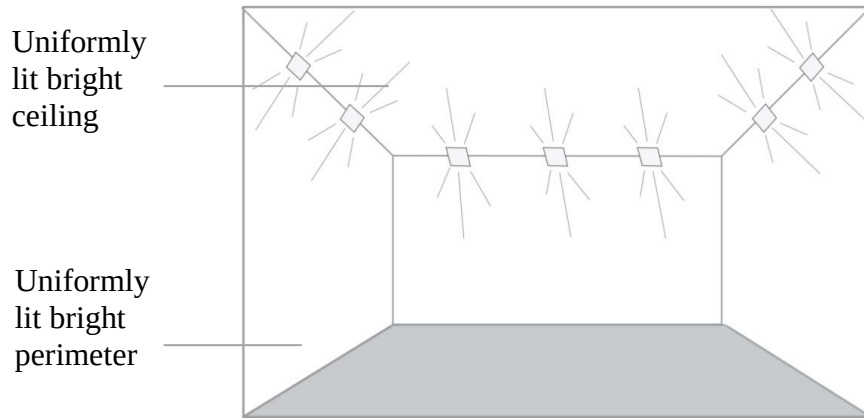


Figure 4.51 : Uniformly lit bright ceiling and perimeter to achieve Spaciousness (Gültekin, 2013).

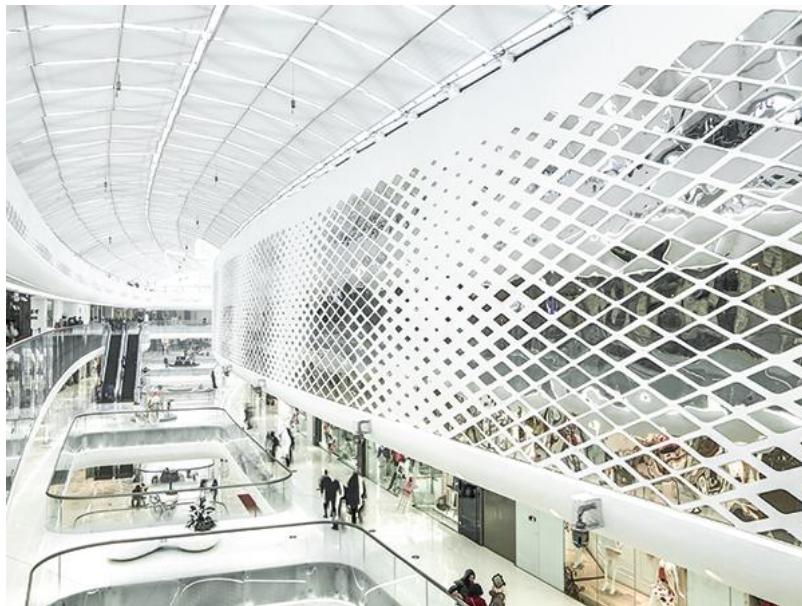


Figure 4.52: Spaciousness : Hanjie Wanda Square, Wuhan, China (Url - 80).

The shopping center on Figure 4.52, is illuminated with high intensity cold white LED lighting. Uniformity of light on walls and ceiling arches is increasing the impression of length and width. So, the ceiling height is perceived as higher.

In the example of Ravensburg Art Museum special ceiling structure is highlighted with uplights and recessed spotlights to achieve the impression of spaciousness. If the ceiling was not lit the space would make the visitors feel confined. Spotlights on the tracks of conjunction sides of the vault - like ceiling structures are also lighting the walls uniformly (Figure 4.53, Figure 4.54).



Figure 4.53: Spaciousness, Ravensburg Art Museum, Ravensburg, Germany
(Url - 81).

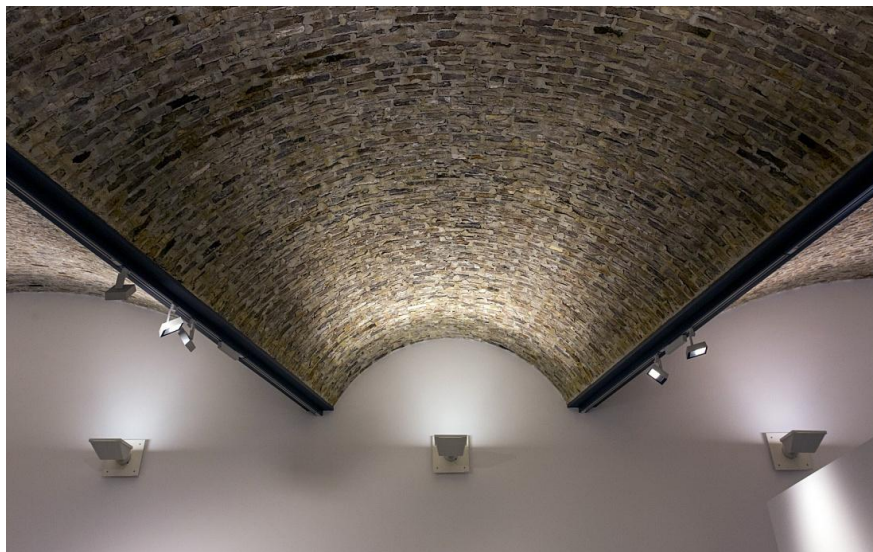


Figure 4.54: Ceiling structure lighting, Ravensburg Art Museum, Ravensburg,
Germany (Url - 82).

The opposite should be done to create an impression of confinement. Dark wall surfaces and using only downlights increases the sense of being in a restricted space. Steffy states that the attention should be given to surface textures as specular wall materials reflect the light and increase impression of spaciousness as well as being an energy efficient approach (Steffy, G, 2008). In the example of Zymo

Genetics, General Administration, dark wall surfaces and hidden downlights are creating a confined space and the impression of intensity (Figure 4.55).

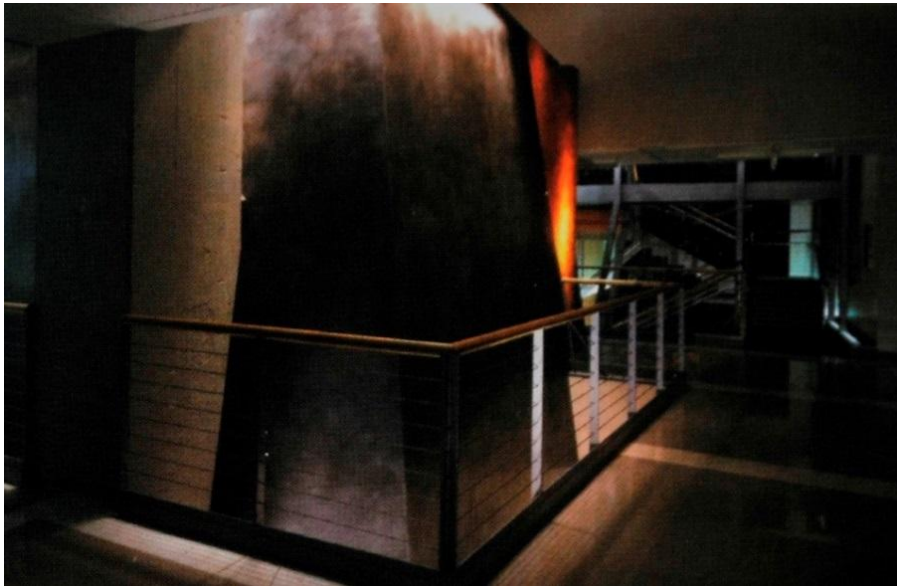


Figure 4.55 : Confinement : Dark wall surfaces, low level of illumination, Zymo Genetics, General Administration , Washington, US (Url - 76).

Visual clarity determines how facial features and details of an interior are perceived by the occupants. Visual clarity is extremely important while lighting work spaces. Instead of uniform distribution of light, higher luminance level on horizontal activity surfaces such as desks or tables increases visual clarity (Gordon, G. , 2003).

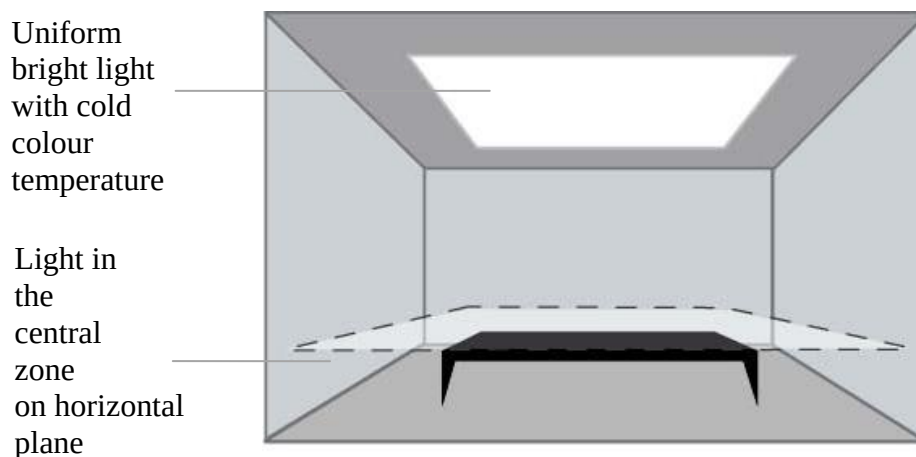


Figure 4.56 : Uniform bright light in the central zone on horizontal plane to achieve Visual Clarity (Gültekin, 2014).

Higher reflectance of horizontal working planes and wall surfaces also increase sense of a visually clear interior space decreasing extra energy use (Figure 4.56). Lighting the center of horizontal task planes brightly and walls relatively dimmer creates the impression of a visually clear interior. In opposition dim levels of general lighting with darker surface create an impression of haziness (Steffy, G, 2008).

Glasgow SocietyM Hotel is a hotel chain targeting the group of workers without a permanent office space who needs to arrange meetings or presentations. The interior is composed of open rooms connected to each other, there are also some rooms that could be hired for private meetings. A meeting room with task lighting is designed for people in need of a more focused working space. Horizontal task space is uniformly lit. Colour of the table is also intensifying the impression of visual clarity. The level and colour temperature of light is allowing the occupants to have their meetings in a visually clear space (Figure 4.57).



Figure 4.57 : Visual clarity , meeting room in the Glasgow SocietyM Hotel.
Glasgow, UK (Url - 83).



Figure 4.58 : Haziness meeting room in the Glasgow SocietyM Hotel. Glasgow, UK
(Url - 83).

Communal corner within the interior space, however, is not suitable for long meetings or presentation. Illuminance is low with warm white colour temperature and is not proper to lead a task. In addition, dark wall partition is making the impression of haziness even stronger (Figure 4.58).



Figure 4.59 : Recreation room, Google Tokyo Office, Tokyo, Japan (Url - 84).

Recreation space of Google Tokyo Office workers, is lit with task lighting. Cold white light temperature is chosen to provide the necessary visual conditions while playing the game (Figure 4.59). Impression of privacy is created with relatively lower levels of uniform illumination in user's zone and high non uniform illuminance level on walls (Figure 4.60). Cocktail lounges, fine restaurants, reception rooms and residences use this effect to create more intimate spaces (Steffy, G, 2008).

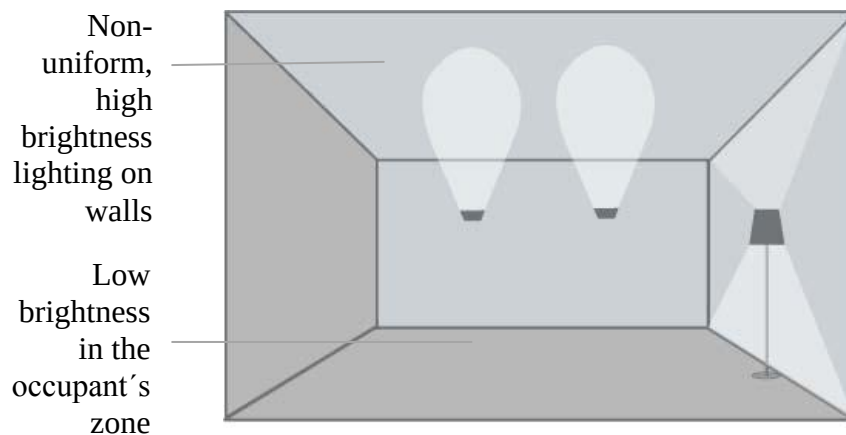


Figure 4.60 : Non-uniform, high brightness on surrounding walls, low brightness in the occupants' zone to achieve Privacy (Gültekin, 2014).

In the lounge of press centre on Figure 4.61, the walls surrounding the occupants are highly illuminated with downward uniform distribution of light. The occupants' area has relatively lower illumination level creating the impression of privacy.

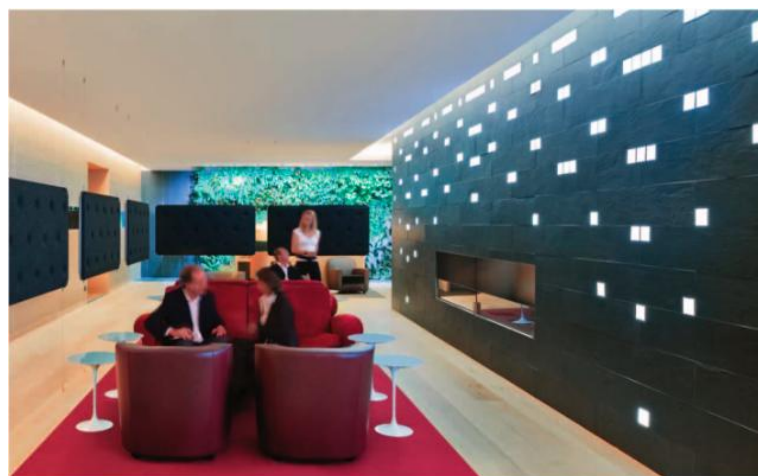


Figure 4.61 : Press Centre, Messe Frankfurt, Germany (Url - 85).

According to Flynn when lighting patterns provide high facial clarity the impression of publicity is stronger. In contradiction, interiors with low facial clarity give a stronger impression of privacy (Gordon, G., 2003). Public and private impression of the same interior is shown on Figure 4.62 relatively lower illumination around the occupants decrease facial clarity. Keeping the only illumination source in occupant's zone also creates the impression of one's being in his private circle.

When an interior is too crowded to create distance between people, they can be detached with lighting (Steffy, G, 2008 ; Gordon, G. , 2003). In a restaurant for example, people do not like to be isolated from the space completely; they would like to see the waiters flow around or communicate to other people, but at the same time they would like to have a defined private area while eating and chatting with their friends. Nobu Hotel Lounge offers such an interior setting for their customers.

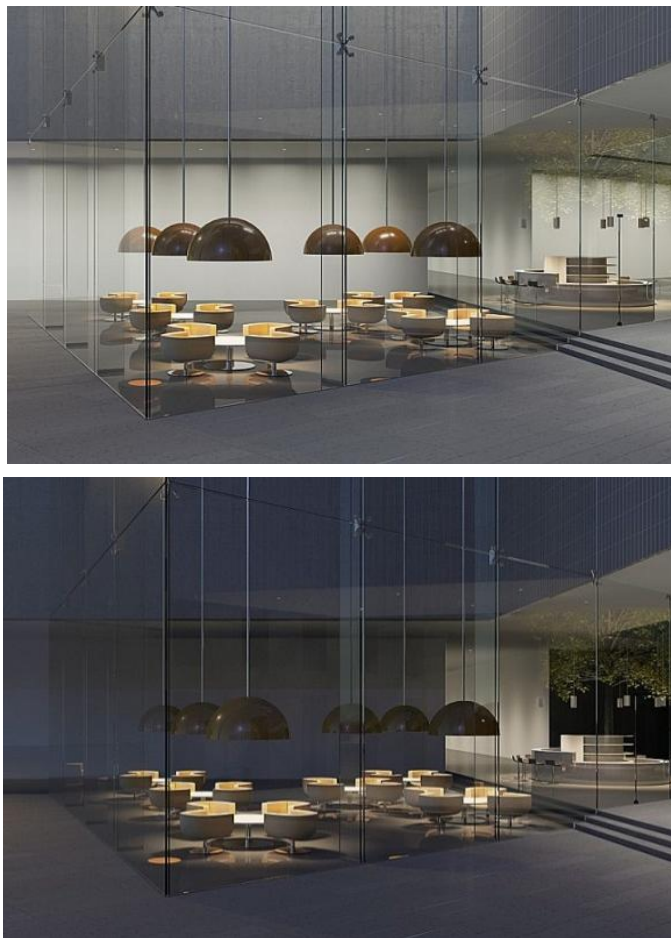


Figure 4.62 : Public (on the left) and Private (on the right) views of the same interior (Url - 86).

Lounge area on Figure 4.63 creates the impression of a public space in the first place. LED downlights are sustaining the ambient illuminance. On the other hand, application of downlights with lower illumination level , on the top of the seating zones is creating an intimate impression (Figure 4.64). Warm white colour temperature and use of fabrics and carpets are also increasing the impression of privacy.



Figure 4.63 : Publicity , Nobu Hotel Lounge, Las Vegas, USA (Url - 87).



Figure 4.64 : Privacy, Nobu Hotel Restaurant and Lounge, Las Vegas, USA
(Url - 88).

Non-uniform, lighting on walls with warm colour temperature

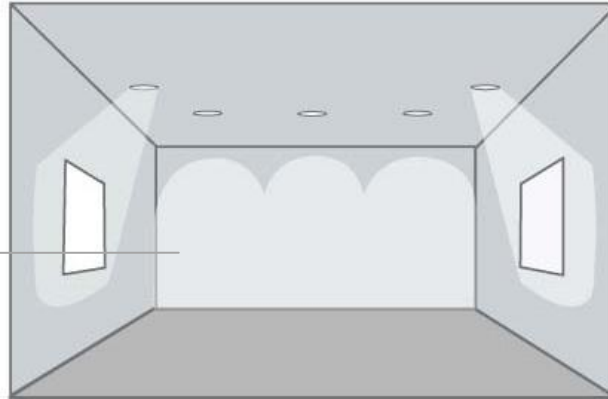


Figure 4.65 : Non-uniform, lighting on walls with warm colour temperature to achieve Relaxation (Gültekin, 2014).

Use of non-uniform distribution with peripheral lighting, and lower light levels will give the impression of a relaxed atmosphere (Figure 4.65). Interiors including hospitality like waiting rooms, several dining functions, lounges and conference rooms.



Figure 4.66 : I1 Millione, Hong Kong, China (Url - 89).

I1 Millione Restaurant in Hong Kong offers a relaxed atmosphere to their customers. Design challenge of the space is that the main room is a closed space without any windows having very limited amounts of daylight. So that, to make people feel being in a cosy relaxed space rather than a confined interior some visual tricks are applied

on the ceiling. Lighting level is low with warm colour temperature. Actually, layers of warm white light is applied all over the room. On the ceiling, a repeated pattern of bowl - like halo structures are applied. Each shallow bowl structure has LED stripes fixed around them providing a golden glow. At the center of each bowl a mirrored panel is fixed to extend the height of the ceiling (Figure 4.66). LED lighting system is dimmable. During lunch service for example the level of light can be arranged to be brighter and smoothly dimmed to very low levels in the evening. Between the halo ceiling structures traditional tungsten halogen sources are placed to support the atmosphere.

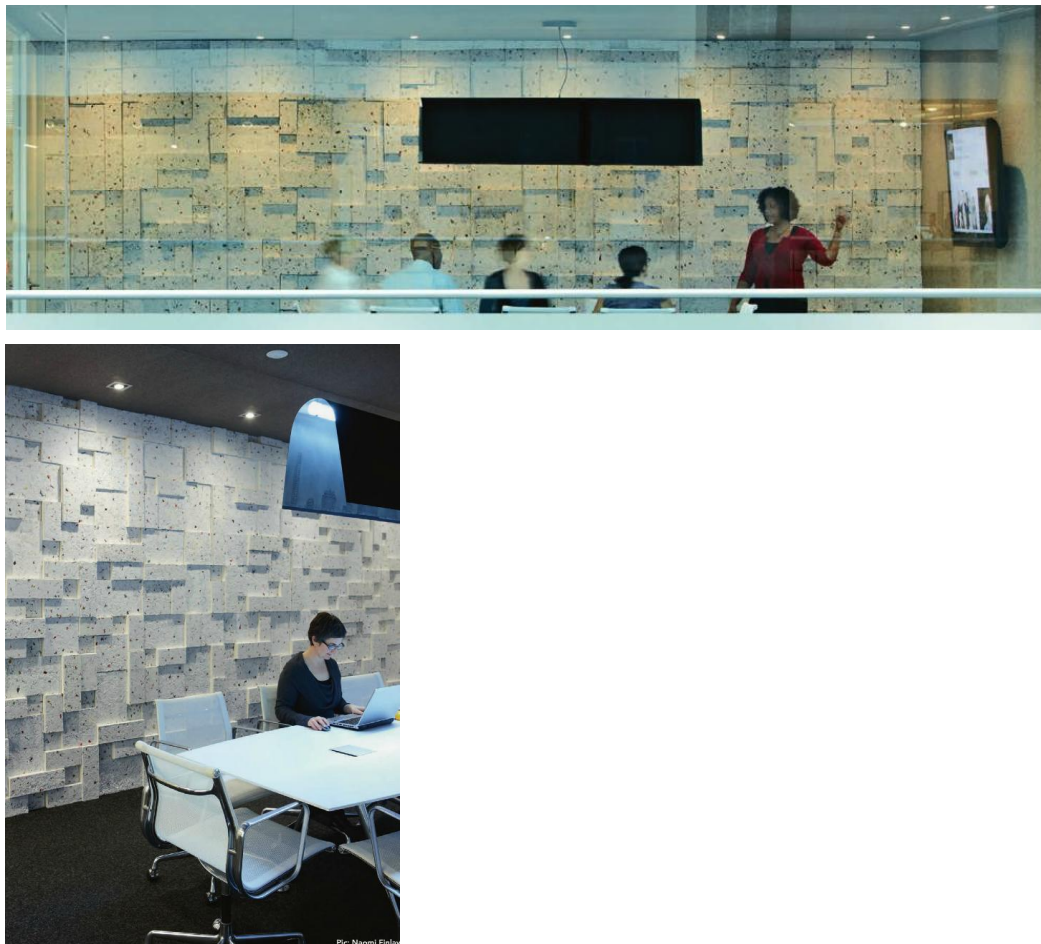


Figure 4.67 : Quadrangle Architects Studio, Toronto, Canada (Url - 90).

Application of only uniform direct lighting is not suitable even for workspaces because sense of tension is increased in these kind of settings. Instead walls should be lit irregularly by enhancing paintings on wall surfaces to create a tranquil

impression (Steffy, G, 2008). Lighting design of Quadrangle Architects Studio meeting room is an example to this situation. Task lighting of the space is achieved with a linear LED light source covered with a folded sheet steal. In addition, special wall structure of the room is highlighted with wall washers to create a relaxed atmosphere during long meetings and presentations (Figure 4.67).

Flyn also found that non-uniform concentrated downward distribution of brightness in an interior is perceived as more pleasant and friendly than the uniform brightness produced by a diffuse illumination system. Soft and dimmer levels of light is considered as more pleasant if the occupants are expected to spend more time in an interior (Steffy, G, 2008). Jamie's Trottaria implements this idea to the lighting design. The space is a small intimate dining area. The interior has a thrifty image of a house rather than a restaurant. A mixture of reclaimed lighting fixtures are used to strengthen the design idea. Reclaimed factory bulkheads are located on each seating zone. Over the waiters' station task lamps are applied. All the fittings are dimmible and when the lamp shade covers the fittings decreasing the visual clarity, LED bulbs are used for support (Figure 4.68). All the elements in the built environment should be in harmony to support the visual setting. Highlighting the relationship between architectural design elements and the space also helps to create a pleasant feeling. In Jamie's Trottaria, accentuating the design elements such as bottles and eclectic wall covers increasing the impression of enjoyment and pleasantness. Perception of being at home is stronger than being in a diner (Figure 4.68).



Figure 4.68 : Jamie's Trottaria, Richmond, London, UK (Url - 91).

4.3. Resume on perception of artificially lit interiors

Visual perception is influenced by physical qualities of light. Level of light defines the required amount of light to perform an activity. Complex activities require more intense illumination levels. Required level of light to read a book and to play tennis for example are not the same. Direction, location and distribution of light source also affect spatial perception. It is possible to show an interior space less confined than it is by manipulating light sources. Special properties within an interior such as a unique wall structure can also be highlighted to strengthen the visual atmosphere.

Human eye is brightness contrast sensitive. In other words, in a poorly illuminated environment the first thing the sense of sight perceives is brightness contrast. So that, degree of brightness contrast is used to affect emotional setting as well as encouraging the intended activity. Reflectancy of materials affect perceived brightness contrast in an interior space.

Colour and colour rendering ability have significant affects on spatial perception. First of all, there are several associations of colours. Cultural and social influences affect perceived meaning of colours, but there are also universal acceptances. In addition, coloured surfaces are perceived differently related with their location in an interior space providing various meanings. Another aspect of artificial light is colour rendering ability. Each light source has different colour rendering abilities. So that, the same objects can be perceived as if they have different colours. Type of the intended activity changes colour temperature preferences. For example people prefer cold white light temperature for tasks that require high concentration such as office work. Opposingly, warm white colour temperature with low intensity is preferred for recreational activity areas such as restaurants.

Spatial perception is influenced by both functional and psychological qualities of artificial light. Especially artificial lighting design of an interior space needs to be planned considering the perceptual reactions of humans, simply because it is not naturally exist, it is artificial. Before traditional lighting scenarios were focused on only physical quality of artificial light sources. Nowadays, playing with these physical qualities, perception oriented artificial lighting is developed. People's perception in interiors is manipulated by degrees of excitement or stimulation,

fundamental concepts of light and finally subjective impressions created with several lighting patterns.

Lighting patterns achieved with different luminance distributions have power of affecting subjective impressions of people in an interior space. Uniformity, location and intensity of light are used to create these lighting patterns. Observations made by Flyn on subjects, by changing lighting patterns, proved that it is possible to create five impressions; spaciousness, visual clarity, relaxation, privacy and pleasantness by manipulating patterns of brightness contrast. Power of visual information on people in an interior differs according to brightness contrast differences of lighting patterns. Changing lighting scenarios to create desired perception, personal control on lighting and using light as an interior design element are rising trends.

5. PERCEPTION OF INTERIORS WITH DAYLIGHT AND ARTIFICIAL LIGHT INTEGRATION

Light is an important tool that enhances interior architecture and affects perception of people. The sun has been the main source of light for humans. About a hundred years ago people had to order their lives according to available daylight conditions as there were no artificial light source but candle lights. Discovery of electric light enabled to have adequate amounts of light even when there is no daylight. People have had control on lighting situations in interiors.

Today, it is not possible to solve lighting requirements by using only daylight. There is no doubt that to sustain their mental and physical well being, human beings need daylight. However, in most of the cases it is not enough to sustain visual comfort. Artificial light sources need to provide the necessary quantity of light for each specific visual task. However, light also has diverse effects on perceptual process of human beings.

When “lighting modes” of a room change, the arrangement and the power of visual patterns on people change. As a result interpretation of the space alters. So that , lighting design of an interior shouldn’t be statistic. It should provide options for different times of the day. Bartenbach explains this situation with an example. He states that daylight during the day has high colour temperature with slightly bluish colour, in the evening however, red colour becomes more dominant. The spectrum of artificial light in interiors should follow this natural quality of light. In the morning for example the best colour choice for a desk lamp in an office is bluish white. In the evening, however a warm reddish colour of white with low intensity is recommended Bartenbach also states that in the next two decades lighting technology will evolve to provide innovative lighting systems to satisfy increased demand for healthy living. LED technology will play a significant role because of having long service life, being economical and also providing options to arrange brightness and even spectral composition of light. This situation will provide new areas to use artificial light technologies as well as creating the possibility to achieve new moods for interior lighting (E., Tsakiridou, 2003).

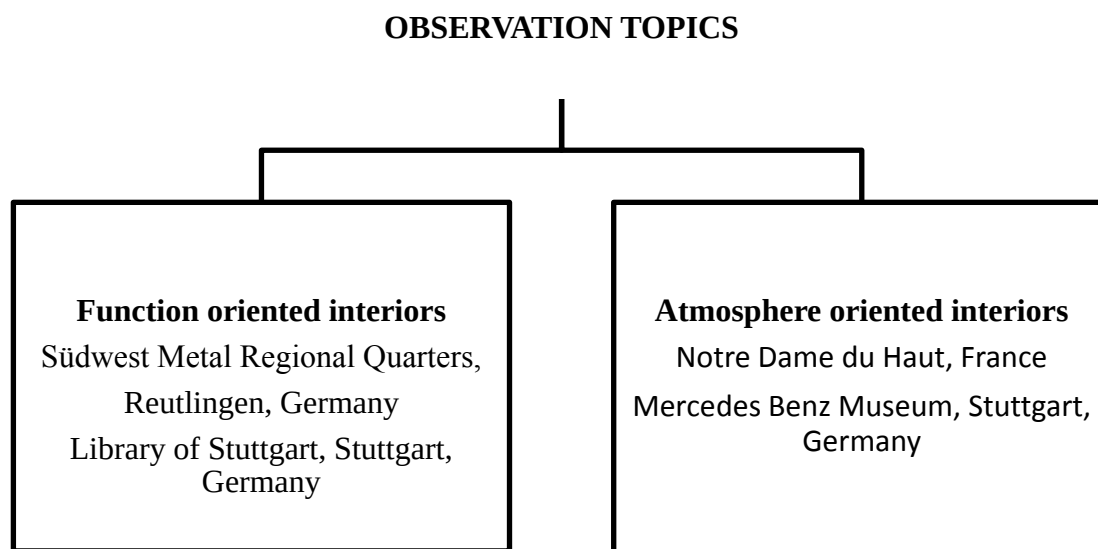
Nowadays, artificial light is usually used to support daylight in function oriented interiors such as offices and libraries. With the technological improvements, they

strengthen the visual perception and psychological impressions of a space together. There are also situations where they are applied together in order to form a special atmosphere. In areas such as museums for exhibition design applications or spiritual spaces light is arranged to create a thematic display. In the light of these implications, with a subjective approach, the observed interiors are divided into two groups as Atmosphere oriented interiors and Function oriented interiors. This two different groups are investigated through different building typologies. Criteria on choice of the cases is the way of using daylight and artificial light to manipulate people's visual and psychological perception. Selected buildings can be listed as:

- An office interior, Südwest Metal Regional Quarters,
- A library, Library of Stuttgart,
- A spiritual interior, Notre Dame du Heut,
- A museum with an exhibition design concept, Mercedes Benz Museum.

Seperation of the observation topics under chosen titles is given on the table below (Table 5.1).

Table 5.1 : Observation topics (Gültekin, 2014).



Visual experience and visually perceived qualities of the spaces and psychological experience of spatial atmospheres in association with lighting is investigated for each building type. The selected buildings are visited and observed according to the

qualities explained on section 3. Perception of Daylit Interiors and section 4. Perception of Artificially lit Interiors. Moreover, ways of using artificial light sources to support daylight for each example is observed and their addition to visual and psychological perception of the occupants is explained.

5.1. Function oriented interiors

Interior spaces which are designed for specific visual tasks such as libraries or offices require lighting settings to establish visual comfort and performance. Natural light has a specific power on these kind of interiors. Having connection with exteriors via openings improve concentration and psychological well being in interiors. However, artificial lighting is also needed to maintain visual comfort and task lighting requirements.

Daylight is crucial for biological homeostasis. Biological activities on human body are regulated by a biological clock in brain. Sun provides secretion of hormones in our body by stimulating it. So that, body knows how to react on different hours of the day. When this information requirement is not satisfied, in other words, when the world does not act the way people expect from it, their biological balance is negatively affected.

Alto states that the absence of windows in offices causes undesirable behaviours on people. People tend to be more talkative and spend a significant amount of less time on working on computer when compared to others working at offices with windows. In the light of this fact, it was hypothesized that people who work in offices without windows can not have enough light to sustain their circadian systems, so to be exposed to daylight as soon as possible they have tendency to spend less time in their offices and look for social interactions. Another explanation to this situation was eyes' need for exercise. The view out of windows in an office interior provide extra short-time stimulation, so differences in behaviour did not have an effect on circadian system at all. (Proceedings of the Fifth Intl LRO Lighting Research Symposium, EPRI: Palo Alto, CA). Regardless of which explanation is true, it can be said that having windows in an office is an advantage to improve concentration and performance in a workplace. However, because of the variation of sun it is not always possible to sustain sufficient amount of daylight in offices. Moreover,

constant lighting levels are required to accomplish tasks such as reading or working on the computer. So that, artificial light and daylight should be planned together in function oriented interiors. With successful planning of daylighting and artificial lighting, visual and psychological perception of a function oriented interior can be improved.

A library's study atmosphere affects mood, perception, concentration and performance significantly. Lighting setting creates several consequences on visual and psychological perception. In interiors, people prefer variable daylight because of the impression of connection to the exteriors. However, for task lighting in a library, daylight is not enough because a static level of light is needed to accomplish several tasks.

The lighting level in a library should enable the occupants to visually see and perceive during reading, writing or working on the computer. Recommended illumination levels according to EN 12464 - 1 is given in Table 5.2. In libraries designed with daylight distraction that might be caused by variability of daylight is prevented by using artificial light sources in collaboration with natural light. The integrated lighting systems including artificial light and daylighting needs to sustain required level of light, visual comfort and glare free interiors (Dean, T., 2005).

Table 5.2 : Recommended Light Levels for Libraries (EN 12464-1).

	Illuminance maintenance values E_m [lx]	Upper limit for direct glare UGR_L	Lower limit for the colour rendition index R_a
Bookshelves	200	19	80
Reading area	500	19	80
Counters	500	19	80

An office building and a library will be investigated on this section. Visual perception and psychological impressions achieved with designed function oriented lighting settings will be explained.

5.1.1. Südwest Metal Regional Quarters

Location: Reutlingen, Germany

Architect: Allmann-Sattler Wappner

Completion: 2002

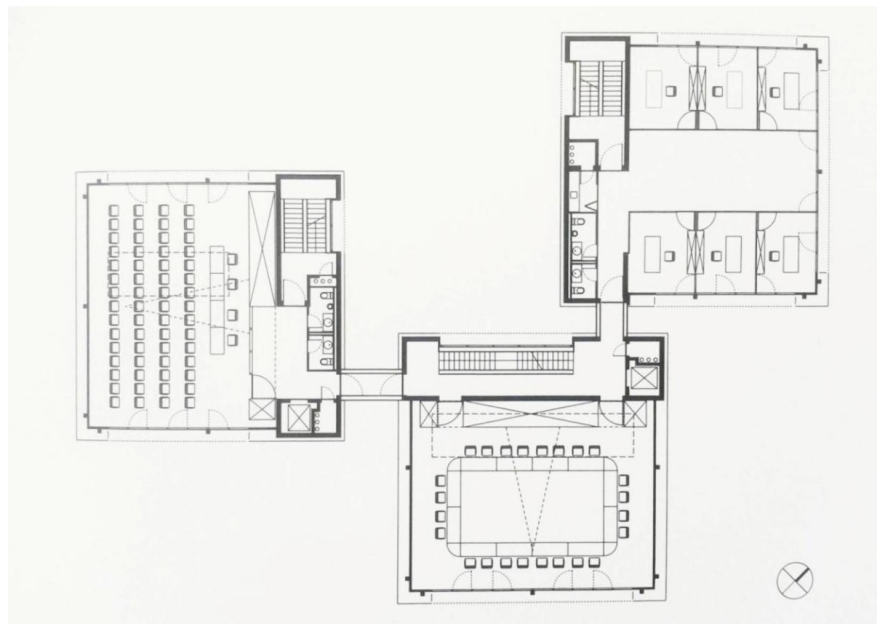
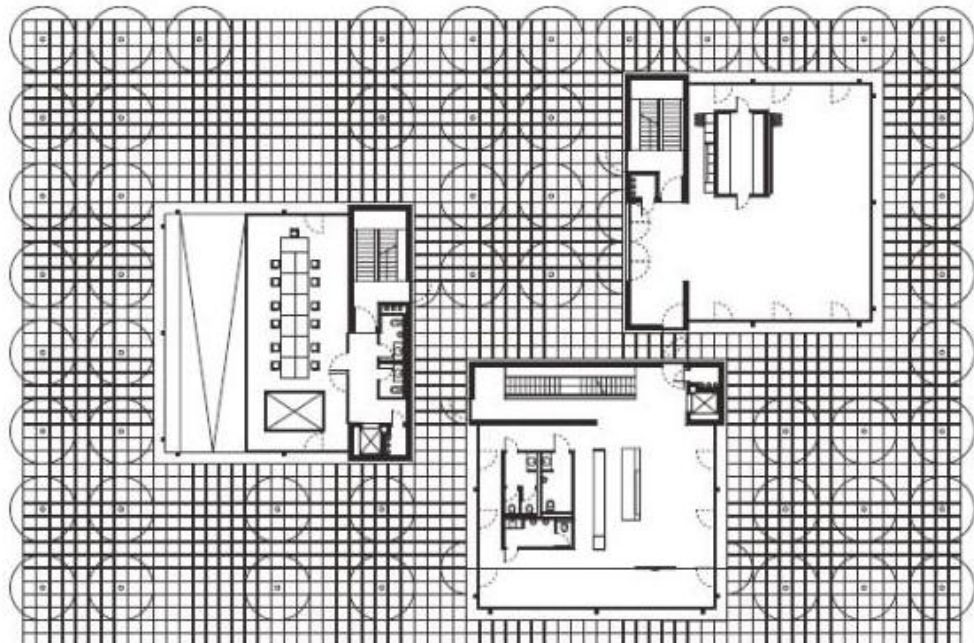


Figure 5.1 : Ground Floor and First Floor plans (Url - 93).

The building is planned as a training center and regional office for the metalworking and electrical manufacturing organization in the state of Baden-Württemberg, is

located in Oststadt in an area with a mixture of domestic housing and small industry. The company is producing metal sheet products. Material of their own production " metal" is used for facade design to inform people about corporate identity of the firm with its architecture. The main idea of the architecture is to provide an office space for people (Url - 92). Public oriented functions of the buildings; entrance, reception hall, cafeteria and the ramps to the underground garage are on the ground floor. Offices, meeting rooms and conference rooms are on the first and second floors (Figure 5.1).

The three saddle roof buildings are suitable to typology of the area. In order not to create a perception of "a town house with garden" on people, unusual surface materials are used: Stainless steel facade and cast steel latticework at the base and in the garden area (Figure 5.2).



Figure 5.2 : Change of the atmosphere on different times of the day, photo by Photo
Courtesy Allmann Sattler Wappner (Url - 92).

The buildings in the area are generally old stone walling and timbered buildings, Typical design components of the buildings are saddle roofs with length of fifteen meters. The design of Südwest Metal Company buildings are a stylised version of the buildings in the neighbourhood. Because of the unusual material use and daylight design approach the building is distinguished easily from the others, but it does not create a contradiction with the general design quality of the neighbour buildings (Figure 5.3).



Figure 5.3: Buildings on the neighbourhood (Url - 94).

Choice of **materials** are specific to the architecture and enhance the experience of the interior space. The lighting concept of interiors is designed in collaboration with a special property of a metal, different experiences and perceptions are achieved in interior and exterior. Patterned metal trellis work starts on the ground floor turning around the buildings to a height of three meters (Figure 5.1). Perforated metal facade also is perceived as a boundary between the public space and the private area of the company as well as providing a light, open and inviting atmosphere towards the street. Daylighting design of the building is serving as a communication symbol.

Perforated facade openings on the ground level are creating the image of transparency and openness.

The facade has a double skin. Inner skin is glazed with a thermal glass. Outer skin is constructed of 4 mm stainless steel sheets, which are fixed without expansion joints to achieve a picture of an uninterrupted continuous building volume. Stainless steel sheets reflect the colors and the light from the environment, so color of the building changes during the day creating pleasant impressions on people (Figure 5.4). At night, the building is lit artificially. Material of the openings create various atmospheres under daylight and artificial light (Url - 95).



Figure 5.4: Change of materials under different shades of light during day
(Url - 95).

Motorized window shutters made of the same stainless steel sheets cover the rest of the facade for daylight control. To meet the needs for view and daylight, the shutters are perforated in different levels (Figure 5.5). When opened, the shutters disappear and when closed, they become a part of the skin. Special construction of the shutters create the perception of an uninterrupted closed building volume. In addition, sunshades are centrally controlled to be opened during the daytime and closed at night to support the homogeneous impression of the design.



Figure 5.5: Shutters made of stainless steel, photo by Photo courtesy Allmann Sattler Wappner (Url - 96).

The facade of the architecture is covered with perforated openings. The facade is turning from a solid substance into an airy screen allowing the daylight shine through inside, letting people experience the changing quality of natural light inside as well as creating shadow plays. In other words, perforated facade is bringing life to interior space (Figure 5.6).



Figure 5.6: Shadow interplays on the corridor of entrance photo by Photo Courtesy Allmann Sattler Wappner (Url - 96).

Reception on the ground floor and cafeteria are benefiting from light shadow plays on sunny days. The building is located in Reutlingen, Germany; a geographic

location that has very few sunny days especially in winter. So that, artificial light is also given significant importance. Similar luminaires of downlights are located on the ceiling: Artificial light is thought as a helping tool to achieve clear visual perception. Warm white light temperature is working in relation with colour and material choice of interiors. White and grey are major tones all over the ground floor. Spaciousness and light airy affect achieved with perforated facade application is becoming stronger with colours (Figure 5.7).



Figure 5.7: Reception on a cloudy day, with electrical light sources switched on (Url - 97).

Floor textures are slightly reflective to enhance perception of shadow interplays. Artificial light sources are also helpful for visual clarity in cafe space. When intensity of daylight is not enough, downlights are switched on to sustain sufficient level of light in cafeteria (Figure 5.8). On the first and second floors long horizontal openings are applied. As it is mentioned before, on the upper floors offices are placed. This quality of the openings allow the daylight in, preventing boring static office environments. Results of the short interview with the workers also showed that experiencing changing quality of daylight inside offices increases positive feelings which is a supporting factor for motivation. Daylight penetration to offices, strengthen the impact of bright interiors as well as letting people experience changing quality of light during the day (Figure 5. 9).

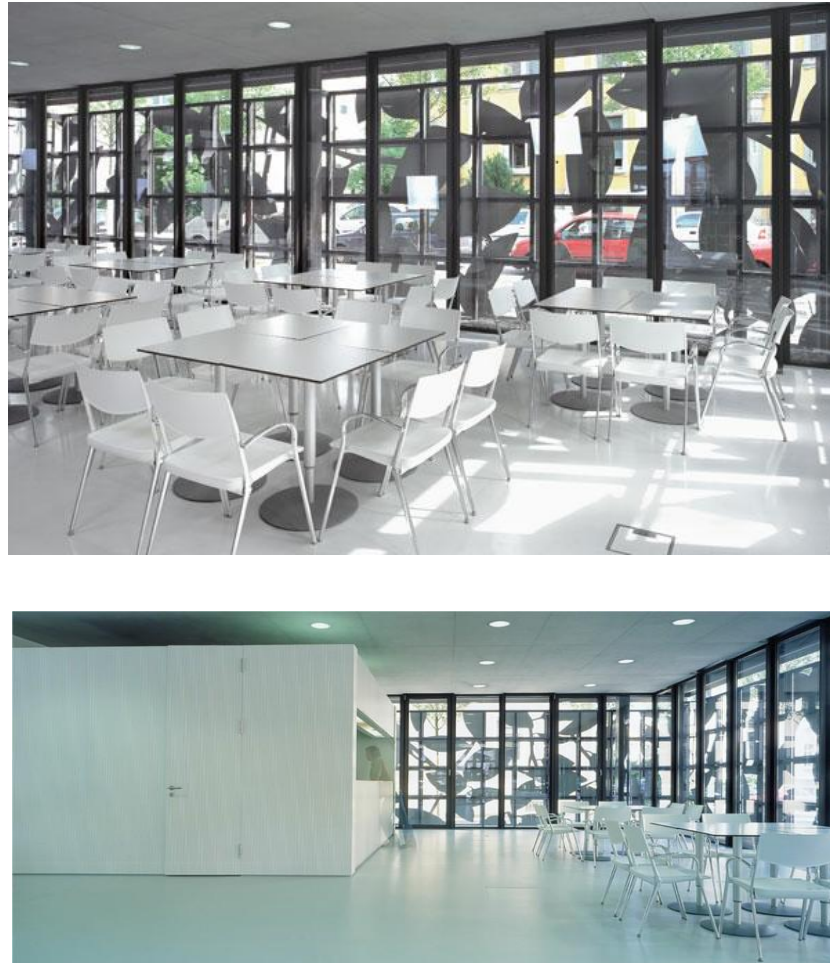


Figure 5.8: Change of the atmosphere in cafeteria under daylight via shadow plays and on a cloudy day with artificial light sources switched on, photo by Photo Courtesy Allmann Sattler Wappner (Url - 98, Url - 96).

In offices, artificial light sources are mounted on the ceilings in addition to natural light from windows (Figure 5.9). Materials and colors inside the offices are white and light coloured. The furnitures are also like floating in the spaces (Figure 5.10). Glass partition walls are also enhancing design the impressions of being in an open space. Floor textures are opaque and light grey in order to prevent any undesired reflections of daylight or artificial light sources, to distract people's attention during worktime. As it was mentioned in the research, cold white colour temperature of artificial light sources have power on increasing concentration. For task lighting of the offices, artificial light sources with cold white colour temperature is applied to improve concentration during worktime.



Figure 5.9 : Interior of one of the offices on the second floor (Gültekin, 2012).



Figure 5.10 : Furnitures like floating in space (Url - 99).

In one of the conference rooms on the second floor, indirect light distribution of uplights is chosen . White and high enough ceiling is already sustaining the general lighting conditions for the room: As mentioned in research, application of uplights on the areas surrounding the occupants creates impression of relaxation. Uplights are creating a semi- formal atmosphere helping the employees to feel more relaxed during long meetings (Figure 5.11).



Figure 5.11: Conference room (Gültekin, 2012).

On the ground floor perceived atmosphere from outside also changes with electrical lighting. On a cloudy day, warm white light distribution projects perforated facade application like a screen. It can also be commented that artificial light is helping the design idea of "communicating to people via transparency" to be managed (Figure 5.12).



Figure 5. 12 : Change of the perceived atmosphere from outside (Url - 100).

5.1.2. Library of Stuttgart

Location: Stuttgart - Germany

Architect: Yi Architects

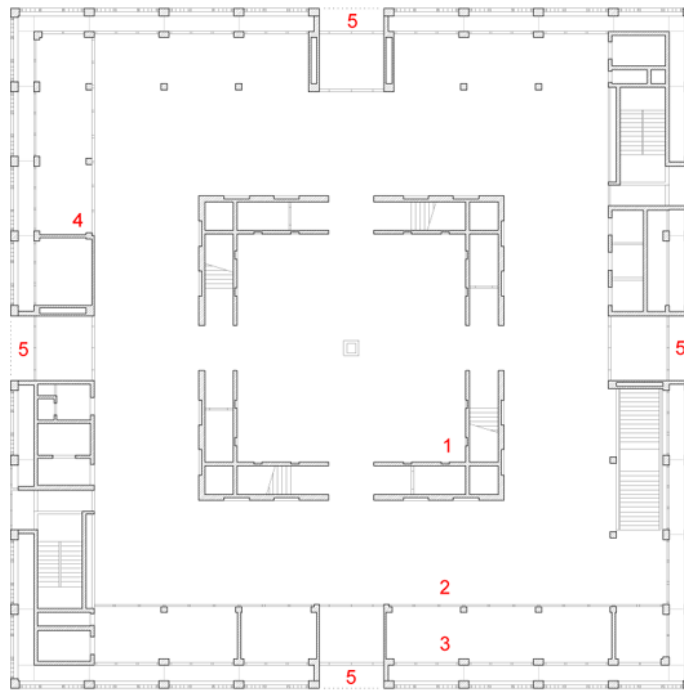
Completion: 2011

The area of the library is in Mailänder Platz, an area which is perceived to be a city centre growing out of the location of Stuttgart. With this approach, the library is designed in the form of a cube with an edge length of 45 meters. The design idea was to give a grand physical presence to the library in order to express its significance. According to the architect the building is planned to be a communication center for all cultures. The new building is intended to be a place of dialogue and cultures (Url - 101).

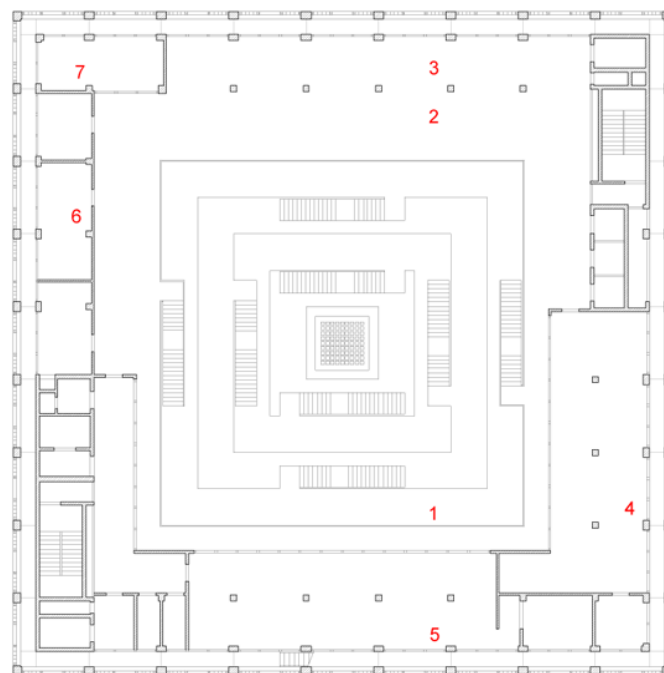


Figure 5.13: Exterior view of Library of Stuttgart (Url - 101).

The building is constructed out of grey concrete cube and frosted glass bricks openings. The shape of the building is inspired by "Cenotaph for Newton" by Étienne Boullée. The facade is made up of double facades. Inner facade consists of a post-and-beam construction. Outer facade is a 9.00 x 9.00 m large concrete cube with square openings stuffed with glass blocks (Figure 5.13). Movable sun protection louvers take place in the space in between (Url - 102). Also, narrow corridors and an artificial lighting system for night takes place between the facades (Figure 5.15, Figure 5.16).



floor plan / level 0
 (1) 'heart'
 (2) entrance hall
 (3) offices
 (4) sorting area
 (5) entrance



floor plan / level +8
 (1) reading room
 (2) media presentation
 (3) workstations
 (4) graphotek
 (5) cafeteria
 (6) offices
 (7) sorting area

Figure 5.14: Floor plans (Url - 102).



Figure 5.15 : Openings stuffed with glass bricks (Gültekin, 2014).



Figure 5.16 : The corridor formed in between two facades (Gültekin, 2014).

There are four identical entrances to the building. On the ground floor a ring shaped entrance hall takes place where information and the entrance to the Heart is located.

The Heart is a cube-shaped empty space of contemplation. The room takes place in the core of the building and is illuminated by a rooflight of glass blocks from the top (Figure 5.17).

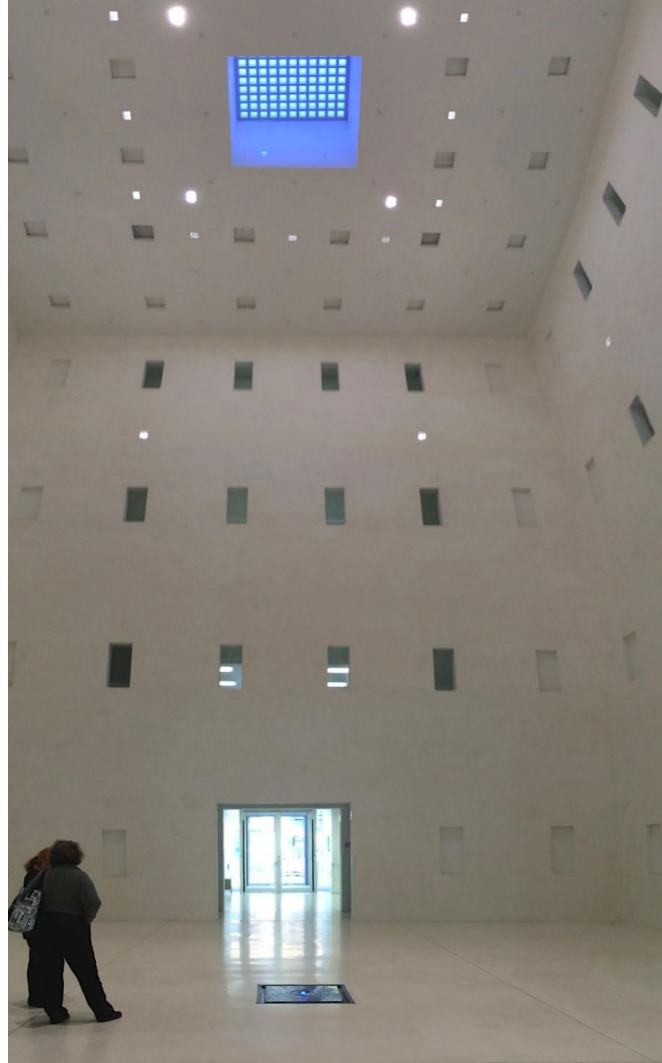


Figure 5.17: The“heart“ of the library, with a central rooflight and small openings (Gültekin, 2014).

Many small openings are located on the adjacent walls and the ceiling of the cube shaped room in order to let daylight penetrate through the facades to the Heart. In the middle of the room there is a fountain. Natural light is diffused from the ceiling and the small openings on the four walls. Also, artificial light sources are placed on some of the openings in order to create a similar impression during cloudy days and when the sun disappears. Ceiling mounted LED luminaries are able to provide three different light distribution according to the desired lighting level (Figure 5.18).



Figure 5.18 : Artificial light application on the ceiling of the Heart (Gültekin, 2014).

With the daylight penetration from the ceiling and the sound of water the space is converted into a spiritual area. The room is also a symbol of communication as it is entered from four sides and visitors meet each other in the heart. The contemplation space is symbolising the sense of homogeneity as all the people from different cultures meet right in the middle of the symbolic space (Figure 5.19, Figure 5.20).



Figure 5.19 : People entering from four sides and meet in the heart (Url - 103).



Figure 5.20 : Fountain in the middle of the room (Gültekin, 2014).

Even if the library is a function oriented interior, perception of people has been given great importance. Both daylight and artificial light is used to enhance significance of communication.



Figure 5.21 : Artificial light sources on 1st floor (Gültekin, 2014).

On the upper floors, music library (1st floor), the Children's Library (2nd floor) and the departments of philosophy, psychology, medicine, and other fields of knowledge (3rd floor) are located. They are located around along with the "heart" of the Library. Offices for employees are located around the openings. So that, many study locations on 1st, 2nd and 3rd floor do not benefit from daylight (Figure 5.21).

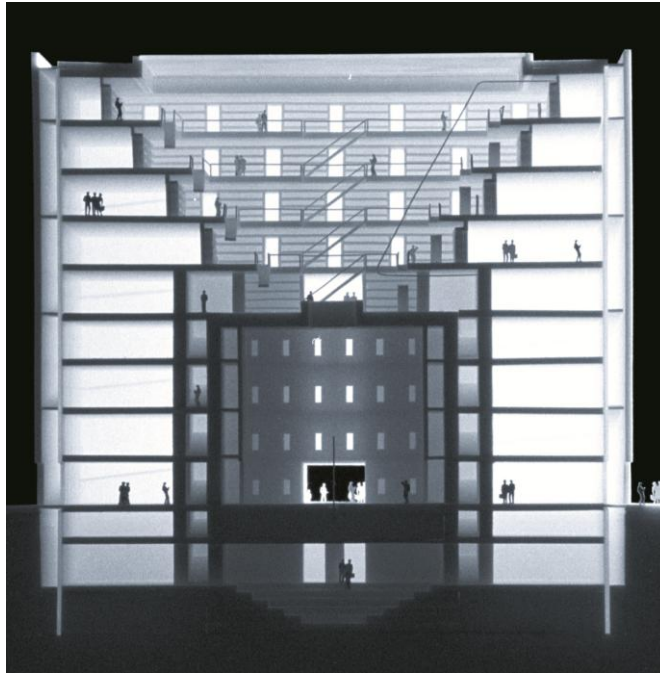


Figure 5.22 : Section of the building : Heart and the gallery (Url - 103).

Studying on this floors for a long time makes people lose sense of time. From the research it is known that according to Lam, one of the most required biological needs for people is orientation. People need to have clear information about their surroundings to maintain their biological well being. Because these areas are lit with static light sources of cold white light temperature, after a few hours of studying sense of time is lost. The library is open between 9.00 - 21.00. When people start studying at 9.00 on the first floor for example and leave the building around 20.00, they are surprised to see the weather outside is already dark. Offices and private study rooms located around the 1st floor prevent daylight penetration to the common study areas.

Above the Heart; the gallery is located. Starting from the 4th floor the gallery is serving as a deep light well (Figure 5.22). The gallery atrium is a funnel shaped five story space richly illuminated from the glass roof made of white marble and steel. The funnel illuminates the study areas and the bookshelves covering the wall surfaces (Figure 5.23). The lower four galleries (4th to 8th floor) serve as reading rooms, on the top the art library and café is located. From here, visitors enter via a staircase to the roof terrace.

The most functional objective/requirement in a library is silence. There are no aligned book shelves one after each other or walls separating the study area, so the library is expected to have a noisy environment. As it can be seen in the section and the plans, the interior has a cone-like atrium with stairs which might cause a lot of noise and distraction for people (Figure 5.24).



Figure 5.23 : View of the funnel shaped gallery space from the 8th floor
(Gültekin, 2014).

However, the choice of sound insulating materials from floor to furnitures and ceilings prevent any inconvenience. To increase the impact of light and silent atmosphere on people, white and non glossy finishes are applied on the walls and floors. This approach is also preventing glare possibilities that may occur because of artificial light sources (Figure 5.23). To prevent overheating of the reading rooms located in the funnel shaped atrium, sunscreens are placed within the rooflight system (Figure 5.24). The system can be controlled centrally and is supported by artificial light. Artificial lights automatically change the lighting level when needed. The control of the artificial lighting is managed with a standard system called Digital Addressable Lighting Interface that can be controlled at the individual lights when required. Lighting equipments are a combination of high pressure sodium discharge lamps and LED's:



Figure 5.24 : The roof with mounted luminaries switched on (Gültekin, 2014).



Figure 5.25 : Day atmosphere versus night atmosphere (Gültekin, 2014 ; Url - 101).

Change of colour temperature daytime and after sunset is shown on Figure 5.25. During daytime intensity of light is low and the perceived atmosphere is natural because of the daylight penetrating through the large roof opening on the top of the gallery. After sunset, the intensity of light increases and the colour temperature is a colder white (Figure 5.25).



Figure 5.26 : Artificial light sources of the reading rooms around the gallery space (Gültekin, 2014).

Artificial light sources of the reading rooms around the gallery space benefits from daylight and artificial light sources imitating daylight. Downlights located right above the seating zones, but directed to the bookshelves are providing the required task lighting level and visual clarity on horizontal surfaces without highlighting the visitors. Also, vertical surfaces (book shelves) are highlighted with non -uniform light distribution. As stated on the research, on section 4.2.3. *Subjective impressions*, lighting the area surrounding the occupants with non - uniform light distribution and keeping the lighting level in occupants zone relatively lower increases the impression

of a privacy. Here, in a crowded public interior, a private atmosphere is created by manipulating artificial light. It can also be added that choosing comfortable seating equipments located on each floor with a proper interval and locating them facing the gallery atrium also increases sensation of privacy (Figure 5.25, Figure 5.26).



Figure 5.27 : Non glossy surface finishes in relation to orientation lights
(Gültekin, 2014).

Orientation lights are located on each corner right above the stools that are located to reach upper shelves when needed. These orientation lights are also composing a relaxing atmosphere and view all over the gallery space (Figure 5.27). Because of the fact that artificial lighting and daylighting is planned to work in relation to each other. The gallery space is not perceived as artificial even on sunless days. Perception of studying outside under sky is achieved with rooflighting system. At different times of the day, shadows change creating different appealing views enhancing the sensation of being in an open space. In winter and summer times of

the year sharpness of shadows and light alters differently reflecting the changing atmosphere of outside to inside (Figure 5. 27).



Figure 5.28 : Shadow plays on a sunny day on March 2014
(Gültekin, 2014).

Right after the sunset artificial lighting system of the facade is activated. Simple, concrete box completely changes with interplay of light achieved by LED light sources forming appealing views. Interior is also affected from the coloured light, but with the right planning study areas are not lit with coloured light, cold white light distribution goes on until the closing time (Figure 5.29).



Figure 5.29: Change of the atmosphere during night and day (Url - 105).

5.2. Atmosphere oriented interiors

Interiors designed to enhance a feeling, an impression or an emotion can be defined as atmosphere oriented. Museums with special exhibition concepts or spiritual spaces are lighted with a thematic display in order to create impressions such as excitement, thrill, drama or spirituality.

Sense of sight is sensitive to brightness contrast differences. According to the research, darkness and light, the extreme ends of brightness contrast difference have significant power on visual and psychological perception.

In spiritual and religious interiors, light is an important symbolic element of faith. Relationship between light and darkness is used to manipulate people's feelings. Messages can be given or religious feelings can be highlighted with contradiction between darkness and light. Various religious interiors are shaped with daylight. Contradiction of darkness and light is implemented to the architecture to convey the desired message. Locations and positions of the openings are manipulated to dim or spread daylight. Artificial light sources are usually used to improve the atmosphere, especially after sunset or add glimmer to the spaces.

To create exhibition design concepts, extreme brightness contrast differences achieved by interaction of light with qualities surface textures are used to create dramatic effects. Increasing - decreasing level and colour of artificial light sources can be changed according to the desired concept.

On this section two different building types; a church and a museum designed with an atmosphere oriented approach will be investigated. The church Notre Dame du Heut is designed with a daylighting approach, the only artificial light source is a chandelier to support perception. Unlike many museums, Mercedes Benz Museum is designed with contradiction between daylight and artificial light. Artificial light setting is supporting daylight perception as well as creating only artificially lit spaces. Each building's lighting design and its affect on visual and psychological perception is explained under following subtitles.

5.2.1. Mercedes Benz Museum

Architect: UN Studio Ben van Berkel and Carolin Bos, Amsterdam, The Netherlands

Exhibition Concept: HG Merz

Completion: 2006

The new automobile museum of Mercedes Benz is located in Stuttgart, Germany. Due to the fact that old museum located in the factory of the company was not able to satisfy the need to exhibit new products, a new museum is opened. The site is located right next to the existing Daimler production area in the north west of Stuttgart, where Stuttgart's industrial area is also located. The site is especially chosen close to the highway and railway, so that it can be seen by people.

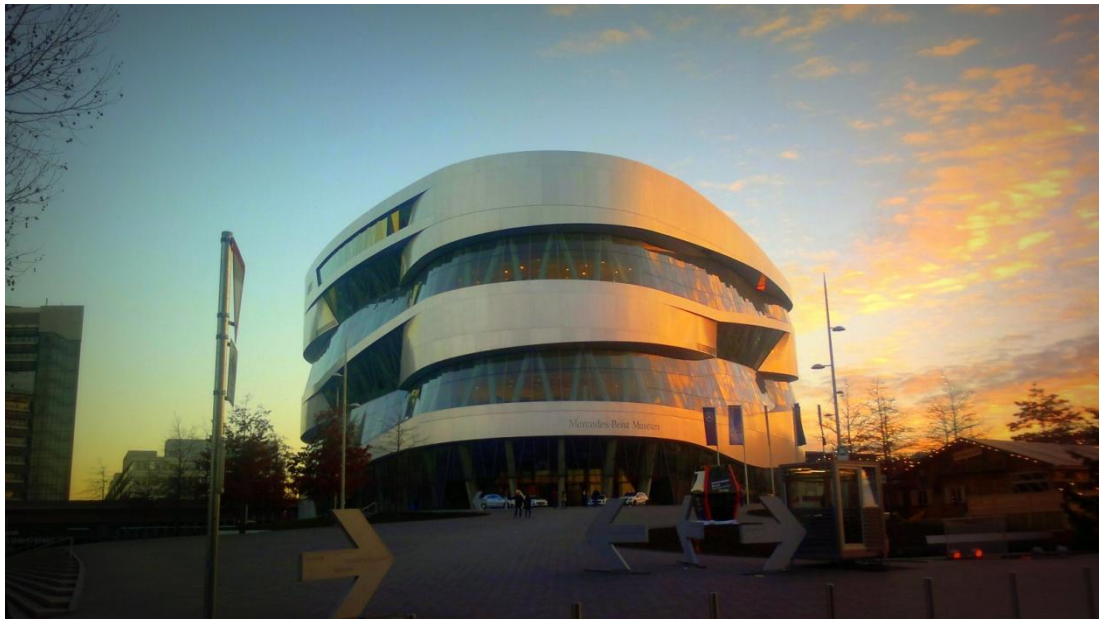
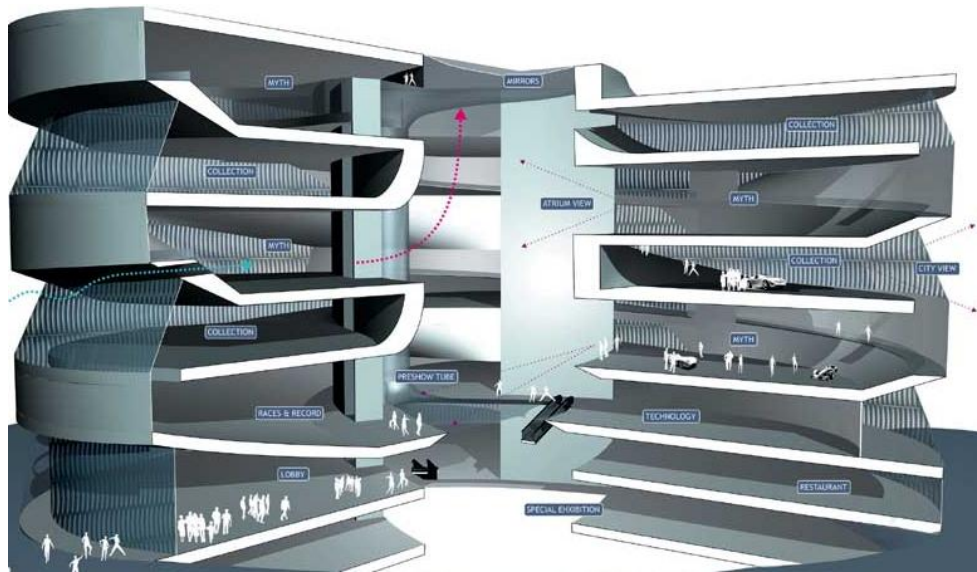


Figure 5.30 : Exterior view of Mercedes Benz Museum (Gültekin, 2014).

The new museum is composed of storeys, completely closed and the other completely open. The exterior is wrapped by an aluminium and glass skin. The building is planned like two spiraling ramps in the form of a double helix (Figure 5.31). The surfaces flow into each other, the ramps incline and become walls, then the walls form ceilings (Figure 5.30, Figure 5.31).



Figure 5. 31 : Exploded perspective of the museum explaining double DNA helix structure (Url - 106).



Lighting process is planned in collaboration with the special structural design of the building. The main concept of the museum is to tell the story of mobility starting from the first car engine produced by the company (Url - 107). So, the museum does not have any right angles. All walls and ceilings are like moving, flowing from one to other offering the visitors a completely dynamic spatial experience (Figure 5.32).

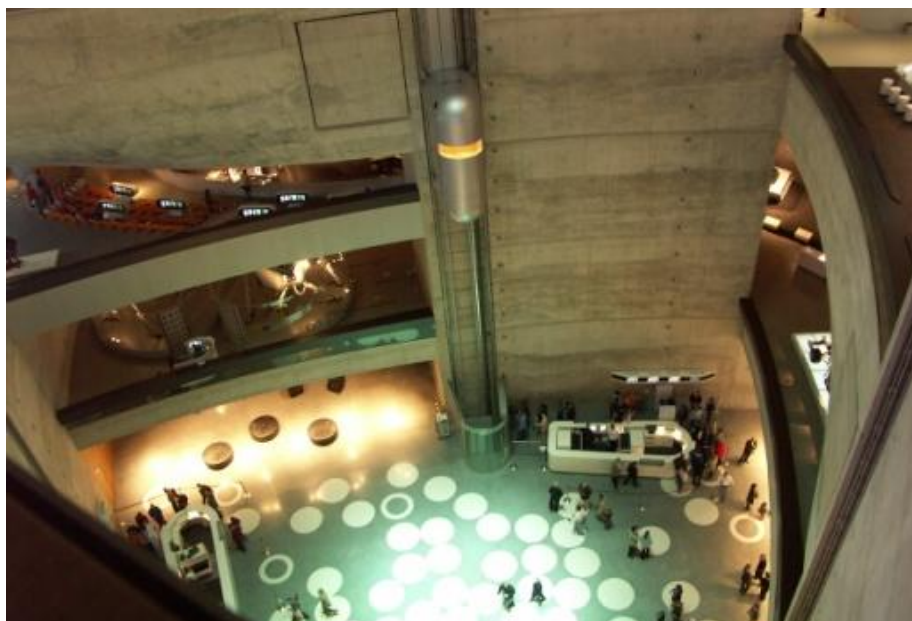


Figure 5.33: Dynamic architecture of museum and atrium (Url - 108).

Lighting design is also developed by focusing on this topic. The visitors, first enter an ordinary hall with a ring shaped information spot right in the middle. Then, they step into a 42 meters high atrium which looks like inside of a spaceship (Figure 5.33). The building spirals around the atrium. There are three lifts on the atrium resembling time machines taking the visitors on the top floor.

Perception of spaciousness and being inside a spaceship is strengthened with lighting right on the top of the ceiling of the atrium. Downlights are emitting a combination of blue and cold white light together, resembling the skylights in holly spaces which enhance greatness (Figure 5.34).



Figure 5.34 : Downlights emitting a combination of blue and cold white
(Gültekin, 2014).

On the ground floor a corner is designed for the visitors to relax in a pleasant atmosphere. Merely, the space is separated from the atrium with light. Non- uniform light distribution on the walls surrounding the occupants and huge comfortable leather couches and cosy wall textures other than dominant reinforce concrete is contradictory to general high - tech atmosphere in the atrium (Figure 5.35).



Figure 5.35 : Relaxation corner for visitors (Gültekin, 2014).

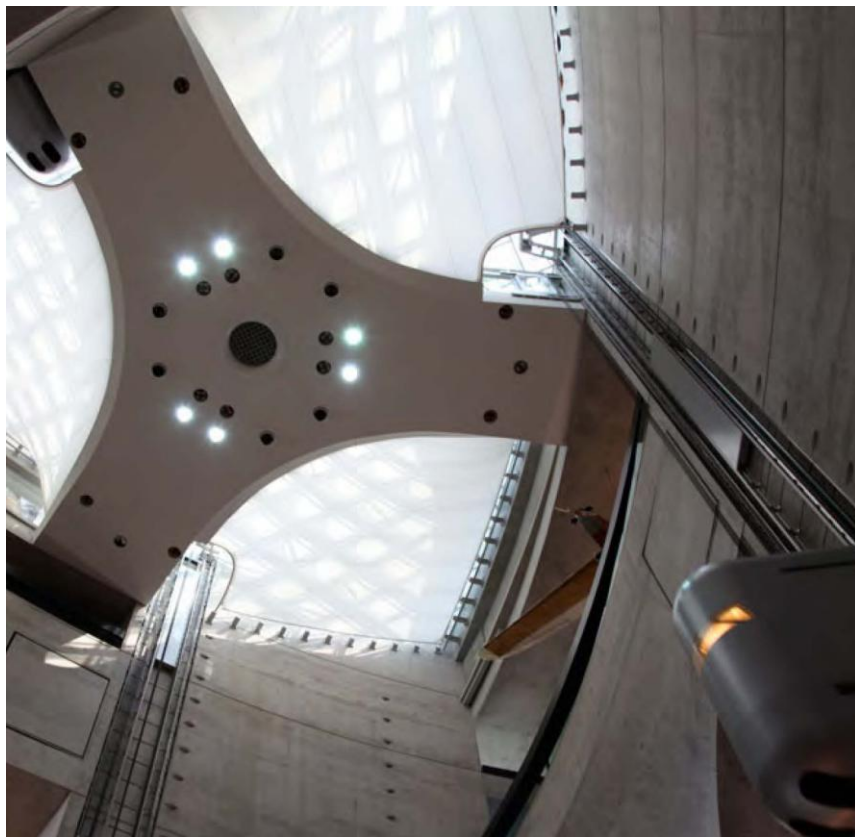


Figure 5.36 : Elevators resembling time machines taking visitors to the 8th floor
(Url - 108).

After reaching the 8th floor, with the elevators the exhibition starts. A horse welcomes the visitors. Here, the colour temperature of light is cold white still

emphasising being inside a time capsule, also the walls and the floor textures are reflective (Figure 5.37).



Figure 5.37 : Starting point of the exhibition (Gültekin, 2014).

After taking a few steps, story of the first car is started being told and the lighting completely changes with the surface textures. In the center of the room, the first car is in the lime light, highlighted with large spots located on a luminous large plate turning around itsels. Visitors are able to percieve it from all sides (Figure 5.38).



Figure 5.38 : Starting point of the exhibition and leather wall covering under artificial light (Gültekin, 2014).

Here, a focal glow is created with luminous large plates in the relatively dark room. On the walls, story is explained with visuals and first prototypes. Leather is used as wall covers and the surface textures are opaque with very low reflectancy to prevent glare possibility (Figure 5.38).



Figure 5.39 : Shadows enhancing the visual perception (Gültekin, 2014).

Shadows of the exhibition objects are also a part of the exhibition. The indirect light diffusing from the slith right next to the wall is working in correlation with spots directed to the objects to create this affect (Figure 5.39). Then, the visitors are led to the main exhibition via inclined ramps. During the trip the visitors have two main exhibition topics: **Legend Rooms** and **Collection Rooms**. Visitor may take one of two spiralling ramps down to reach the exhibition rooms.

One can visit a series of artificially lit theatre like rooms taking the ramp down to reach *Legend Rooms*. Similarly, one can walk through a series of naturally lit five rooms taking the stairs, which offer a view of Stuttgart to reach *Collection Rooms*. Light is the main element of the unusual architecture of the museum. Contradiction between daylight- artificial light is used to unify two different exhibition topics (Figure 5.40).

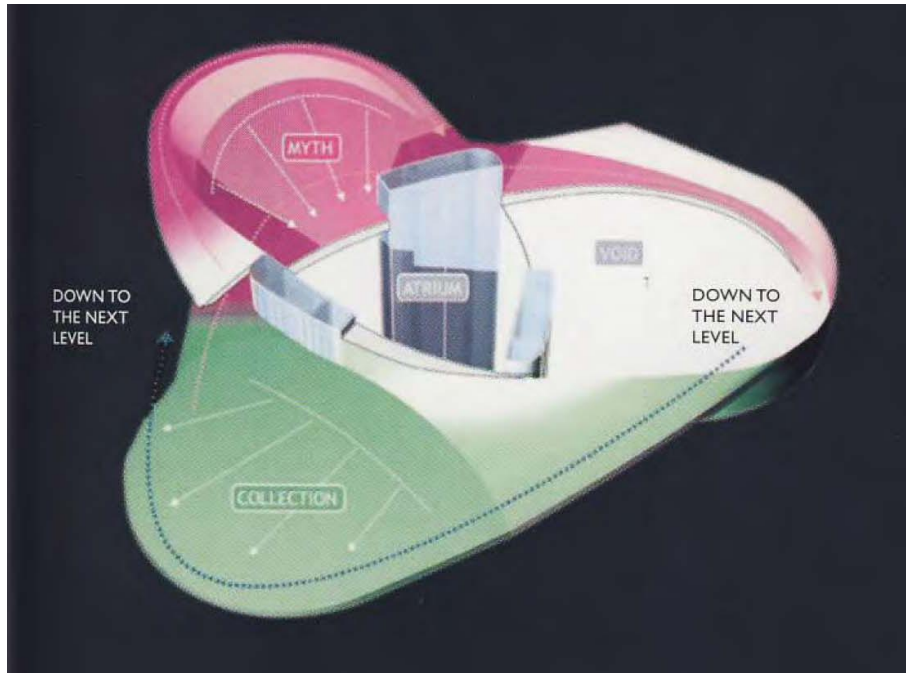


Figure 5.40 : Plan explaining complex structure of ramps and stairs (Url - 109).



Figure 5.41 : Indirect light distribution of light for orientation (Gültekin, 2014).

On every inclined ramp taking the visitors down to the Legends Rooms, indirect light distribution maintains clear orientation, while directed downlights distribute un - uniform light to enhance the pathway and the visuals on the walls telling the history of the brand. Non-uniform distribution of light on wall textures is also strengthening the sensation of historical sequence explained on each floor by highlighting wall textures (Figure 5.41). On Figure 5.42 for example the walls are covered with metal

used for car production on that period. Then, in the following floors, materials become leather and airbags. Another addition of non-uniform light distribution on the ramps to the atmosphere is decreasing the impression of unpleasantness that may occur because of the long way that needs to be walked through the ramp down. Legend Rooms are designed to receive very little amount of daylight and always lit artificially (Figure 5.42). Exhibition areas are theatrically illuminated for each thematic displays on eight floors.



Figure 5.42 : Legend Room on the seventh floor (Url - 110).

Cars are like acting on the scene. The impression of watching the cars on the stage is achieved. Materials have the most significant role in the exhibition area as floors of crosscut oak under downlights of large spots enhance the perceived visual quality of the exhibition. Spots directed to the exhibited objects are providing sufficient task lighting to visually perceive the objects with the proper lighting level (Figure 5.42).

On Figure 5.43, the chandelier is highlighting the core exhibition object and adding a magical atmosphere to the room. Here, reflection of the object falling on the floor is also doubling the magnificent affect.

Brightness-contrast on cars lighted with large spots and the surfaces left relatively in the dark creates a theatre-like scene (Figure 5.43, Figure 5.44). The visitors get the impression of walking around an interactive theatre being a part of the scene

exploring the exhibition objects from various aspects. This affect is interrupted only on the fifth floor because of the high background scene.



Figure 5.43 : Glimmer (Gültekin, 2014).



Figure 5.44 : Legend Rooms create the impression of a theatre scene under artificial light (Gültekin, 2014).

On the third floor, zero emission cars are exhibited under multi - coloured LED application on the ceiling. Task lighting is achieved with directed spots while the visual display is strengthening the atmosphere. One of the significant points about the exhibition concept is, lighting design is also becoming more technological as the exhibition objects get newer (Figure 5.45).

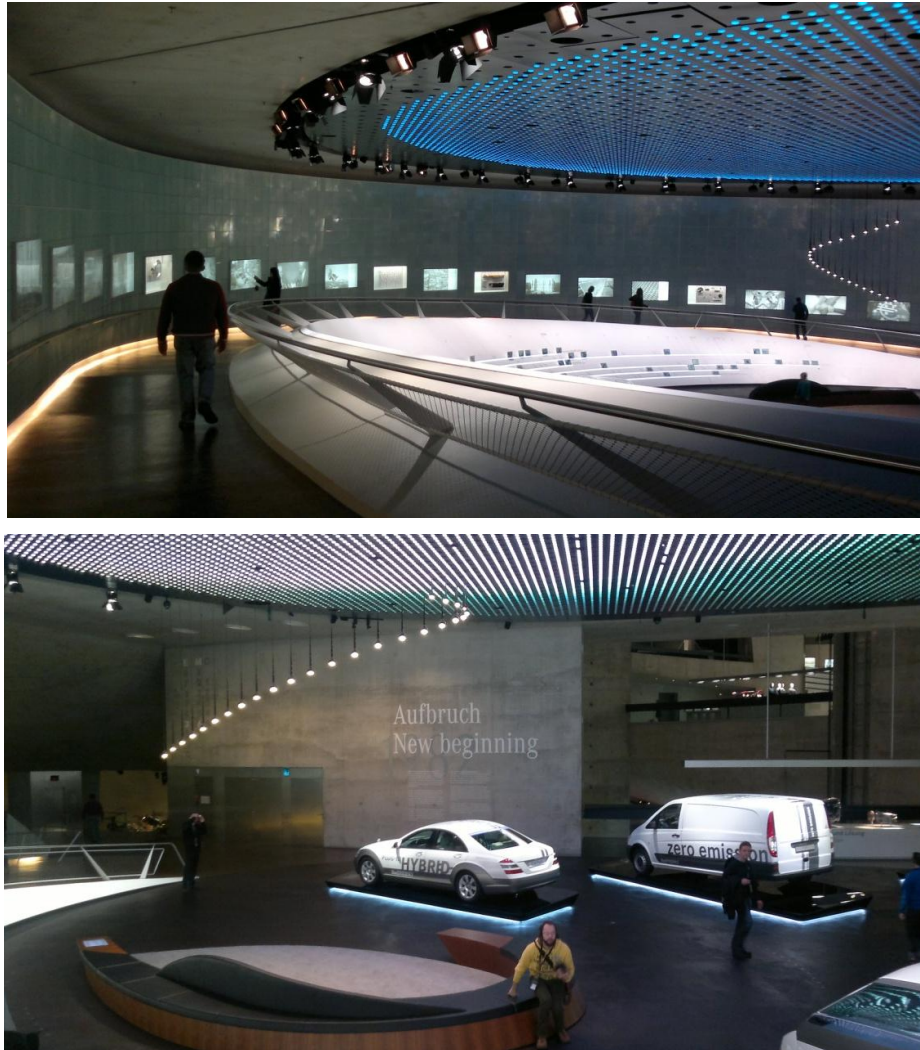


Figure 5.45: Exhibition concept on 3rd floor(Gültekin, 2014).

Another eye catching quality of the exhibition is the way of lighting used to create a specific impressions according to the historical sequence in which the exhibited object belong to. On Figure 5.43, the ceiling is dark, intensity of light is lower with warm white colour temperature and the perception created is more confined. The atmosphere is like a black and white movie scene. As the ramps go spiralling down

and down the atmosphere changes. The ceiling becomes concrete again, LED technology is involved in the process and the lighting level increases and the space becomes more spacious (Figure 5.45).

Visitors are also given a specific area to rest under the magical light show. The huge leather couch is highlighted with a pendant chandelier to catch the visitors attention (Figure 5.45/2), but the intensity of the chandelier is very low in order not to distract the affect achieved via multi-coloured light application on the ceiling.

On the first floor of the exhibition, race cars are exhibited. Visitors take the long stairs down to reach the area. Downlights with non- uniform light distribution and LED's mounted on the vertical surfaces of the stairs are leading the visitors to the exhibition room (Figure 5. 46).

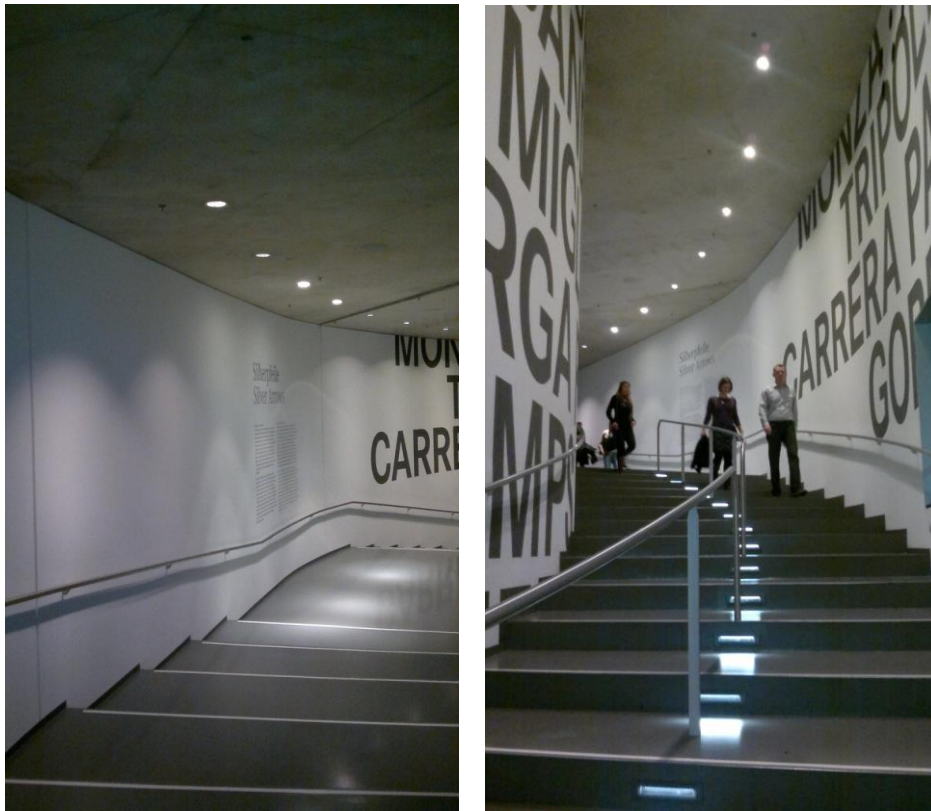


Figure 5.46 : Orientation lights on the stairs (Gültekin, 2014).

A unique synthetic floor finishing is developed for the exhibition of race cars for functional purposes. The material is keeping the cars on the track without any extra

precautions against sliding. Interaction of light with material creates an impression of cars tracking each other on an asphalt road and strengthening the fascination of people (Figure 5.47).

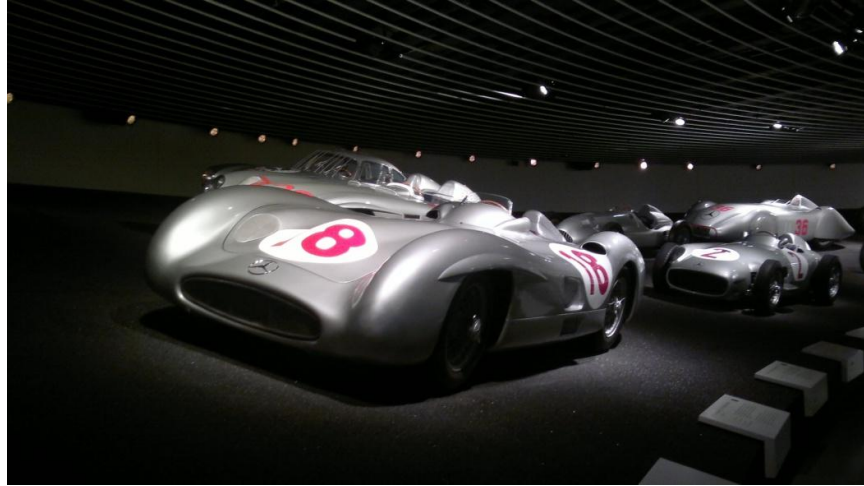


Figure 5.47 : Racing car tracking each other (Gültekin, 2014).

Collection Rooms have a ceiling height of 4.5 metres. The vehicles are displayed under daylight which is similar to the atmosphere outside where the vehicles are expected to be. The ceiling is bright with a light colour evoking the feeling of sky (Figure 5.48).



Figure 5.48 : Inclined ramp from Legends Room to Collection Room
(Gültekin, 2014).

Large openings on the facade filter the daylight into the rooms. Stuttgart landscape serves as a background for the exhibits. Inclined shape of the openings creates a relationship between passing cars and the exhibition rooms. From each Legend Room it is possible to enter the following Collection Room by following a ramp (Figure 5.48). After daylight study, artificial lighting equipments are applied to the areas critical in terms of daylight. Lighting equipments are integrated into the ceiling providing direct light into the rooms just like sunrays diffusing through the clouds. Artificial light sources are chosen in a way that enhance the feeling of daylight atmosphere in the rooms (Figure 5.48, Figure 5.49). Artificial light sources provide similar spectrum of daylight during the day. During the night however, the colour temperature is switched to cold white. Daylight and nighttime atmospheres are shown respectively on Figure 5.49 and Figure 5.50 (Brandi, U, 2006).



Figure 5.49 : Natural lighting of Collection Rooms (Gültekin, 2014).



Figure 5. 50: Artificial lighting of Collection Rooms (Gültekin, 2014).

It is also possible to reach other Collection Rooms via short - cuts. Uninterrupted glazed windows are always angled and also serve as a huge patterned opening on the facade creating shadow plays while diffusing daylight into the rooms. Various spatial expressions are achieved on different times of the day. Difference of the atmosphere and change of the materials on a cloudy day and on a sunny day on the staircase reaching the upper floor is shown in Figure 5.51.

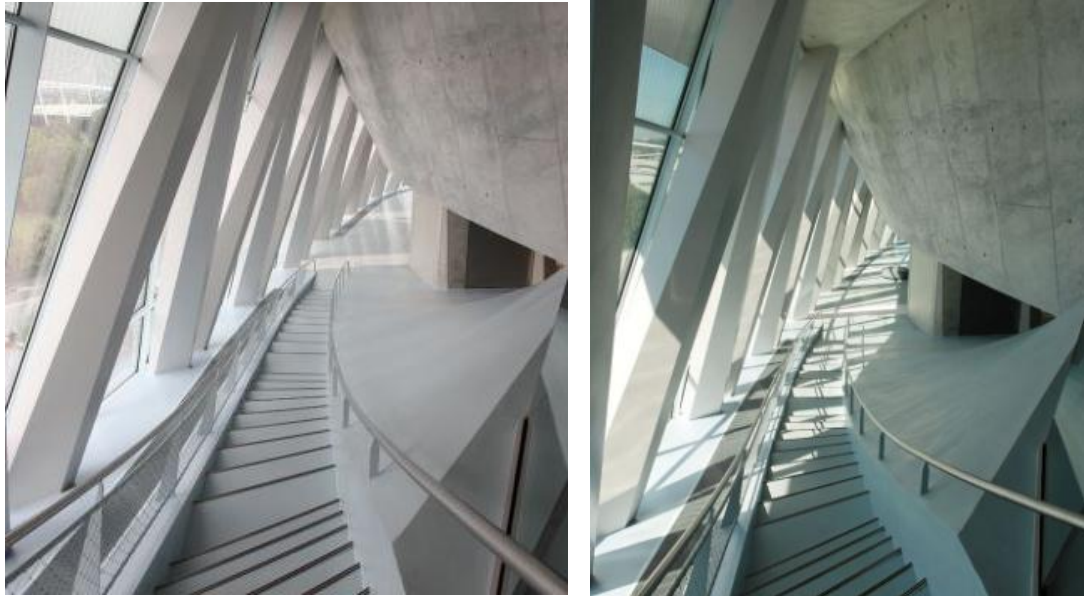


Figure 5.51: Access via a high staircase to reach the other Collection Room
(Gültekin, 2014).

5.2.2. Notre Dame du Heut :

Location: France

Architect: Le Corbusier

Completion: 1955

Le Corbusier's Notre Dame du Haut is designed for a meditative and reflective purpose by using daylight. The church is built between 1950 - 1955 to replace the previous church demolished during World War. Daylight's variation on different times of the day and different seasons of the year is implemented to the design idea of the church. The location is on the top of a hill, a sacred space. Sculptural form is achieved with inclined walls, floor and ceiling (Figure 5.52, Figure 5.53).



Figure 5.52 : Location of the church on the top of a hill (Url - 111).

Light enhances spirituality and evokes emotions related to religion. Visitors experience a different atmosphere and have different spiritual experiences in one space, as space regenerates itself under the dramatic play of light and shadows in relation to materials, form, space and openings. Daylighting is managed by several openings types on different locations, in changing shapes and sizes. The only artificial light source is the chandelier emitting candle lights.



Figure 5.53 : Exterior view of the church (Gültekin, 2014).

Strong affect of direct sun is decreased with diffuse light concept implemented to the building. Light penetrates into the space through splayed jambs, light wells and the long thin gap located between the roof and the walls. Dim shadows are softly revealed sculpting the space.

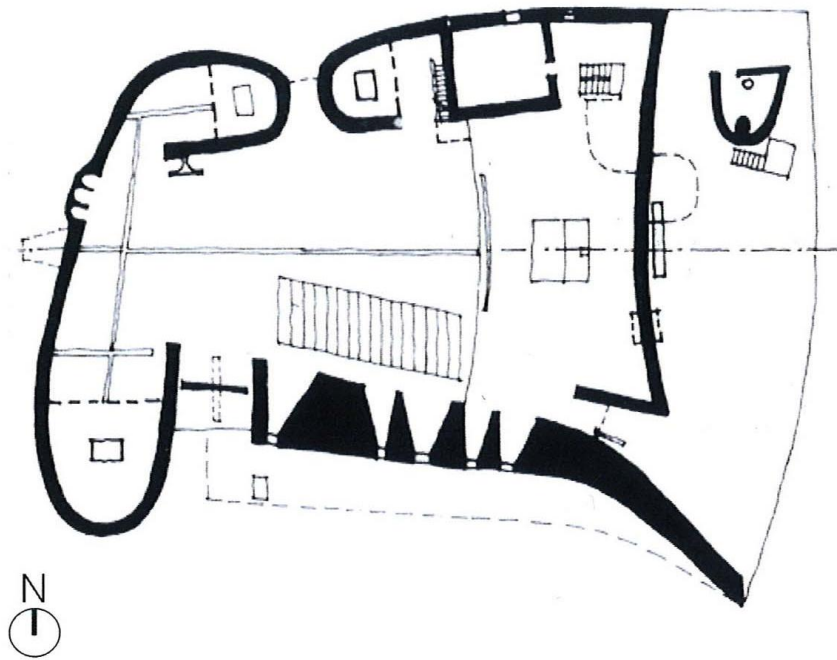


Figure 5.54 : Floor plan (Url - 112).

Two entrances, an altar, and three chapels take place inside the church. From the plan it can be seen that the altar is located on East direction in order to get the first sunrays. The main entrance is located on west direction. When people first enter the space the first thing they see is the roof buffering above their heads and the heavenly light diffusing from a long slith (Figure 5.54, Figure 5.55).

The massive curved roof is a source of astonishment. The roof is perceived as if it is floating on air above the walls. This affect is achieved with the long slith that creates a 10 cm gap on the intersection of the walls and the dome. The roof is perceived to have a heavy structure bending into the space, but it is also perceived to be softer because of the slith. This perceived contradiction created by playing light is surprising for visitors. Floating roof affect is intensifying spiritual emotions and light diffusing through sliths is perceived as almighty and holy (Figure 5.55).



Figure 5.55 : The buffering roof (Url - 113).

The altar is illuminated with a small rectangular aperture with adjacent sides. Because the opening has adjacent sides, there is a sharp brightness contrast between light and dark areas. The light penetrating through the small opening and the slith is enhancing the cross intensifying spiritual feelings (Figure 5.56).

The only artificial light source is the chandler emitting candle lights. The candle light is adding glimmer to the space improving the atmosphere as well as focus of perception. The location of the chandler is significant in this regard. It is located in the intersection of communal praying area and the altar (Figure 5.56/1). Here, light conveys information with its location, highlights the praying area and catches the occupants' attention. It excites the spiritual emotions and improves the magical atmosphere of the space. With the candle light the religious atmosphere is enhanced with the sparkles.

On the South Wall, various openings with different shape and size are located and covered with either clear or coloured glass. From the research it is known that small openings provide a directional beam, highlighting a shape or the space as well as orientating the eye. Various small openings of splayed jambs are placed on the

concrete facade. Splayed openings provide an intermediately illuminated space by distributing light penetrated from the openings uniformly (Figure 5.57, Figure 5.58).



Figure 5.56 : The Altar enhanced with openings (Url - 114).

Light diffuses through the splayed apertures on the south wall. The luminosity of the interior changes rapidly because of the size, depth and directions of splayed openings with various angles. The colored glass on the splayed openings let the light diffuse softer through the interior space (Figure 5.57). The room is brightened with soft coloured shades. Color displays of light on plastered walls and ceiling creates a sense of spirituality forming coloured light fields. In addition to colour variation shadow plays are also increasing the sense of spiritualism.

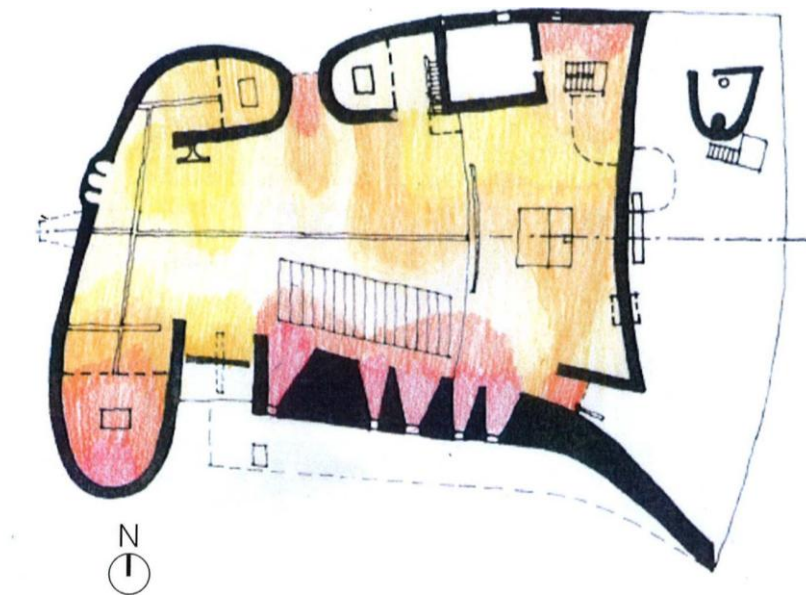


Figure 5.57 : Daylight intensity under overcast sky (Url - 115).

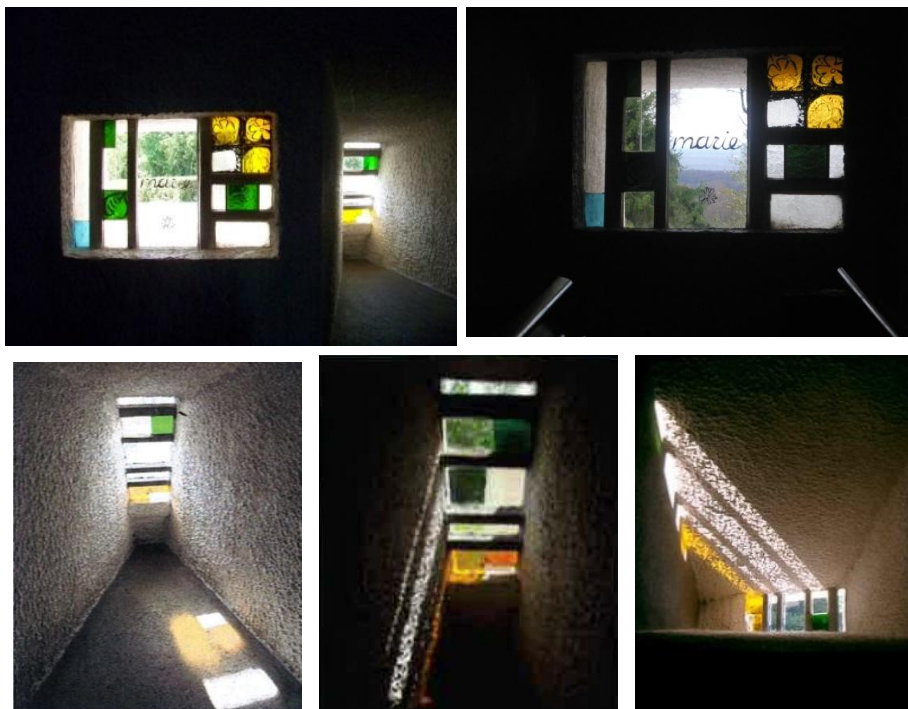


Figure 5.58 : Variations of colored glass on different times of the day (Url - 116).

Colour variation achieved with multi - coloured and clear glass create strong colour light fields on the walls and the floor. Reflections through the glass differs with changing angles of the sun forming various shadow plays. An exciting vivid color

play is achieved enhancing excitement. Moreover, praying area is washed with fussy colourful shade of light. So that, the praying area is enhanced without causing any discomfort, drawing a calm spiritual territory for contemplation (Figure 5.59).



Figure 5.59 : Change of perceived atmosphere with daylight penetration through the splayed openings on different times of the day (Url - 117).

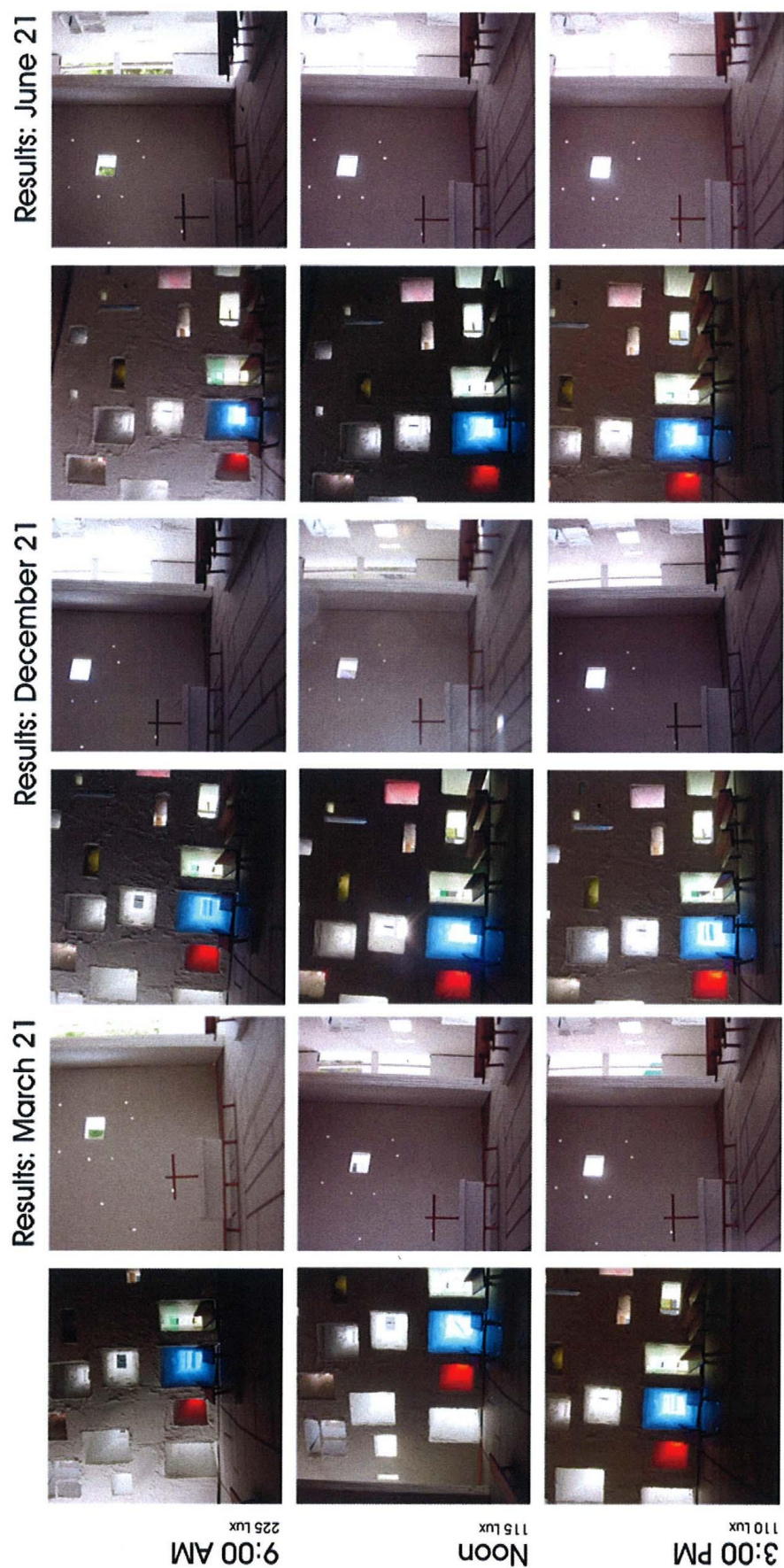


Figure 5.60 : Change of the atmosphere in the altar and the common praying area on different months of the year (Ungnungseesanon. 2012).

Intensity of brightness contrast changes rapidly on different times of the year. Variation of daylight changes the atmosphere. The brightness differences on the walls supports the unclear fussy sensation of the interior architecture by creating a play of light and shadows on the walls. Emotional perception changes due to this variation. On Figure 5.59 for example the interior is perceived as relatively lively and hopeful while second picture is perceived as gloomy and relatively more intense. A daylight study by Nick Ladd on Buildings Lighting poetics shows how the atmosphere changes on altar and the south wall according to different days of the year (Figure 5.60).

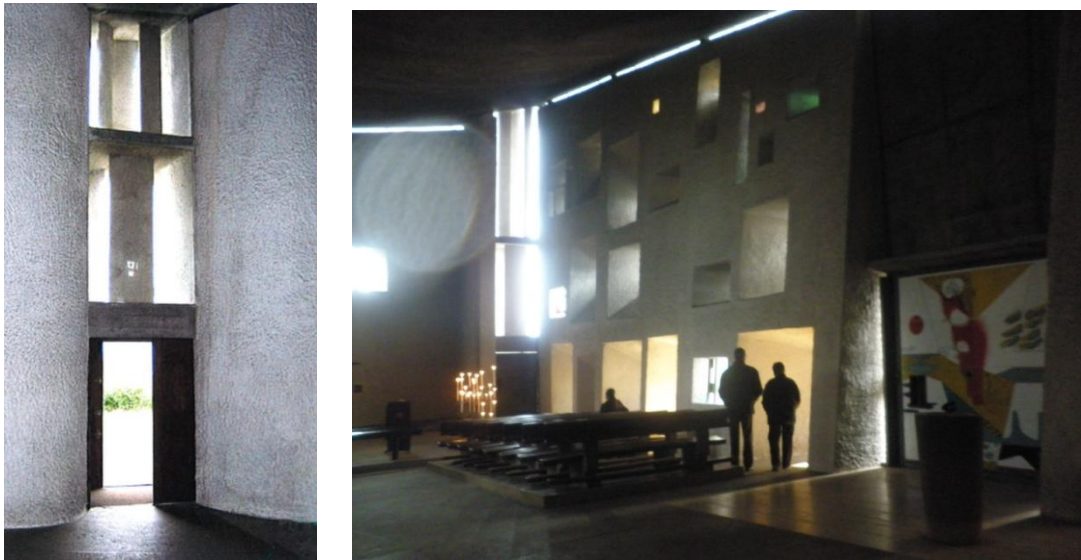


Figure 5.61 : Vertical core at the second entrance and the main entrance
(Gültekin, 2014).

Because of the fact that only openings are small openings located on south wall, to achieve sufficient brightness, vertical openings are added on the top of the second entrance (Figure 5.61). There are three light scoops to increase lighting level in interior, one facing east, other facing north and as the last one, the scoop facing west direction. Each tower is activated according to the movement of sun. Since, all of them are located on different directions, each of them has specific times to convey light to the interior. Under the piercing light of scoops, personal praying zones are defined for people to pray. Locations of the light scoops in relation to the floor plan can be seen on Figure 5.62.

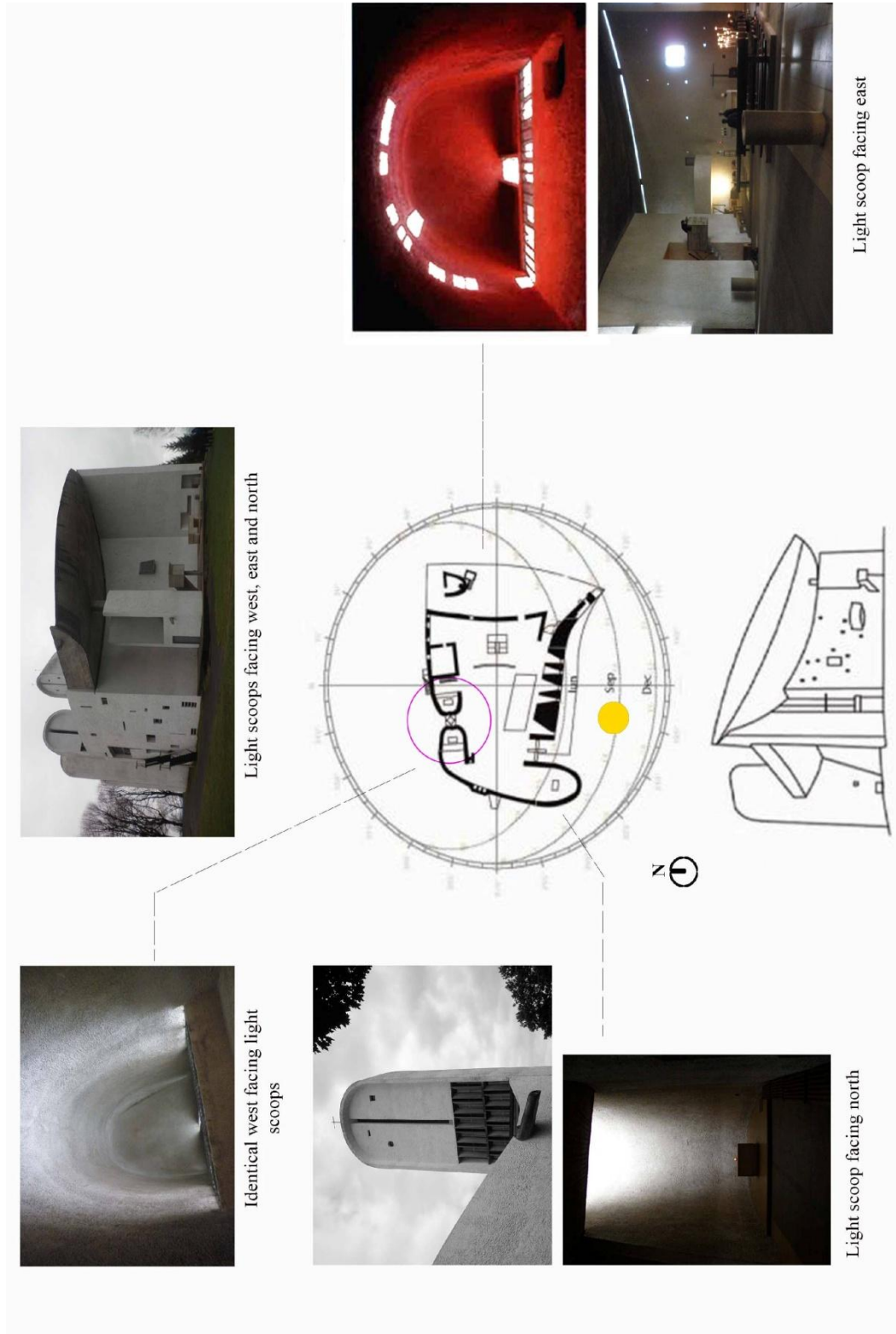


Figure 5.62 : Location of light scoops (Gültekin, 2014).



Figure 5.63 : Baffling light piercing through the light scoop (facing east) on the altar (Gültekin, 2014).

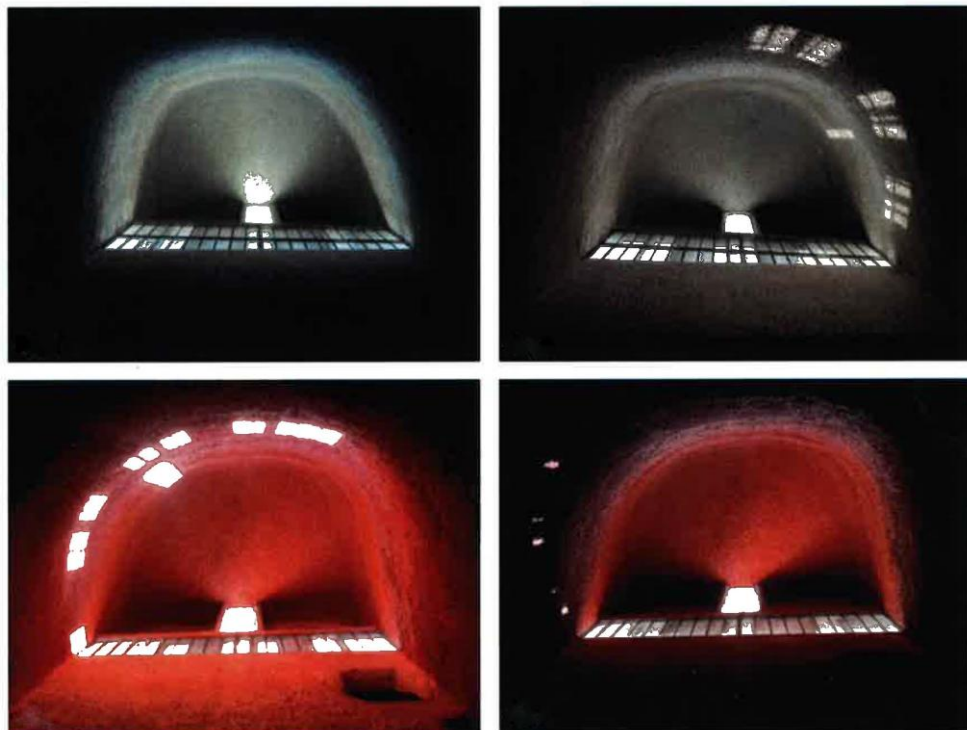


Figure 5. 64 : Variation of daylight inside the light scoop facing east (Legitz, 2013).

The scoop facing east direction forms a baffling light creating the impression of a holly light from the heaven. Variation of daylight is reflected to the interior with changing angles of sun. The location of the scoop is also forming a private space for people to pray with light. Piercing light and the chandelier are adding glimmer to the space increasing impression of being in a magical atmosphere (Figure 5.63, Figure 5.64). When the light scoop facing west is illuminated with direct sunlight , brightness of the interior is increased adding variation to the space (Figure 5.65). Scoops facing west and east directions can be seen on Figure 5.66.



Figure 5. 65 : Interior view of west facing light scoop (Gültekin, 2014).



Figure 5.66 : Exterior view of the light scoops (Gültekin, 2014).



Figure 5.67 : The light scoop facing north (Url - 118, Url - 119, Url - 120).

The light scoop facing north has relatively the brightest illumination level. This tower serve to penetrate light through the interior to provide more light into the interior space, as the church's facade openings are restricted with only one wall. Light also serves as a source of glimmer right above the praying area, so it also strengthens the feeling of being close to god (Figure 5.67).

5.3. Resume on perception of interiors with daylight and artificial light integration

Light may refer to functional requirements by enabling and improving visual perception, shaping the space and forming a refreshing tool for design. It is also possible to refer to people's emotions by creating an atmosphere in interiors, improving aesthetic satisfaction and consequently effecting people's psychological perception. Under subtitles of Function oriented interiors and Atmosphere oriented interiors four building types are investigated.

Südwest Metal Company is an office building and a training center. An alternative daylight design approach is followed as a design concept. Unique facade design is in contrast with the material; metal. Metal is a non porous, opaque element symbolising strength. However, building design is composed of perforated metal sheets produced by company. Perforation is creating the image of transparency, lightness on people inviting them in. Under daylight the material is changing color, making shadow plays, reflecting exteriors to the interiors. In interiors, in recreational areas like cafe and public spaces like information spot, positive sensations are achieved by daylight via shadow plays. In the offices on the upper floors, daylight penetration through long horizontal openings on the facades improve concentration and positive feelings of employees. Requirements of task lighting is achieved with artificial light sources emitting cold white light temperature to improve concentration. For the building's lighting design, it can be said that the psychological perception and experiences of people of the brand are also considered as well as functional requirements.

Library of Stuttgart is a function oriented building with the main purpose of providing a study space for people. The architect manages to meet functional needs of a library in an unusual way of using daylight as a refreshing material for people and artificial light as a supporter. Daylight penetration through the rooflights and artificial light sources with the same spectrum of daylight together are creating the perception of being outside under the sky during the day. Here, on the gallery, artificial light is maintaining task lighting requirements as well as supporting the positive sensations achieved with daylight by imitating daylight spectrum, adjusting itself to the required levels improving emotional well being of people and creating aesthetic emotions.

In general, profit-making companies like Mercedes Benz and museums are not a perfect match. Normally in museums telling the history of a brand, the most important element is the exhibits and understanding of their physical presence under correct lighting levels in chronological order. The company changed this common idea with a perception oriented museum design approach. Focus of the design of the interiors is perception of people about the exhibition through spatial experience of the space instead of the exhibits. A usual museum visit is transformed into a magical experience with its extraordinary lighting design approach. In other words, the architecture as well as people's understanding of the space is shaped by light. The contradiction between natural light and artificial light is used to form two completely different atmospheres. The spatial qualities of the architecture such as materials, colors, textures, angled openings, curved walls are the sub - elements of the equation. Various artificial light concepts are applied to each exhibition topic for Legends Rooms. Rooms reached via high inclined ramps are presented under several lighting settings to tell the history of the related period. The exhibitions are perceived as an interactive theatre. Collection Rooms are exhibited under daylight, but still supported with artificial light sources when needed. The museum is different than an ordinary museum as it is projecting the recognizable identity of the brand on people by appealing to their imaginative perceptions.

Notre Dame du Heut is a spiritual space completely shaped with light - darkness contradiction. The only artificial light source is candle light. During the research it was investigated that daylight has unique ways to shape perception especially in spiritual spaces. The church is a pure, specific example of this situation. Spiritual impression is achieved via changing intensities of brightness contrast according to daylight. Very few splayed openings covered with coloured and clear glass are diffusing light, creating a calm spiritual impression. Level of light changes every hour of a day, seasons of the year sculpting the interior differently. Light scoops are symbolising heavenly light piercing from above, defining spatial praying areas for people. Interaction of light with the physical space is creating a perceived space of fascination.

6. EXPERIMENTING LIGHTING DESIGN PROPOSALS FOR A CONCEPTUAL SPIRITUAL CONTEMPLATION ROOM

6.1. Aim of the experiments

Learning from the theories is an effective way of learning. With the profound research in the previous sections, it is understood how light and space together have the power to affect people's visual and psychological perception. However, experimenting offers a better opportunity to understand theoretical background. It was assumed that experimenting the theoretical research would lead to a better understanding of the whole study.

In order to practise theoretical section ; investigating the possible lighting situations of a Spiritual Contemplation Room that people work in the company can use to relax their soul, to think, to pray or to meditate was the main aim of the tested settings. Possibility of running daylighting observations right inside of the room and making artificial lighting tests without losing time were effective while choosing the location. But, why a Spiritual Contemplation Room was chosen as the main concept?

During the research various spiritual interiors shaped with light were investigated. Light had the impact of enhancing spirituality in all of the examples. Many of these lighting settings were concentrated on using daylight like Dwan Light Sanctuary, UWC-USA in Montezuma, New Mexico or Prayer & Meditation Pavillion, Khartoum, Popular Republic of Sudan (Figure. 6.1). There were also spiritual spaces enhanced with artificial light such as The Pavilion of Light in Phoenix, USA or The Grand Mosque in Dubai (Figure. 6.2). These examples were investigated in 3. *Peception of Daylit Interiors* and 4. *Perception of Artificially Lit Interiors* respectively. Most of these spaces were spiritual spaces. No matter if it is a mosque, a church, or a secular meditation room these spaces were enabling people to get in touch with their mind and soul through quiet contemplation. That is why testing lighting situations of a spiritual interior is preferred. Then, what is a Spiritual Contemplation Room?

Spirituality points to personal beliefs about being a human being and the values that one prefers to follow. The word "Spirituality" comes from the Latin *spiritus* word which means wind or breath. (Url - 119). A Spiritual Contemplation Room can be defined as a secular interior space that people use to relax themselves by meditating or simply just thinking. It can also be defined as a praying room beyond any religious aspects. There are thousands of different faiths in the world and faith involves spirituality in itself, but spirituality can also exist individually. One can still be spiritual without following a particular religion. So that, the space is called as a Spiritual Contemplation Room.



Figure 6.1 : Examples of spiritual interiors shaped with daylight from the research (Url - 10, Url - 14).

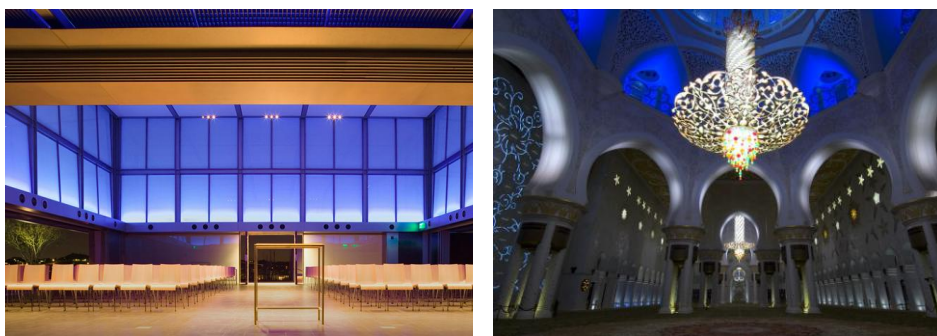


Figure 6.2 : Examples of spiritual interiors shaped with artificial light from the research (Url - 67, Url - 69).

6.2 Location of the experiments

One of the rooms located in Nimbus Group showroom is chosen as the experiment space. The building located on Leitzstraße 4, 70469, Stuttgart, Germany, used to be a shelter for refugees before Berlin Wall was demolished. When the company purchased the space, they decided to keep the showroom area as it is and re - organised some of the rooms to exhibit the acoustic products of their sub - brand Rosso (Figure 6.3).

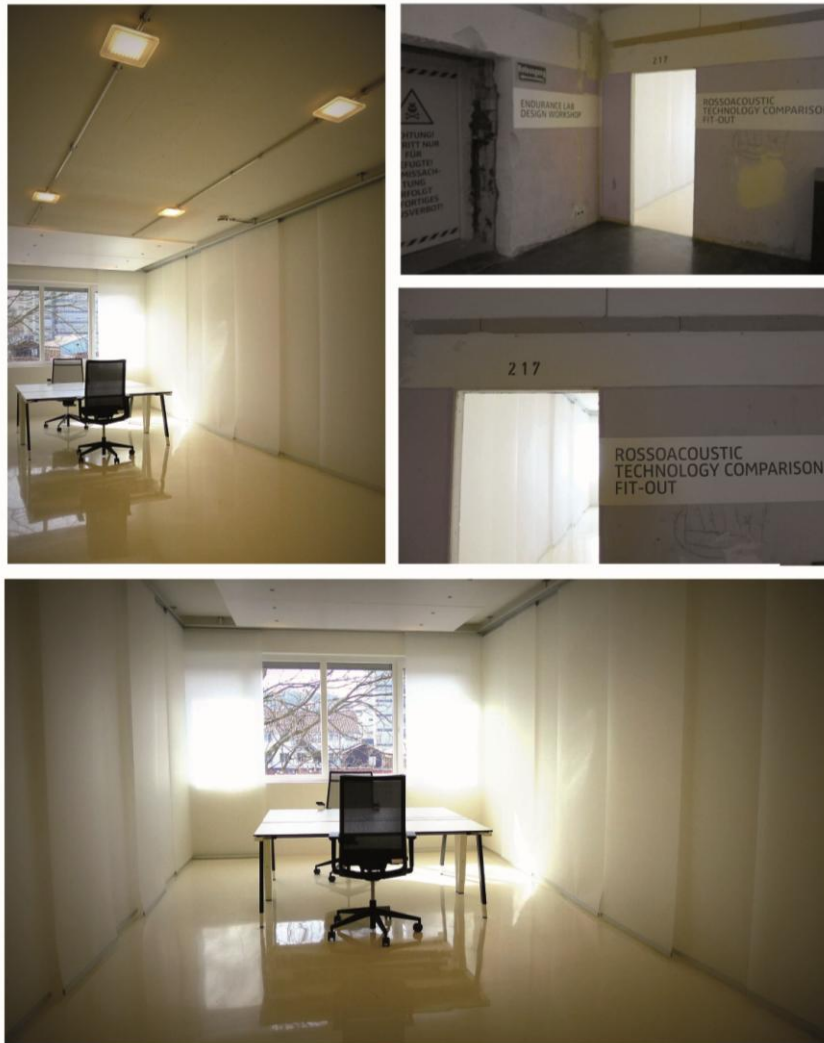


Figure 6.3 : Room 212, Mock Uowroom, Germany (Gültekin, 2014).

Stuttgart has a changing climate. The temperatures may reach very high levels of 90F and on winter of 15F. Generally, summers are warm with an average of 70F. Winters are mostly rainy and snowy (Url - 117).

Room 212 - room chosen for the experiments - is located on the second floor of the building and is oriented in South – West direction (Figure 6.4). Because of its orientation, the room is exposed to high intensity of sun between 13.00 - 17.00 starting from late February. During summer, the days become longer, the sun sets around 21.00 – 22.00. On winter there are many days with overcast sky and very low intensity of sun. Also, on winter the sun sets very early. At about 16.00 outside is completely dark. Dimensions of the room are given on Figure 6.5. The room is suitable to be used by 6 to 8 people at a time.

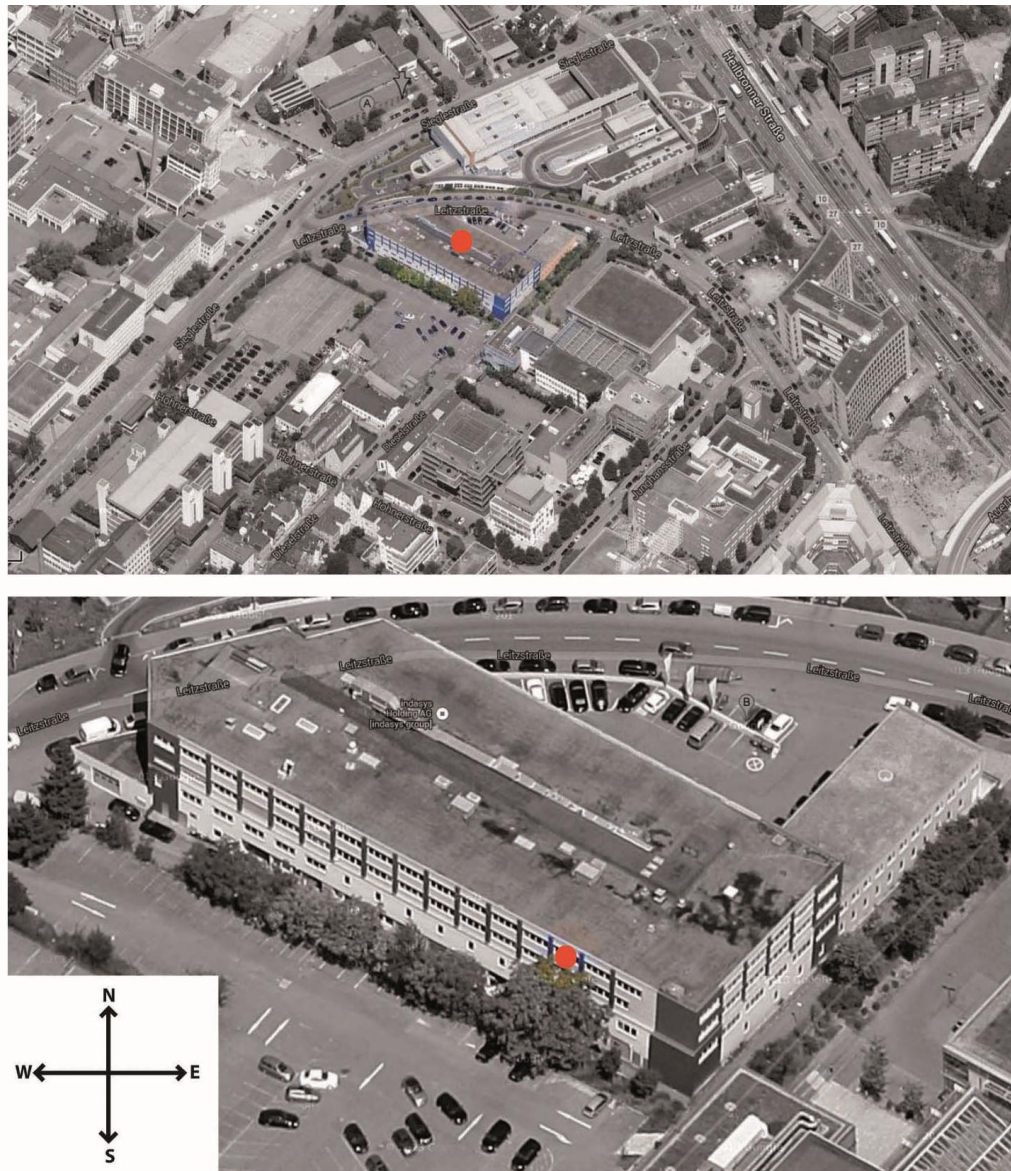


Figure 6.4 : Location of the building and the room (Url - 120).



Figure 6.5 : Dimensions of the room (Gültekin, 2014).

6.1. Content of the experiments

In order to practise theoretical information derived from the research, under titles of Daylight Experiments and Artificial Light Experiments two groups of experiments are done. The lighting requirements of a conceptual spiritual contemplation room has been chosen for the tested settings.

The thesis was written as a master student in Nimbus Group GmBh. Because of the time restriction, the experiments are concentrated on lighting tests and the design of the interior space is kept conceptual. Subjectively, the most important aspects from section 3. *Perception of daylit interiors* and 4. *Perception of artificially lit interiors* sections that are considered to have power on creating a spiritual atmosphere are chosen to experiment.

First of all, lighting requirements of a contemplation room are investigated according to the theories which were explained in section 2.3. *Perceptual Requirements of a Luminous Space*. According to *Biological Needs* and *Activity Needs* of people in the room. Lighting requirements of the space for a spiritual lighting atmosphere are investigated. Space organisation decisions are made according to the requirements

listed in this section. Then, under titles of *Daylight Experiments* and *Artificial Light Experiments*, lighting experiments are made to achieve spiritual contemplation atmosphere of the room . The aim of *Daylight experiments* was to find out how the qualities explained on section 3. *Perception of Daylit Interiors* effects this specific interior. With this approach, relatively the most important aspects from the section are chosen to find out natural light's effect on;

- Opening types in general,
- Private Area and
- Assembly Area

For the *Opening types*, several tests with application of various openings are made on a scaled model in order to understand site specific daylighting qualities of the space that has power on creating a spiritual atmosphere. Then, with the information derived from previous section ; the observations on several opening types and listed lighting requirements of a luminous interior space the space is divided into two functions as Private Area and Assembly Area.

After the first experiments, two different perforated opening proposals suitable for the functional requirements of the space are made and tested. Reasons for choosing these opening types among all is explained. Consequences for each proposal are recorded with photos from observations on different times of the same day.

Finally, the results are summarized under subtitle of *Results and suggestions of daylight experiments*.

Artificial experiments were concentrated on artificial lighting tests. *From Daylight experiments*, it was experienced that the daylight is magical itself. A light ray, for example, diffusing from a window to the space, had the power to invent and reinvent spirituality because of its naturally changing quality. However, creating a spiritual atmosphere by using artificial light is also possible by appealing to subjective impressions of people. The lighting patterns affecting subjective impressions; location; direction - distribution of light and intensity of light are tested considering

that also colour of light and its interaction with space have power on shaping perception. With a similar approach to *Daylight experiments*- considering the listed requirements are tested under following subtitles :

- Light for Private Areas
- Light for Assembly Areas

Finally, the results are summarized under subtitle of *Results and suggestions for artificial lighting tests*. The settings which were successful at creating a spiritual contemplation atmosphere are underlined with visuals.

6.3. Lighting Requirements of the Spiritual Contemplation Room

Lam's qualitative approach for lighting requirements of an interior space is considered starting with the question of what will be the needs of occupants in a spiritual contemplation room. This section has created the base for the experiments. Space organisation is decided according to this section. As it is explained in the theoretical section 2.3. Perceptual requirements of a luminous space, Lam divides lighting requirements of a space into two as Biological Needs and Activity Needs (Figure 2.3).

Activity Needs

Activity needs are related to the information to accomplish various tasks. Type and requirements of the visual task needs to be known. There are several physical data such as required illumination, luminance distribution or colour temperature of light. However, for a perception oriented lighting atmosphere a more detailed analyze is suggested by Lam. Activity types, time interval and location should be considered for each lighting scenario. In the case of Spiritual Contemplation room activities assumed to be done in the space can be listed as:

- to sit
- to relax one's soul
- to think

- to concentrate
- to meditate
- to pray

The atmosphere of the room is concentrated on emotions rather than performing a physical activity. In offices, for example, task lighting requirements are concentrated on performing activities such as reading, writing. From the research it is known that these kind of settings generally require cold white temperature of light because of the task lighting requirements cold white light temperature is preferred.

However, in a Spiritual Contemplation Room; rather than performing an activity, making connections with one's soul is the case. A warm, welcoming lighting setting that encourage relaxation and concentration should be provided. Since the space is assumed to be used during the day and night, ambient lighting should be able to dimmed during night to strengthen the intimate atmosphere. Colour temperature of artificial lighting setting should be warmer tints of light with low intensity.

Biological Needs

In order to feel to psychologically and physically well people have some psychological expectations from a visual environment. Biological needs define these requirements. According to these informations, what would be the *Biological needs* expected from a Spiritual Contemplation Room? The most important biological needs for environmental data of the specific contemplation atmosphere of the room are divided into three as Orientation need, Discernability need and Communication need according to Lam's theory.

Orientation needs expected from a Spiritual Contemplation Room

Time, weather and environmental conditions affect perception. So, both natural lighting and artificial lighting conditions should support spiritual atmosphere. The atmosphere should be natural and pleasant. Spirituality is enhanced with daylight. In spiritual spaces such as churches holly atmosphere is enhanced with daylight changing with time and environment conditions via openings. In a room people

orient themselves according to the sun rays. During the day contradiction between light and shadows have significant impacts on orientation decisions of people in an interior.

People expect the weather outside to be dark or bright according to the time orientation of their clock. Taking daylight in with a large opening during the day with a created shadow interplay to enhance spirituality would be a suggested for a spiritual contemplation room as in the example of see-through church in, Looz, Limburg, Belgium (Figure 3.44, p.85).

During the night time, however, applying a lighting setting with high intensity of light - just like during the day - would be perceived as unnatural and disturbing. So, lower illuminance with warm white colour temperatures is suggested, as the atmosphere achieved would be informal and relaxing with the choice of warm light.

Discernability needs expected from a Spiritual Contemplation Room

"Discernability is related to distinguishing and perceiving the surrounding environment. The space should be sufficiently visible for people to feel safe, make sense as a clearly structured whole and fit to our expectations"
(Gansfald & Hofmann, 2003).

For the Spiritual Contemplation Room it can be said that not everything should be definitely visible. The specific contemplation atmosphere requires a tranquil ambiance as well as providing opportunity for relaxation and stimulation of the mind, body and senses.

Assuming that the room will be used for quiet contemplation, spiritual meditation and praying for several occupants having a general fixed lighting level all over the space to sustain sufficient visibility of everything would be uncomfortable. As Lam suggests the luminous environment should fit to our expectations. Expectation of lighting atmosphere for people who would like to be isolated or hidden from the others while praying is different than people who would like to meditate as a group.

Communication needs expected from a Spiritual Contemplation Room

People need to interact with other people and themselves. The most important biological need for the Spiritual Contemplation Room is the communication need. Neither being exposed to a lot of information nor being too isolated is beneficial for people's emotional well being. Considering that the space would be used by at most 6 to 8 people to relax, pray or contemplate in a quite spiritual atmosphere, providing clearly defined location with regard to other people is needed. To maintain the balance, territories or boundaries should be defined providing personalization of private areas. Dividing the spaces with light and shadow contradiction for example would be helpful to define zones.

In the light of the implications explained above the space is needed to be divided according to different needs and expectations of the occupants. Some occupant for example would like to contemplate by themselves while others would prefer a communal meditation session. Considering this consequences derived from the implications; in order to achieve a tranquil space which involves privacy and clearly distinguished boundaries, the space was needed to be separated into different functional areas.

6.4. Daylight experiments

Daylight has the power to change an interior space naturally. Inevitably, perception is affected by these unique qualities. It is possible to change perception of people with daylight by changing opening types shapes or size and locations. Especially, in spiritual spaces shadow plays achieved with light penetration through several types of openings are serving as the source of astonishment enhancing faith as shown on Figure 6.1. Also, when the light meets the space, it interacts with materials, colours recreating the visual and psychological perception over and over again.

Daylight experiments are composed of daylight observations and tests to find out how to create a spiritual atmosphere by using daylight. From the assumptions derived from the previous section, 6.3. *Lighting Requirements of the Spiritual Contemplation Room* the space was decided to be divided into functional areas. However, to have

proper space organisation decisions, sun penetration to the room was required to be examined. So, first of all *Openings in General* are tested.

Openings in General

First, observations are started with experiments on *Openings in General* by,

- Changing opening types
- Changing materials of the openings,

in order to understand variation of daylight in the room and to observe shadow creation on different hours of the day.

Experiments on *Openings in general* are done on a scaled model with white walls, floor and ceiling. The emphasis is on material of the openings. With this approach, first daylighting observations are made on a 1/10 scaled model of the empty white room.

The room originally has one façade with a large opening facing South – West direction. First tests are about how different types, sizes and locations of openings change the atmosphere of the room. Possibility of creating a spiritual atmosphere with daylight is searched. The following photographs are taken in the room on February 2014 (Figure 6.7).

Since it is late winter, the sun sets at 17.00. Generally there is overcast sky and limited sunny days on winter. Even if there is clear sky, because of the orientation of the buildings in the neighbourhood, between 9.00- 13.00 the room is not exposed to harsh sunlight. Between 13.00- 17.00 however, the sun rays are pretty intense. As it is explained in section 3.2.1. Openings (Table 3.1, p. 68) are divided into three as Façade Openings, Roof Openings and Perforated Openings. Façade Openings and Perforated Openings are determined to run tests.

Facade Openings can be divided into four as Small Openings, Large Openings, Long Horizontal Openings, Long Vertical Openings according to the research

(Table 3.1, p.68). Since the room already does not benefit from daylight much between 9.00 – 13.00. Long and Large openings are applied to the façade to be able to maintain daylight penetration to interior as much as possible.



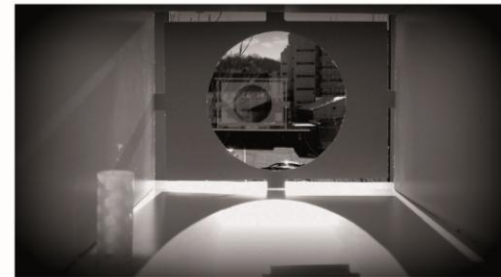
1. Large Opening with glass



2. Long horizontal opening on the eye level



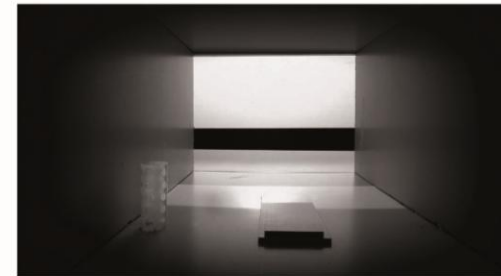
3. Long horizontal opening, located in the middle + long horizontal slits



4. Large circular opening +long horizontal slits



5. Large Opening with a translucent window treatment



6. Long horizontal opening made of translucent material



7. Long vertical opening made of translucent material

Figure 6.6. : Changing opening types and materials, February 2014, at 15.00
(Gültekin, 2014).

First, a large opening is tested (Figure 6.6 /1), leaving the façade with the opening is left completely open. According to the research, large openings enable uniform daylight distribution to the interiors. Linking the interior to the exteriors, large openings create the opportunity to experience the variation of the day and the rapidly changing seasons. According to Figure 6.6/1, to create a spiritual contemplation atmosphere the view or feeling the changing qualities of the day inside might be helpful. However, between certain hours the room is exposed to high intensity of sunlight. So that, to apply such a large opening, a shading element would be needed for the occupants' comfort.



Figure 6.7 : Church of Light resembling Figure 6.6/2 (Philips, D., 2000, p.89).

On Figure 6.6/2, a long horizontal opening is applied. Since the room was assumed to be used while sitting, the opening is organized according to the eye level of a sitting person. According to the research, long horizontal openings orientate the eye as well as providing panoramic views. When applied, the result was different than Figure 6.6 /1. The space was darker because of the opaque material covering most of the facade. The light bouncing from the ground resembled the Church of Light and St. Fransiskus Church from the research (Figure 6.7, Figure 6.8).

As it is explained on theoretical research, contradiction between dark and light adds value to space. Contrast between darkness and brightness is used as a sign of faith and spirituality on Church of Light. On Figure 6.7, light is used symbolically to enhance faith adding a spiritual feeling to the church. Despite diffusing through a

small cross patterned opening, darkness- brightness contrast forms reflections to illuminate the whole interior space. Similarly, even though the light diffuses through a relatively small opening on Figure 6.6/2, when compared to Figure 6.6/1, darkness brightness contrast illuminate the whole interior via bouncing light from the ground. On Figure 6.6/1 however, brightness contrast is not in equilibrium, interior is too brightly lit and the atmosphere is not spiritual as on Figure 6.6/2.



Figure 6.8 : St. Fransizkus Church resembling Figure 6.6/2 (Url - 20).

The outcome of the long horizontal opening test on Figure 6.6/2 was spiritual because of the balance between dark and light areas. Also, as in the example of St. Franziskus Church, long horizontal openings located on the lower part of the facade is creating a light wave bouncing from the ground, intensifying spirituality (Figure 6.8).

On the Figure 6.6/3, a large rectangular opening with slits is applied. The idea was creating a floating opening effect as in the example of Meditation Space, UNESCO Paris, France from section 3. *Perception of Daylit Interiors* re - shown on Figure 6.9. However, the result was very harsh sun inside with nearly any shadows. A very large area was exposed to direct sunlight with an imbalanced rythm of shadows. Then, a large circular opening with slits is applied to increase the shadow area in comparison to Figure 6.6/3. The resulting shadow was greater, however intensity of brightness contrast was very harsh and even disturbing. It would not be suitable to contemplate in such a setting because of the large are exposed to direct sunlight.



Figure 6.9 : Floating effect of Tadao Ando`s Meditation Space, UNESCO Paris, France (Url - 42).

The first four tests were focused on opaque materials as surface textures of the openings. When light hits an opaque surface, it is absorbed and reflected. Materials with diffuse reflection like paper, fabric or translucent materials diffuse reflected light equally creating a softer and a calmer effect just like Shoji screens of Japan houses, mentioned on section 3. *Perception of Daylit Interiors* (Figure 6.10). On Figure 6.6/5, the opening is covered with a translucent window treatment to achieve the atmosphere of Shoji houses. When compared to the very first test on Figure 6.6/1, with a large opening and the following tests on Figure 6.6/2, Figure 6.6/3 and Figure 6.6/4 the achieved atmosphere was completely different.

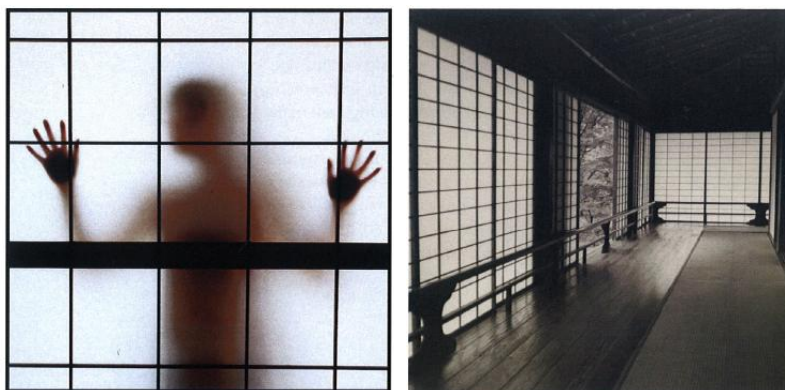


Figure 6.10 : Example of a translucent material: Shoji screens of Japan houses (Ungrungseesapon, 2012).

The light was gently diffused through the material providing a calm atmosphere resembling experimental house made of a glass-fiber cloth membrane from the

research (Figure 6.11). On the other hand, having no opening on facade to orient the eye, consequently, no variation at all caused a dull atmosphere rather than spiritual. In Kengo Kuma house, openings on the various facades were reflecting light rays on the walls, adding liveliness to the space (Figure 6.11). So, on the next step, long vertical and long horizontal opening made of the same translucent material is tested.



Figure 6.11: Experimental House by Kengo Kuma, Hokkaido, Japan (Url - 38).

Long horizontal opening of translucent panel diffused light equally through the space creating a calming effect Figure 6.6/6 and Figure 6.6/7. According to the research, long vertical openings strengthen the ambiance of an interior by highlighting other architectural elements.



Figure 6.12 : Example of a vertical slith, Santa Maria Church : Marco de Canavezes, Portugal, 1997 by Alvaro Siza (Url - 22).

In Santa Maria Church, mentioned on section 3. *Perception of Daylit Interiors* before, the vertical slith on the facade is the only opening that conveys daylight to

the room. Having a single opening, in order to diffuse light uniformly, the adjacent walls are sloped (Figure 6.12). On Figure 6.6/6, there was no need to have sloped joints on the adjacent sides as the translucent material was already enabling diffuse reflection to the space. Also, shadow falling on the ground changed in size, shape and location adding variation to the room enhancing the spiritual sobriety. An other noteworthy consequence was the contrast between shadow and light which was softer when compared to Figure 6.6/2, Figure 6.6/3 and Figure 6.6/4. Moreover, the unique quality of the material was reflecting the variation of the daylight to the room. The most spiritual impacts created were with the translucent opening application when all the options are considered.

Variation of the daylight has also changed with every different option as distribution of light has changed. Figure 6.13 shows the pictures taken at 15.00 and 17.00 on the same day of February 2014. Change of shadow plays, reflection of outside to inside are different for various options. The most significant outcome of this observation was that translucent materials have the ability to filter daylight without blocking it.

Openings made of opaque materials such as wood (Figure 6.13/2) were creating very intense brightness contrast differences which might be disturbing for the occupants to concentrate on contemplation. Translucent elements however were diffusing the sunrays before transmitting them to interior. Also, the material created softer shadow plays which would strengthen a spiritual atmosphere as shown on Figure 6.13 / 4 and 6.13/ 5.

According to the results from the first tests of the *Openings in general* explained above, the spiritual setting created with translucent material would provide privacy as well as filtered light. Also, the transmission of light through the space would have a softer affect. The facade was covered with the translucent blind completely on Figure 6.6 /5. Despite being translucent, the light spread towards the room had a very low intensity and the space was perceived as gloomy rather than spiritual. On the next step, perforations are applied to the structure to observe the difference. The following photographs of the lighting tests are taken on the same day of February at 9.00, 12.00, 15.00 and 17.00 (Figure 6.14).

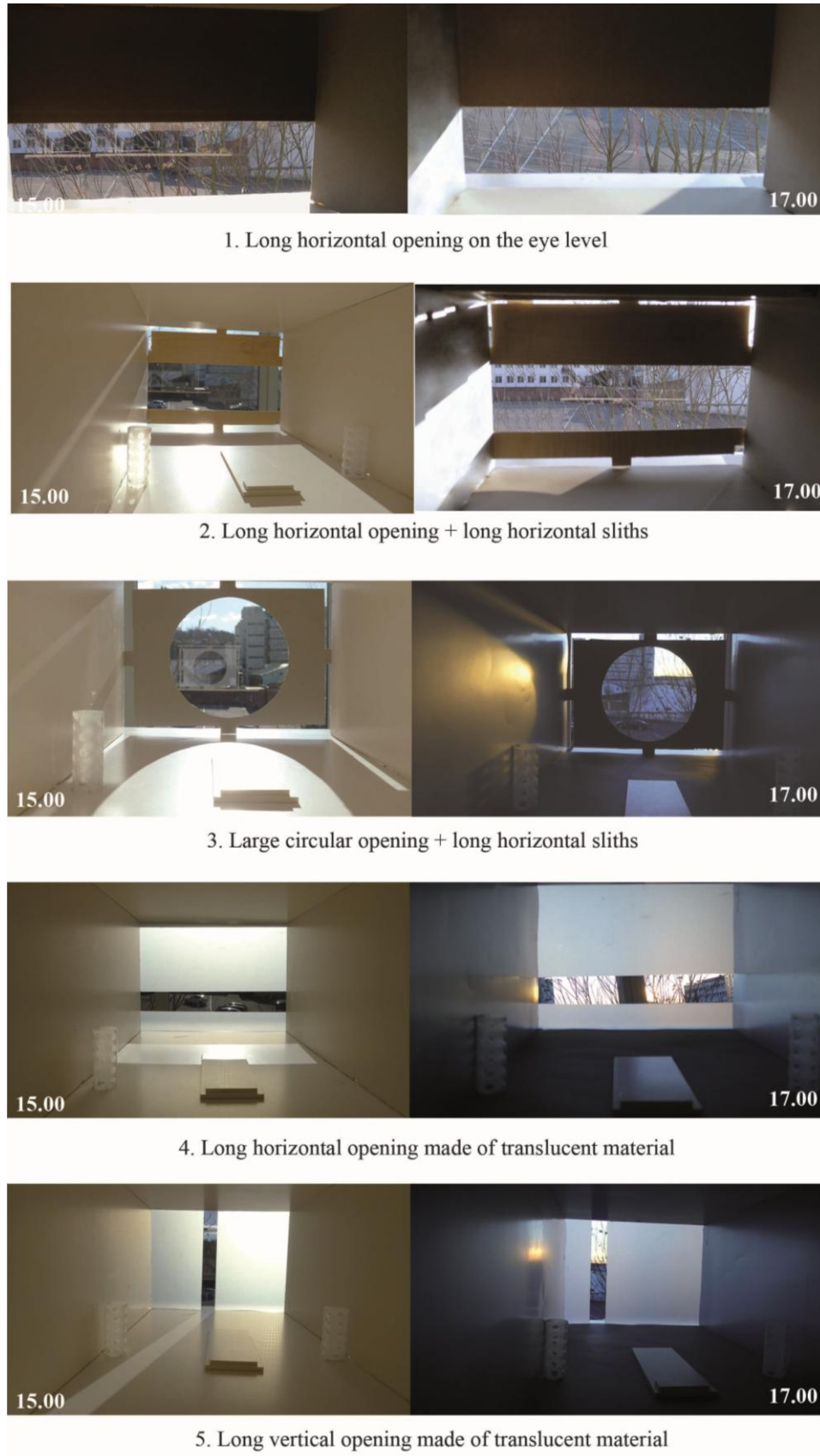


Figure 6.13: Variation achieved with different opening types and materials, at 15.00 and at 17.00 on 10 th of February 2014 (Gültekin, 2014).

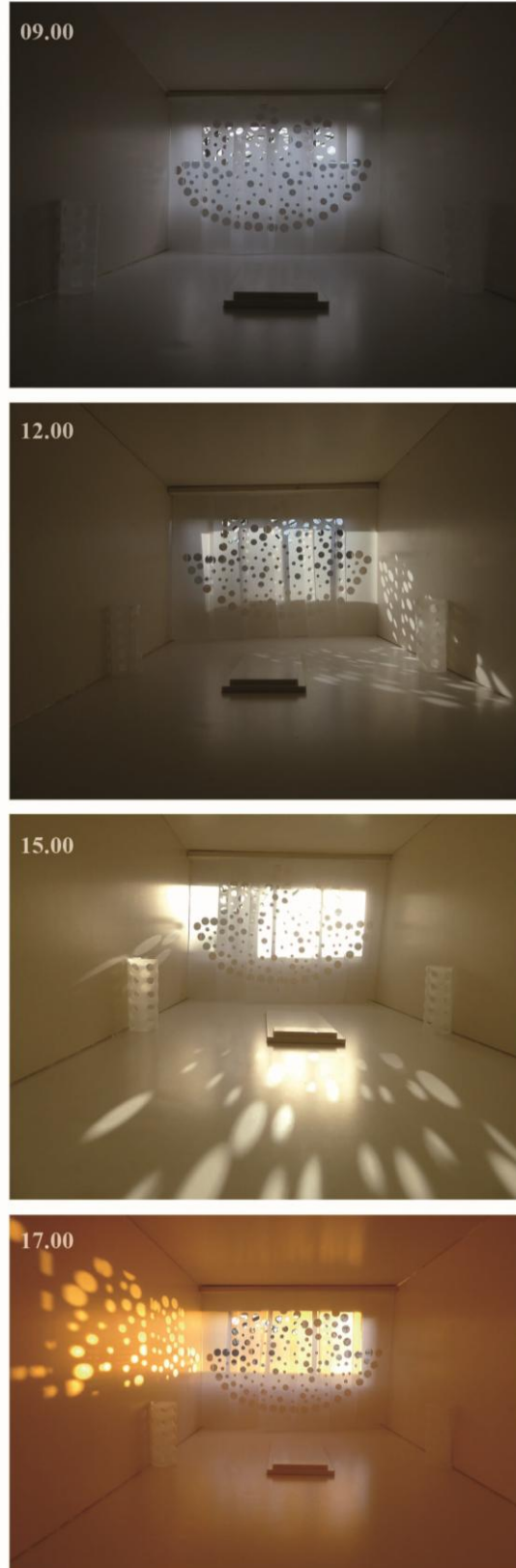


Figure 6.14 : Lighting tests, February at 9.00, 12.00, 15.00 and 17.00
(Gültekin, 2014).

The results showed that having perforations on the material increased intensity of light in comparison to Figure 6.6/5. Also, a flower pattern of perforations helped to observe the movement of shadow plays in the room during the day. Interplay of shadows enhanced the intended spiritual contemplation atmosphere in the room by reflecting variation of exterior to interior as in the example of Sidi Saiyyed Mosque from section 3. *Perception of Daylit Interiors* (Figure 6.15). As mentioned in the theoretical research, changing colours of the day have a positive effect on emotions. Reflecting this quality to interiors enhance feelings of spirituality especially in interior spaces related to faith and spiritualism.



Figure 6.15: Perception of the perforated facade opening under different shades of daylight resembling the results of lighting tests on Figure 6.14, Sidi Saiyyed Mosque, India (Url - 33).

These tests helped me to understand a few facts. First of all, the movement of the sun in the room is analyzed by observing shadows. Results of the tests on Openings in General have shown that material choice for daylight diffusion is very important to create spiritual perception. Opaque materials were creating insense brightness contrast differences but general lighting level was very low. Translucent materials were transmitting variation of sun to the interior and creating a calm atmosphere. Perforations were creating shadow interplays with very strong sensorial expressions.

Secondly, the room was supposed to be used by employees of Nimbus Group. In other words, the occupants would be German people, who live and work under sky conditions of Stuttgart, Germany. It was realized that during the observations of *Openings in general*, people's behavioral response to sun was not considered. As it is broadly explained with several theories on section 2. *Perceived Space and Light*; perception of people differs according to different cultures, social backgrounds and geographic locations. Also, it was mentioned on section 2.3. *Perceptual requirements of a luminious space*, that expectations of people needs to be

considered and analysed properly. People in cold countries react to sun different than people living close to equator (Figure 6.16).

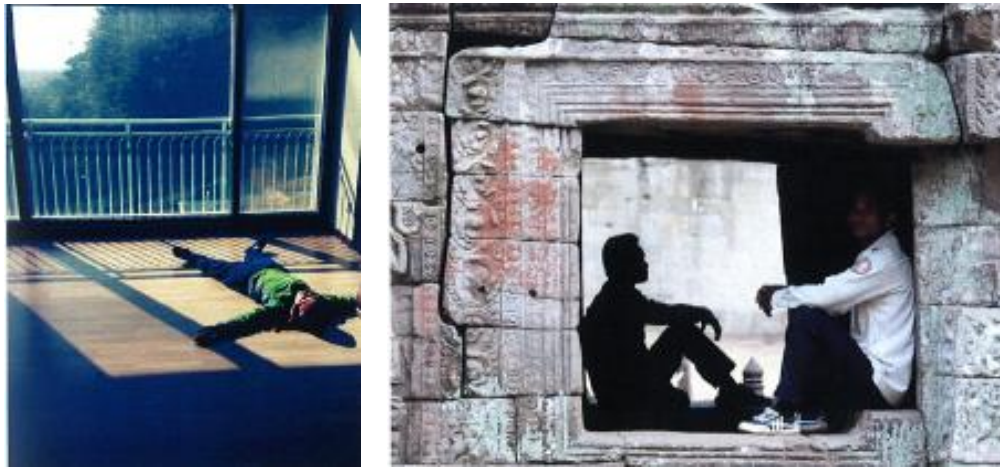


Figure 6.16 : Example to different reaction of people to sun from the research
(Ungrungseesapon, 2012).

As there are many dark days during winter, people in Stuttgart are generally moody in winter. Most of the time, even on very hot days they usually like being exposed to direct sun. Also, their emotional state gets better. Whenever there is a sunny day, people go outside lie down under the sky or in front of their windows to enjoy it. The same situation is experienced several times, for employees of the company. On the lunch breaks the employees go to the roof and spend their break lie down under the sunny sky. This situation is the opposite for people living in a country close to Equator. When the geographic location and cultural background of people are considered, the space should have been considered as a Middle European spiritual room.

Tests on Openings in general were concentrated on preventing possible discomfort by blocking the intense sunlight. However, sun is a source of relaxation and happiness for people in Stuttgart even when it is intense. Sunny days are perceived as a gift rather than something to be hidden from as it usually is in countries close to equator (Figure 6.16). Whatever the diffusing material is, covering the whole opening would be forcing the occupants to contemplate under one single circumstance.

Trying to provide a pleasant contemplation atmosphere, the sun shouldn't be blocked or the occupants shouldn't be forced to contemplate under one single circumstance. Considering people's different needs instead of blocking the light from window with a blind or a window treatment, options were needed to be provided to people. Implications from section 6.3. *Lighting Requirements of the Spiritual Contemplation Room* had also shown that lighting in the room needed to be arranged in a way that the occupants to have different options. In the light of these results and assumptions, according to the penetration of sun, the room is divided into two functional areas as *Private and Assembly Areas* with a perforated room divider that creates a blurred distinction between outside and inside as well as shadow plays.

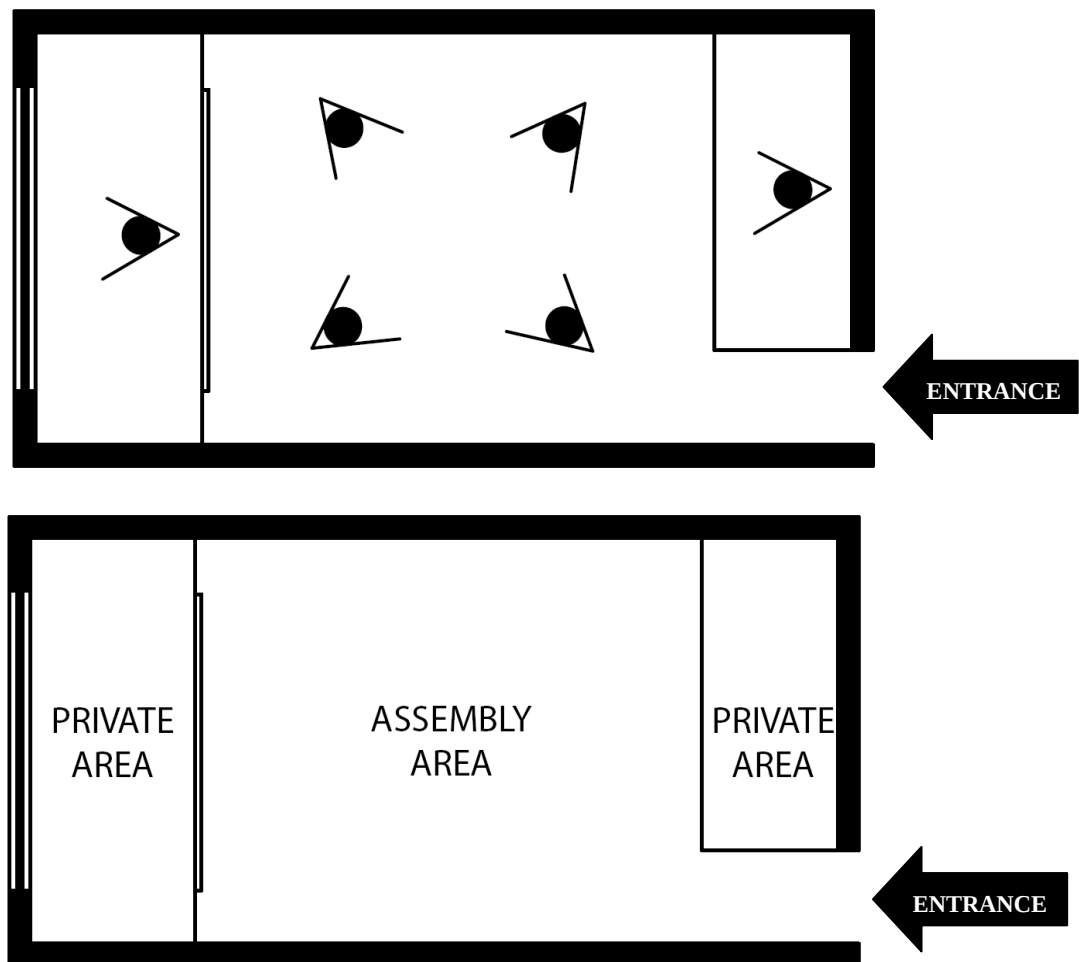


Figure 6.17 : Organisation of occupants and space (Gültekin, 2014).

Private area refers to the space that a person can be isolated from the rest of the space. There are two types of private areas in the room:

- Right in front of the window, under bright daylight with a pleasant view of outside or,
- In the back of the room, completely under shade, with the view of a shadow interplay. In this area, like watching a theatre scene, occupants would experience the changing shadow plays according to movement of sun outside.

Assembly area symbolise the space where people pray or meditate together in the middle of the room. Shadow interplays occur in this area with the light diffused by the shading element. Space organization and orientation of people are explained visually on Figure 6.17.

In order to observe light's impact on the contemplation atmosphere in relation to materials of the space two perforated materials are tested as room dividers. The material of the room divider with specular reflection is made of metal with high reflectancy and no transmittancy. For the setting with the translucent room divider, Rosso Acoustic (sub-brand of Nimbus Group GmbH) translucent screening material is used . The material is made of matt polyester film. It is translucent and 1200 mm thick with capability of transmitting light approximately 77% (Figure 6.18).

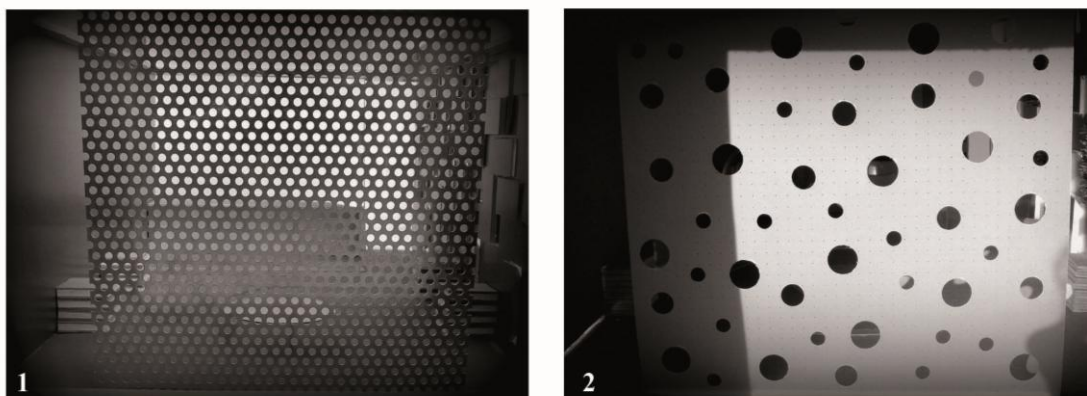


Figure 6.18 : Two different perforated element to diffuse sun rays

(1) Perforated metal room divider

(2) Perforated translucent room divider

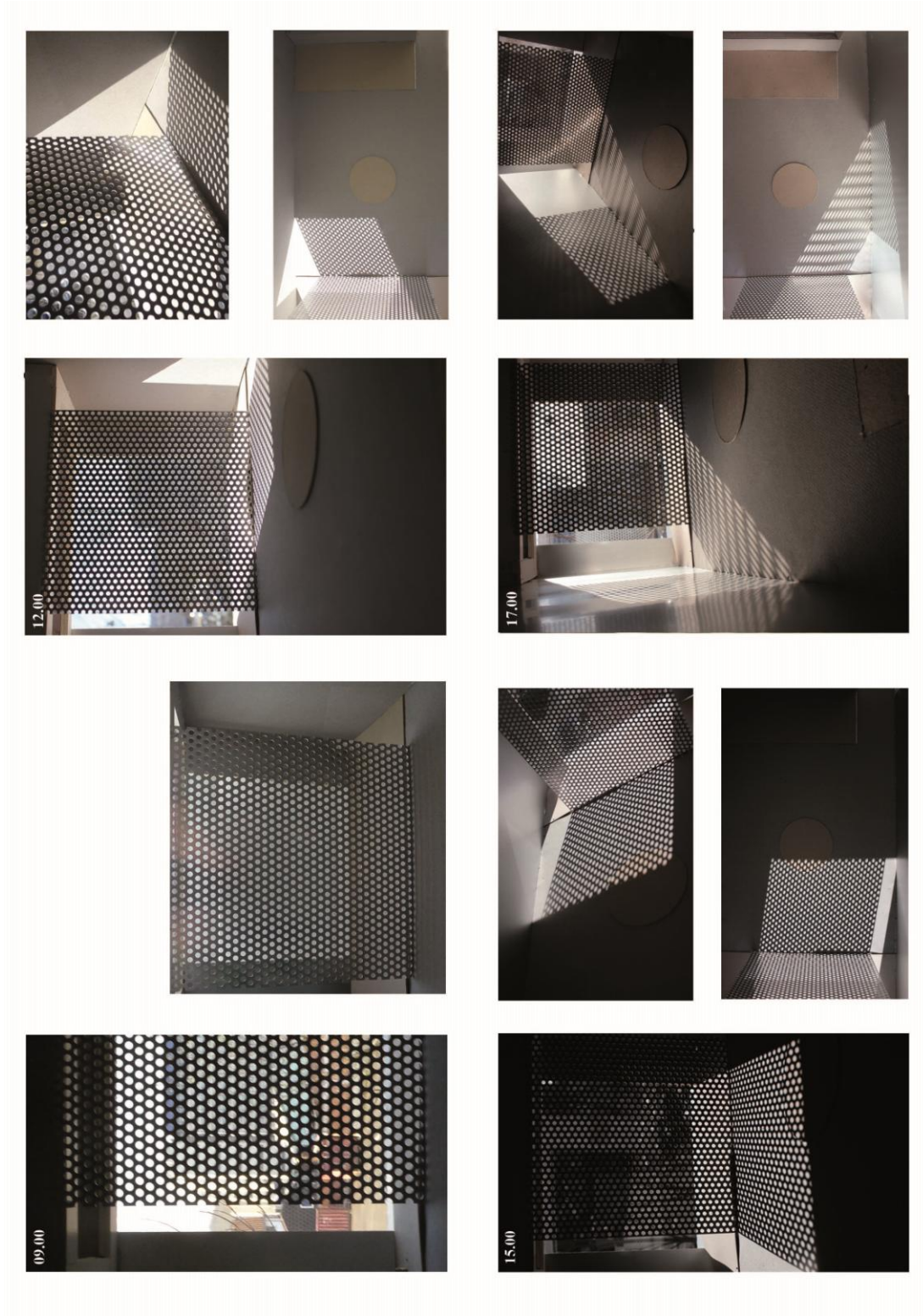


Figure 6. 19 : Observations of perforated metal room divider at 9.00, 12.00, 15.00, 17.00 on 15th of March 2014
(Gültekin, 2014).

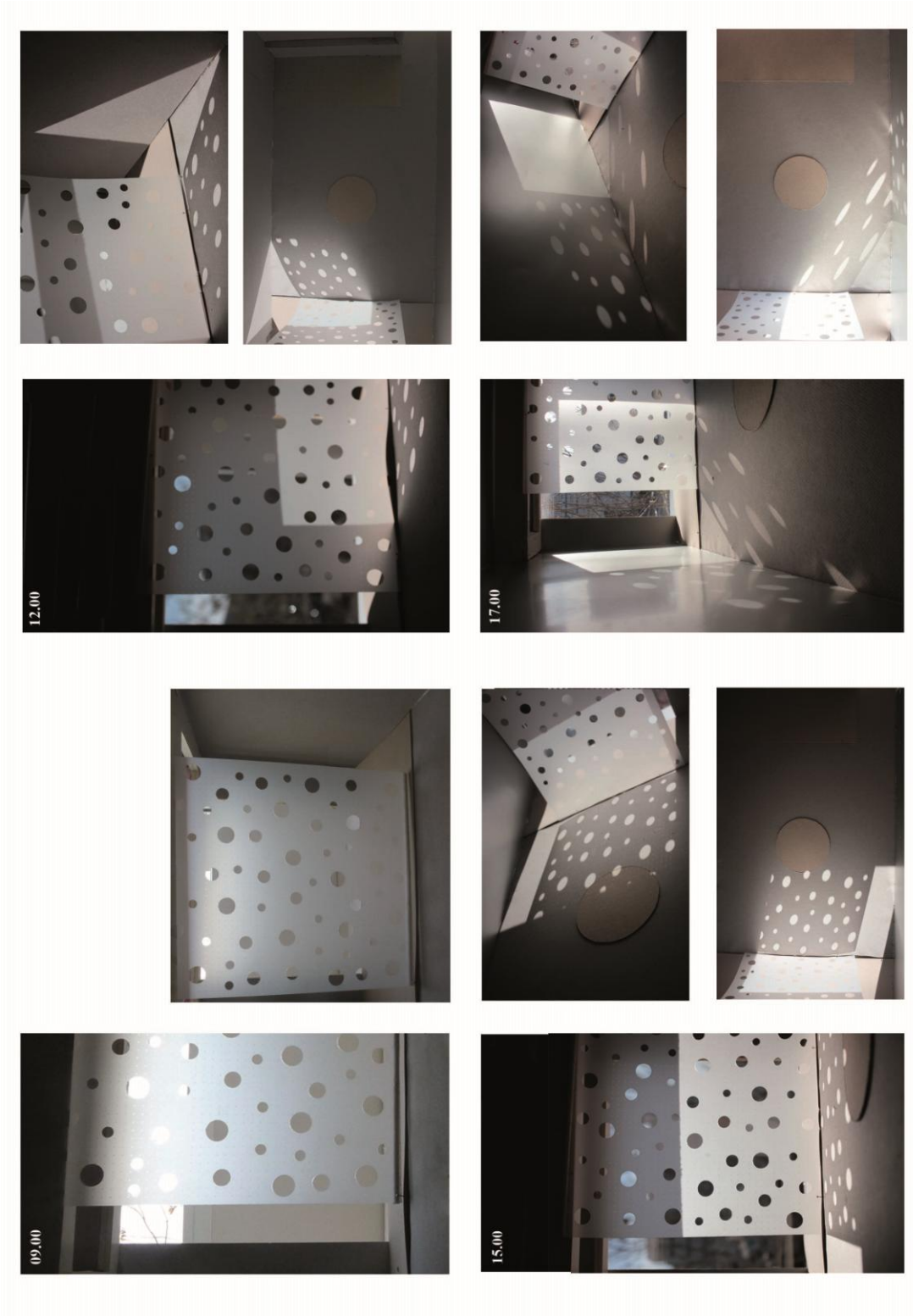


Figure 6. 20 : Observations of perforated translucent room divider at 9.00, 12.00, 15.00, 17.00 on 15th of March 2014 (Gültekin, 2014).

In the following experiments with perforated room dividers the scale of the model is 1/10. The colour of the walls, floor and the ceiling is khaki (dark beige), a neutral colour. Colour of the interior space is neglected.

Shadow interplays and their addition to the atmosphere are recorded for each setting. Changes of the colours, materials under daylight and their impacts on creating a spiritual atmosphere is observed. Both elements' effect to the Private Area and Assembly Area are recorded between 9.00 - 17.00 on the same day of March, 2014. As it can be seen on Figure 6.19 and Figure 6.20 that the effect of each material is different . Sun rays are very intense between 12.00-17.00 with a shadow interplay moving from the ground to the walls. Between 9.00 and 12.00, however , the interior is exposed to very low intensity of light that there are hardly any shadow plays. Affect of specular and translucent materials to the overall atmosphere will be explained step by step under the following subtitles:

Private Area:

The room divider acts like a shading element diffusing the sunrays for the rest of the room and define a private area in front of the window for people who would like to feel the intensity and warmth of sun during contemplation. Figure 6.21 and Figure 6.22 show location of people near window with specular room divider.

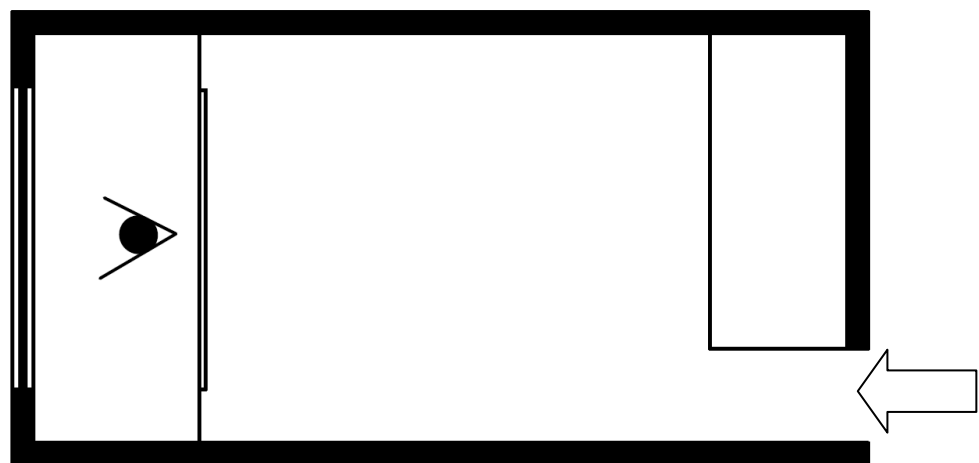


Figure 6.21 : Organisation of the occupants on Private Area Near Window
(Gültekin, 2014).

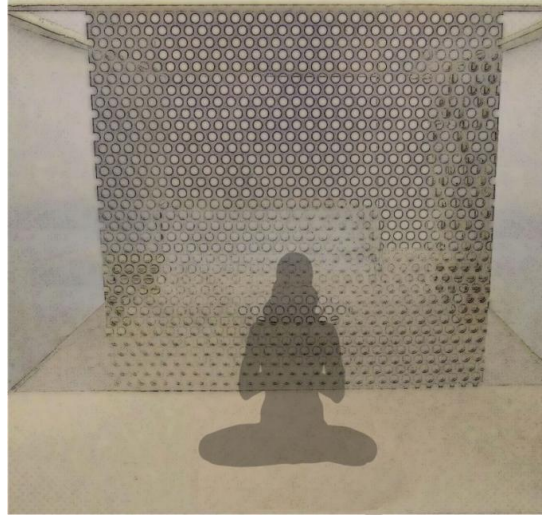


Figure 6.22 : Illustration of Private Area Near Window (Gültekin, 2014).

Also, sitting in the back of the room, close to the entrance with a view of shadow plays diffusing from the shading element, it is possible to contemplate in a spiritual setting. Figure 6.23 and Figure 6.24 show the orientation of occupants in Private Area Near Entrance.

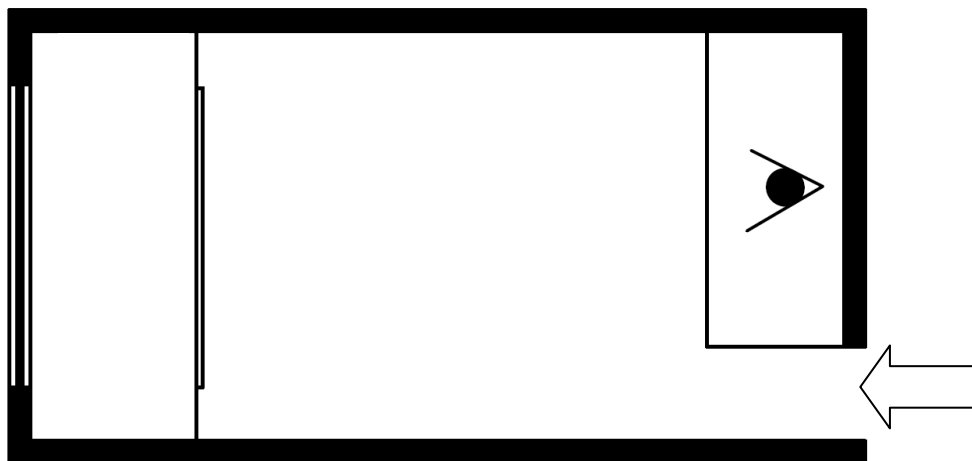


Figure 6.23 : Organisation of the occupants on Private Area Near Entrance
(Gültekin, 2014).



Figure 6.24 : Illustration of Private Area Near Entrance
(Gültekin, 2014).

With the changing quality of daylight, perceived atmosphere change, adding liveliness to the spaces. Reflectance of metal is greater than the translucent materials. This difference on the physical qualities of materials also change visual and psychological perception in space.

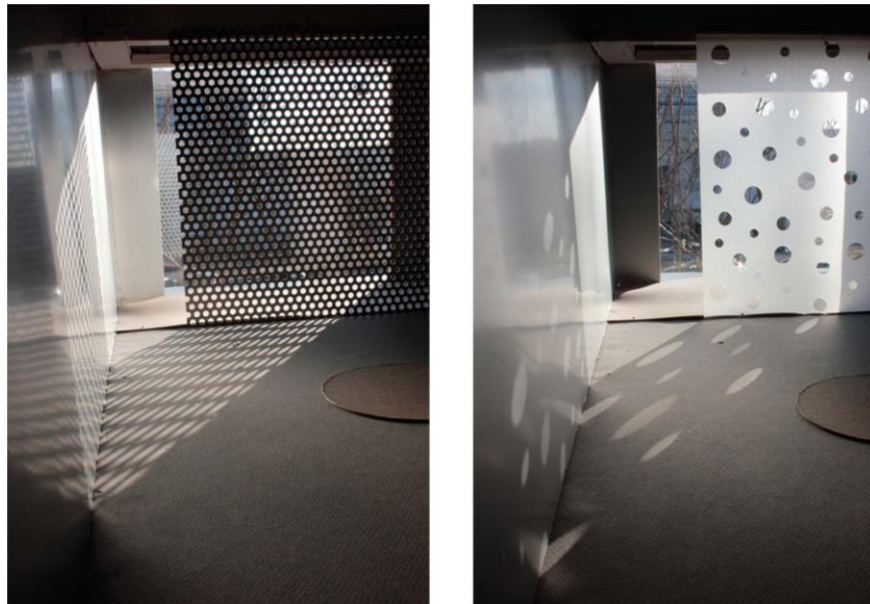


Figure 6.25 : Specular reflection of metal versus diffuse reflection of translucent material at 17.00 on March 2014 (Gültekin, 2014).

When the interaction of sun with the perforated metal shading element and the perforated translucent shading element are compared, it was realised that translucent perforation creates softer shadows with diffuse reflection. In contradiction to this,

metal provides specular reflection with sharp and even intense shadows. The element is acting just like a screen. This situation is noteworthy because it would effect the emotional perception of occupants. As it can be seen on the figure above, metal perforation is forming reflections on the wall that might cause discomfort glare and disrupt concentration during contemplation. The effect achieved with translucent perforation is softer and even calmer (Figure 6.25).

Assembly Area:

Area in the middle of the room where people are able to do communal praying or meditating activities (Figure 6.26). Illustration of the Assembly Area is shown on Figure 6.27. Perforated shading elements are acting like a room divider separating the Assembly area from the private area in front of the window.

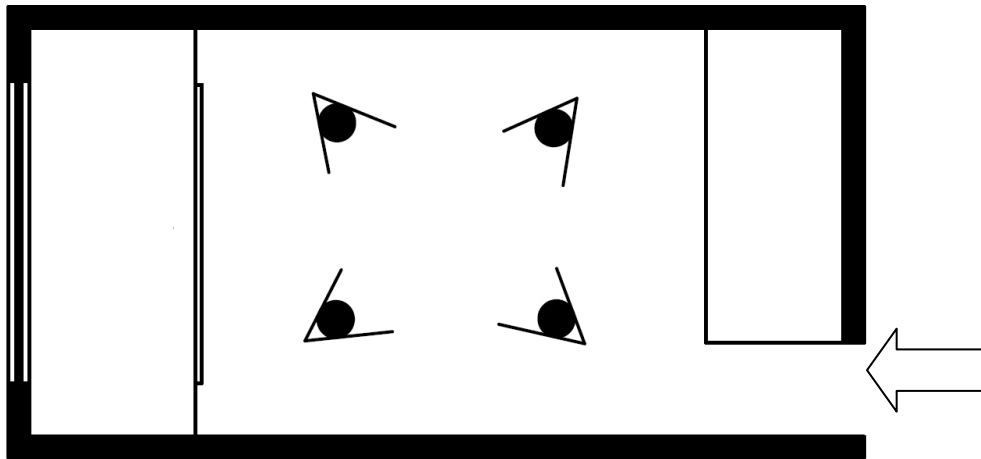


Figure 6.26 : Organisation of people in Assembly Area (Gültekin, 2014).



Figure 6.27 : Illustration of Assembly Area (Gültekin, 2014).

For the contemplation atmosphere reflecting the variation of the day to the interior was possible with perforated screens. Vivid shadow animation is also reflecting the colour changes to the interior. The following pictures show the change of the perception in interior in relation to changing sky conditions.

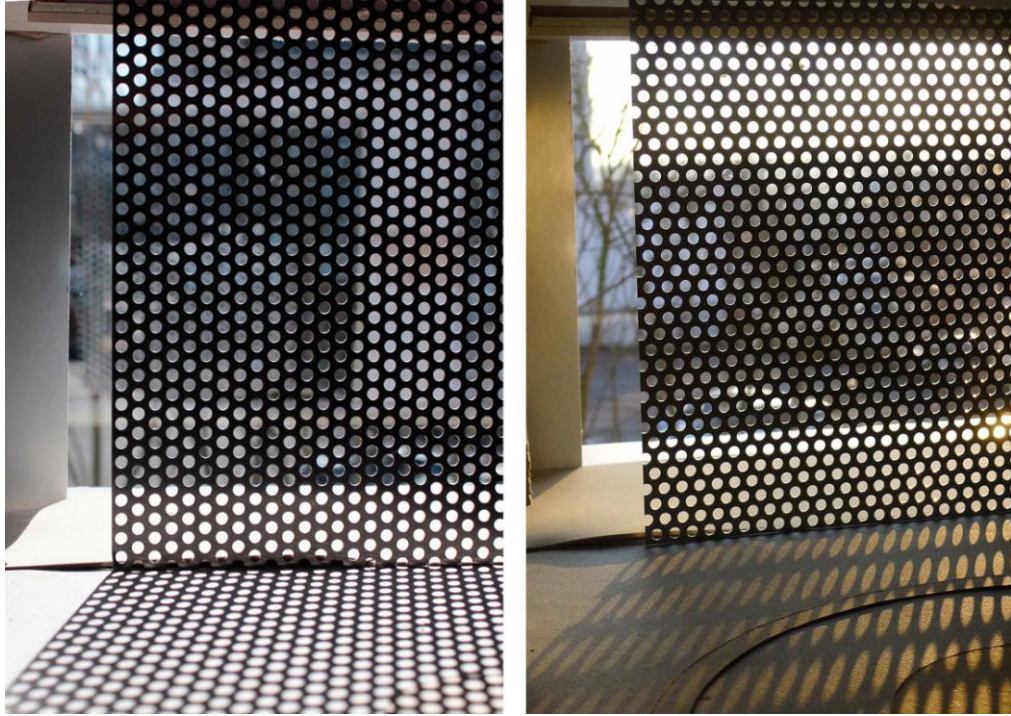


Figure 6.28 : Perception difference in interior with the same perforated shading material on late March and early February (Gültekin, 2014).

Picture on the left is taken in late March at 17.00 while picture on the right is taken in early February at 17.00. Shadow creation slightly differs with the changing angle of the sun. Diffused colours of the day and sharpness of shadows are different. Also, shadow interplays are adding liveliness to the space providing variation (Figure 6.28).

Perforated openings are also serving as a reflected screen as in the example of Kaust Mosque from section 3. *Perception of Daylit Interiors*. Spirituality of the room is enhanced with perforations on the room divider. Perforated room divider in front of the window is interacting with sun creating a patterned shadow play adding liveliness to the interior. On Figure 6.28, direct sunlight is mediated with a projection on the ground as on Figure 6.29.



Figure 6.29 : Patterns of Kaust Mosque from the research resembling Figure 6.28
(Url - 31).

The pictures shown on Figure 6.30 are taken at 12.00 on the same day of March under the same sky conditions. Translucent perforation is offering diffuse level of light to the area which would be suitable for a group meditation/contemplation strengthening the feelings of spirituality. For metal perforation however, there is a sharp brightness contrast difference between light and shadow areas. The visual perception is sharper and more intense which may distract concentration during contemplation (Figure 6.30).

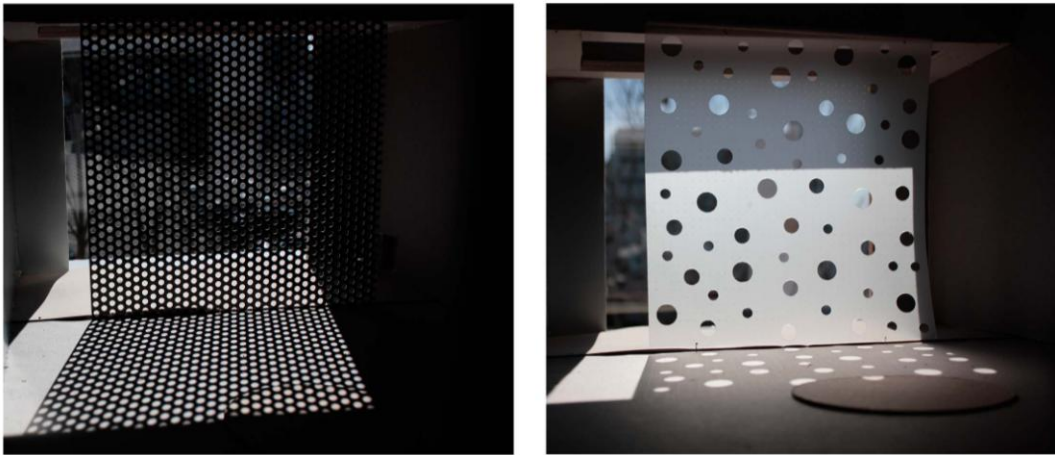


Figure 6.30 : Visual perception of different shading elements (Gültekin, 2014).

As shown on Figure 6.31, with translucent room divider, general lighting level of the Assembly Area is higher than the setting with the metal room divider. Colour of the walls and floor is also perceived differently. Because of the specular reflection and high brightness-contrast difference between light and dark areas, in the setting with

metal room divider ; walls are perceived as if they a darker tint of beige when compared to the setting with translucent room divider (Figure 6.31).

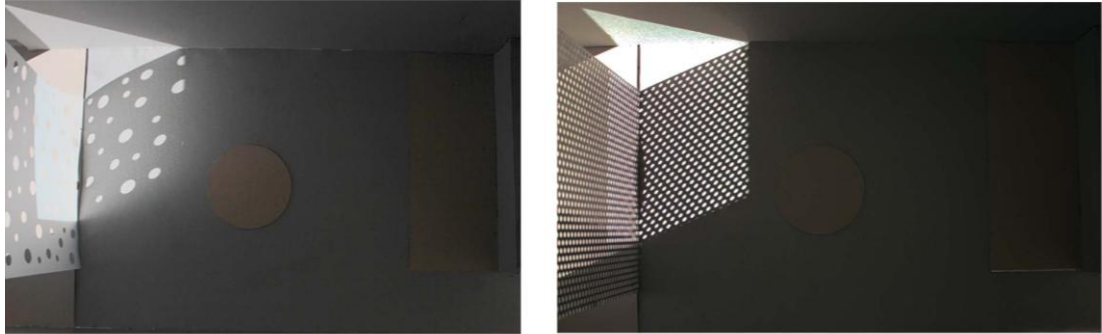


Figure 6.31 : Visual perception of the space under diffuse and specular reflection
(Gültekin, 2014).

Another outcome is that in the setting with metal room divider and translucent room divider for a group of people sitting on the Assembly Area view of the same wall washed with light is visually perceived differently (Figure 6.32). This is caused by different reflective qualities of the materials. Because of the fact that translucent materials let the light diffuse through the space and cause very low reflection, the difference between light and dark areas is not sharp as could be seen on Figure 6.31. For metal perforation however, because of the high reflectancy and low transmittancy of metal, the wall looks as if it is a lighter tint of grey when compared to the setting with the translucent room divider (Figure 6.32).

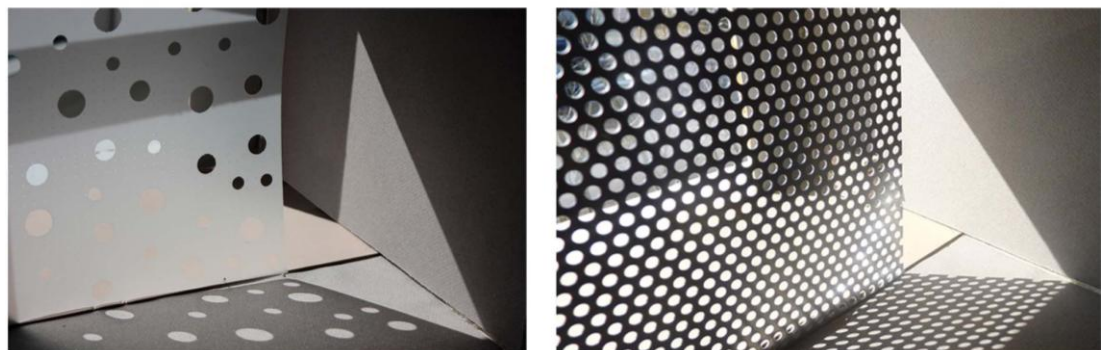


Figure 6.32 : Visual perception of the walls under diffuse and specular reflection
(Gültekin, 2014).

6.6. Resume on results of daylight experiments

Perception of daylit interiors change depending on opening types, locations and sizes. During the experiments several opening types are tested and the consequences are matched with the examples from the research. Impact of each trial on creating a spiritual contemplation atmosphere is explained. Geographic location and socio - cultural background of the occupants are also taken into account. Because of the fact that the room was supposed to be used by employees of Nimbus Group, located in Stuttgart, Germany, their behavioral reactions to sun is reconsidered. According to people's expectations , sun penetration to the room and analysis made on section 6.5. *Lighting requirements of a spiritual contemplation room* the space is divided into two functional areas as *Private and Assembly Areas* with a perforated room divider. A metal perforated room divider and a translucent perforated room divider are tested on a 1/10 scaled model. Each experiment offered various expressions in interior re -shaping visual and emotional perception. Different reflective qualities of materials affected distribution of light and perception of the space. Their impacts in relation to sun is observed on different times of the day. Then the consequences are compared.

6.7. Artificial light Experiments

Artificial light has a completely different nature than daylight. It is static, it is human made, it is a much more complex union of rules and physical facts. As it is broadly explained in theoretical section of the research, it is impossible to think space, people and light as separate elements.

As Flynn discovered, lighting patterns caused by different distributions of light effect our subjective impressions and consequently their psychological perception of a space. These lighting patterns are divided as location, uniformity, and intensity of light. So that ,

- Location of light source (Horizontal Surface - Vertical Surface),
- Direction and distribution of light (Upward - Downward or Uniform – Non-Uniform),
- Intensity of light
- Colour of light are chosen to test.

In order to find out the required artificial lighting situation for a spiritual atmosphere; several artificial lighting situations are tried on a 1/10 scaled model. The colour of the walls, floor and the ceiling is preferred khaki (dark beige), a neutral colour, as in the previous daylight experiments. Colour of the interior space is neglected. Space division decisions taken on the previous section *Daylight experiments* are followed. The observations are summarized under the subtitles :

- Light for Assembly Area
- Light for Private Areas

The spiritual atmosphere of the room is not under restriction of any particular religion. In other words, it only provides a quiet space for non religious (or religious depending on personal choice) spiritual contemplation. Lighting requirements and concept of the space are decided with this approach. Because of ease of access to the LED light sources in the company and their wide range of colour rendering options

all tests are made with LED light sources. Lighting experiments will be explained step by step under the subtitles below.

Light for Assembly Area

For the specific atmosphere of the contemplation room, impression of privacy and relaxation are the two basic requirements. Degrees of privacy is different on each specific area. Assembly area is located in the middle of the room for people's communal meditation, praying or thinking activities (Figure 6.33).

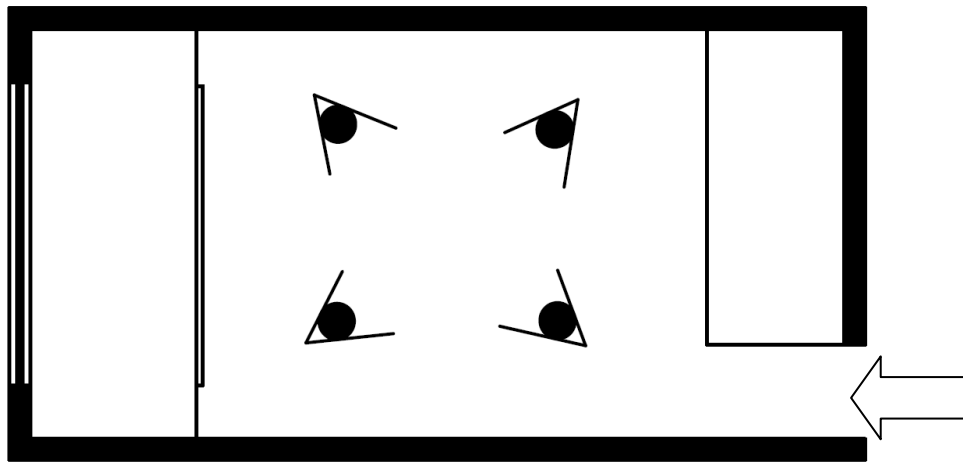


Figure 6.33 : Organisation of people in Assembly Area (Gültekin, 2014).

According to implications derived from Lam's theories, lighting requirements of the Assembly Area are listed as:

- Lighting should provide a tranquil atmosphere
- Lighting should support concentration as well as maintaining a level of private feeling in the circle
- Intensity of light should be lower with warmer colour temperature
- The area should be highlighted to create the impression of being together

To achieve the steps above following tests are made.:

- *Using ceiling mounted light sources to emphasise the area*



Figure 6.34 : Direct downward light distribution to define a private area, Der Spiegel, HQ Canteen, Hamburg, Germany (Braun, Z., May 2012).

First of all, direct downward distribution of light was applied to the Assembly area. Light is a powerful element to define spaces. A light zone above a seating area in a large room for example can define a private area as in the example of Der Spiegel, HQ Canteen (Figure 6.34). Light hanging above the seating zones are dividing but not blocking the space providing the perception of privacy.

For the spiritual contemplation room a similar lighting setting is applied. Since Assembly area is going to be used for communal praying sessions or group meditation, the lighting intensity is supposed to strengthen the impression of being together. Highlighting the assembly area, three different intensity of light is tested (Figure 6.35). It is observed that intense directed light right above the assembly area affects general lighting of the whole space. Atmosphere achieved with Figure 6.35 /1 and Figure 6.35/2 resembled John Flynn's experiment done in a conference room from the research (Figure 6.36). Results of his study showed that overhead direct light created a strong contrast between light and dark areas and intensity of light was too harsh to light faces. The impressions of the occupants were a hazy interior with strong impression of confinement. (Steffy, G., 2008).

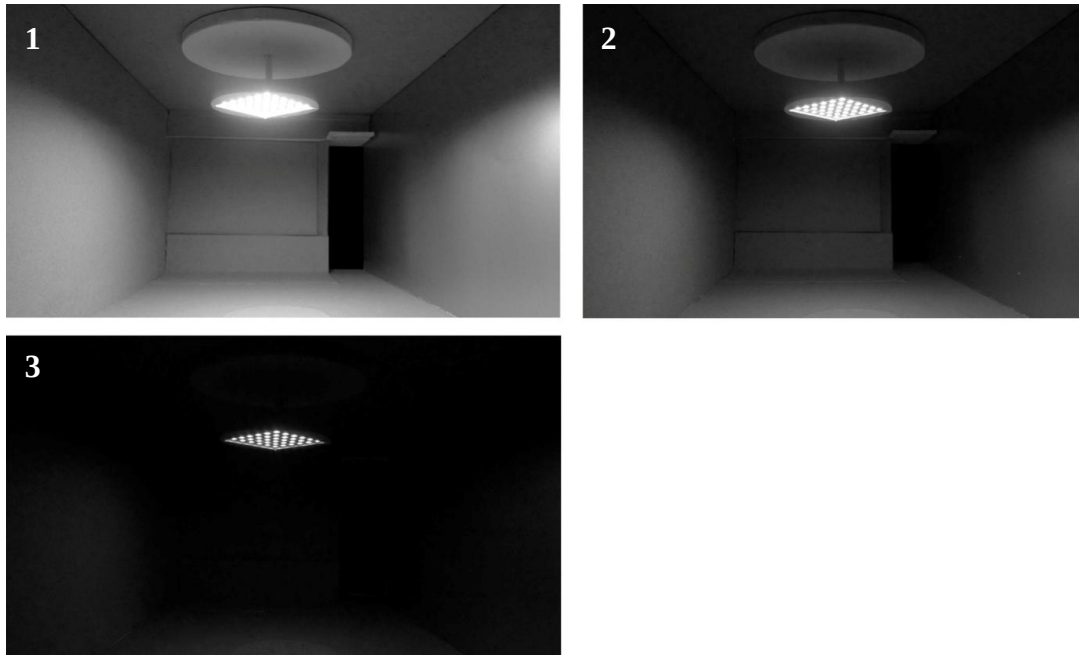


Figure 6.35 : Lighting the Assembly area with three different intensities of direct downward light distribution (Gültekin, 2014).

For the occupants of the spiritual contemplation room, atmosphere on Figure 6.35 /1 and Figure 6.35/2 would be similarly hazy with low visual clarity. Since Assembly area is going to be used for communal contemplation, the lighting is supposed to be with even a lower intensity. On Figure 6.35 /1 however, direct light diffusing downwards was too intense that it would cause tension and feeling of being exposed on the occupants. From the research it is known sense of tension is increased with application of only uniform direct lighting (Steffy, G, 2008).

Secondly, effect of colour temperature is tested. From the research it is known that psychology of people is strongly affected by colour temperature of light. Spiritual Contemplation Room requires a warm, welcoming lighting setting that encourage relaxation and concentration. Also, colour temperature of artificial lighting should be warm with low intensity. Both cold and warm tints of light (low colour temperature) are tested to compare the results.



Figure 6.36 : Illustrations of lighting condition with overhead / direct lighting on table from Flynn's experiment (Steffy, G, 2008, p.114, 115)

LED pendant luminaries and their effect to the Assembly Area can be seen on Figure 6.37 and Figure 6.38. On both of the settings light is defining a zone for people to contemplate together to satisfy Communication Needs. It was explained in section 6.3. *Lighting Requirements of the Spiritual Contemplation Room* that the most important Biological Need of the Spiritual Contemplation Room is Orientation. Here, light zone on the ground is providing a clearly defined location for people in Assembly Area with regard to others. A boundary is formed, the space is divided and personalized with light and shadow contradiction (Figure 6.38).



Figure 6.37 : Cold and warm white colour temperature of LED pendant light (Gültekin, 2014)

Warm light temperature created the impression of a more tranquil atmosphere when compared to cold white temperature of light. Since the space will be used for

activities such as praying, meditation and contemplation warm colour temperature of light with low intensity would create an atmosphere that encourage relaxation and spiritual contemplation (Figure 6.39).

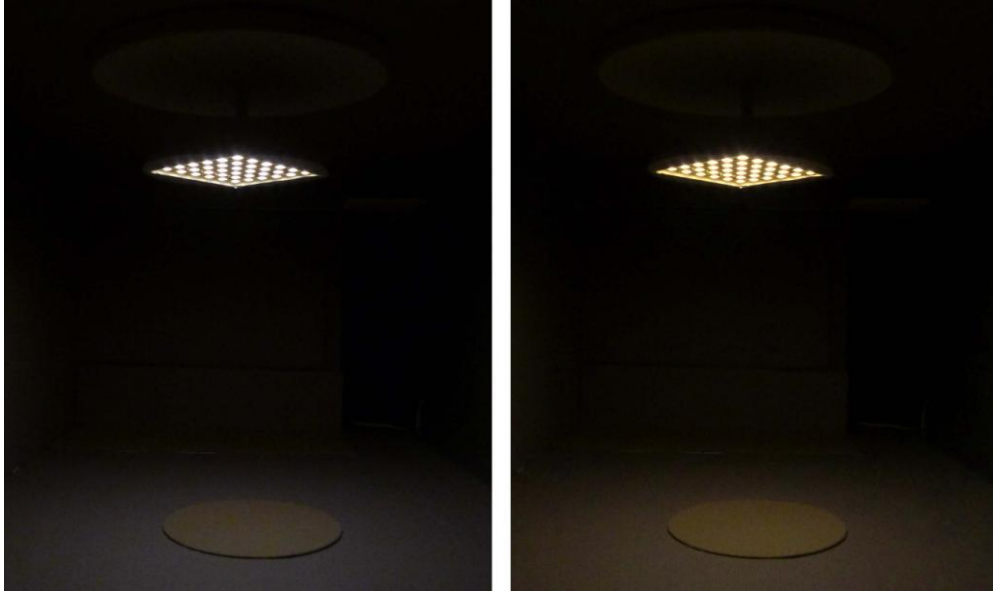


Figure 6.38 : Lighting the Assembly area with downward (direct) lighting with low intensity, perception of cold white and warm white colour temperatures (Gültekin, 2014)

Then, the Assembly area is lighted with upward (indirect) distribution of light (Figure 6.39) with three different intensity. From 6.39/1 it was observed that very intense indirect light right above the occupants lighted the whole space evenly and too brightly. However, the aim was highlighting only the Assembly Area. Then, intensity of light is lowered down (Figure 6.39/2). This setting was more suitable for a spiritual contemplation atmosphere as people would not feel like being exposed during contemplation. The impression created was calmer. On the previous tests on Figure 6.35, direct light diffusing downwards would cause tension and impression of being exposed right in the center of the room. With the setting on Figure 6.39/2, this problem was eliminated. Figure 6.39/2 shows the lowest intensity of light. As it is mentioned in the research minimum value in interior spaces required for recognizing facial features is 20 lux (IESNA, 2000). This setting was inefficient to even see and visually perceive the space. So it wasn't possible to talk about perception.

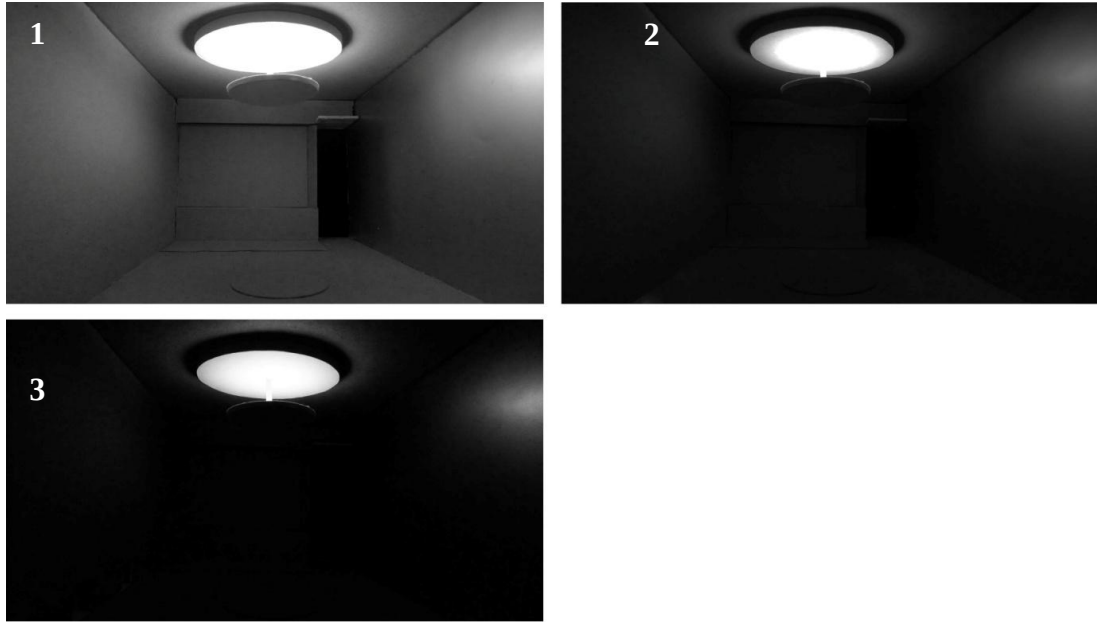


Figure 6.39 : Lighting the Assembly area with three different intensities of upward indirect light distribution (Gültekin, 2014)

On the next step, two different atmospheres are achieved with different colour temperatures. Similar to the first test, cold white light temperature was less relaxing when compared to warm white light. Also, warm white colour created a more tranquil atmosphere when compared to cold white (Figure 6.40 and Figure 6.41).



Figure 6.40 : Lighting the assembly area with upward (indirect) lighting with low intensity, perception of cold white colour temperature (Gültekin, 2014)



Figure 6.41 : Lighting the assembly area with upward (indirect) lighting with low intensity, perception of warm white colour temperatures (Gültekin, 2014)

According to the research, light distribution in an interior space differs according to material qualities. Reflectance of surface textures affect distribution of light. Materials have different reflection levels. This changes the brightness contrast of an interior.

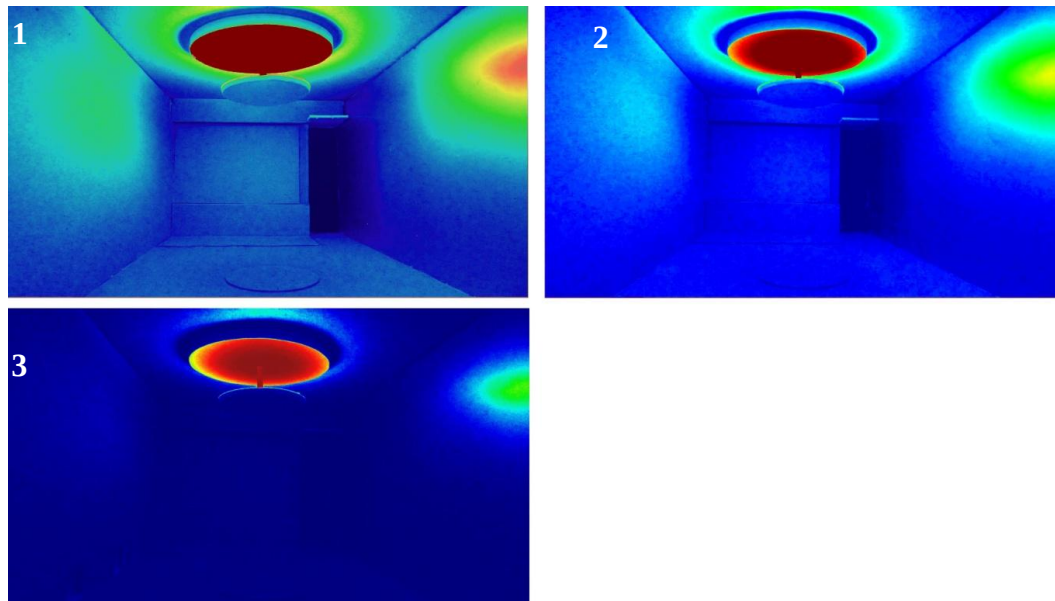


Figure 6.42 : Distribution of different intensities of light with indirect light distribution (Gültekin, 2014).

From Figure 6.41 it can be seen that wall A and wall B are made of different materials. From the research it is known that surfaces like fabric, paper etc. cause

diffuse reflection while materials like metal, polished paint cause specular reflection (Gordon, G. , 2003). When it is assumed that wall A is wall paper while wall B is polished paint. Wall B is a material with specular reflection when compared to wall A. So that as can be seen on Figure 6.42, distribution of light on wall A and Wall B are different. Wall B is reflecting light more than wall A.

- ***Using a special wall structure to improve spirituality***

Lighting special wall structures emphasis the surface textures and improve pleasantness and relaxation as in the example of highlighted wall structure of Quadrangle Architects Studio from section 4. *Perception of Artificially Lit Interiors* (Figure 6.43).



Figure 6.43 : Pleasant and tranquil atmosphere of Quadrangle Architects Studio, Toronto, Canada (Url - 90).

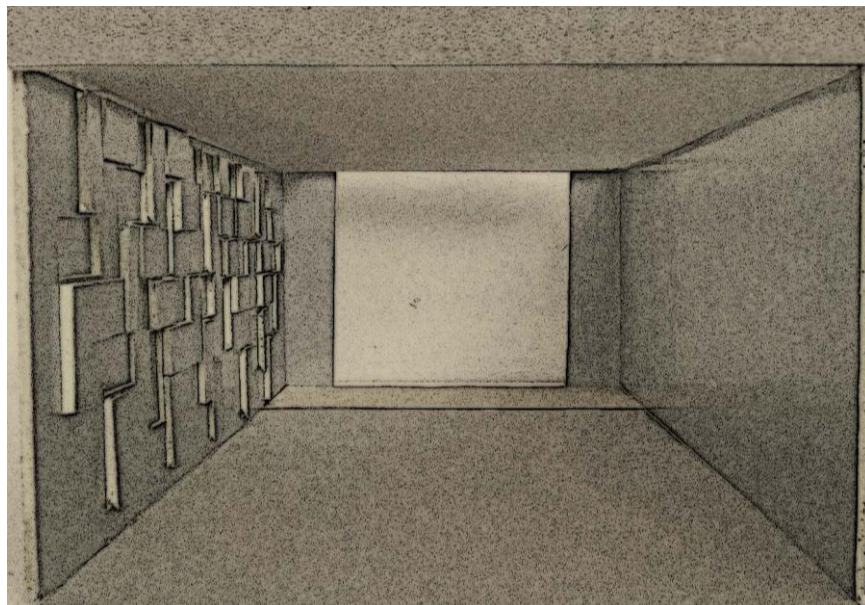


Figure 6.44: Sketch showing the wall application (Gültekin, 2014).

In order to improve the ambiance of a spiritual setting a special wall structure is developed and highlighted to achieve a tranquil atmosphere during contemplation (Figure 6.44). According to research summarized on section 4. *Perception of Artificially Lit Interiors*, peripheral lighting of non-uniform distribution with warm tints of light creates impression of relaxation. Irregularly lit walls, by enhancing a unique wall structure or paintings on wall surfaces will create a tranquil impression as it is re-shown on Figure 6.45 (Gordon, G. , 2003). To test this theory, first of all the wall structure is lighted with wall washers to emphasis surface textures (Figure 6.46).

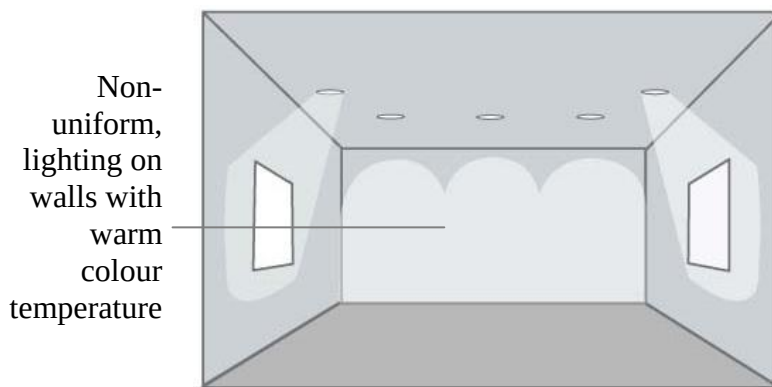


Figure 6:45 : Non-uniform, lighting on walls with warm colour temperature to achieve Relaxation (Gültekin, 2014)

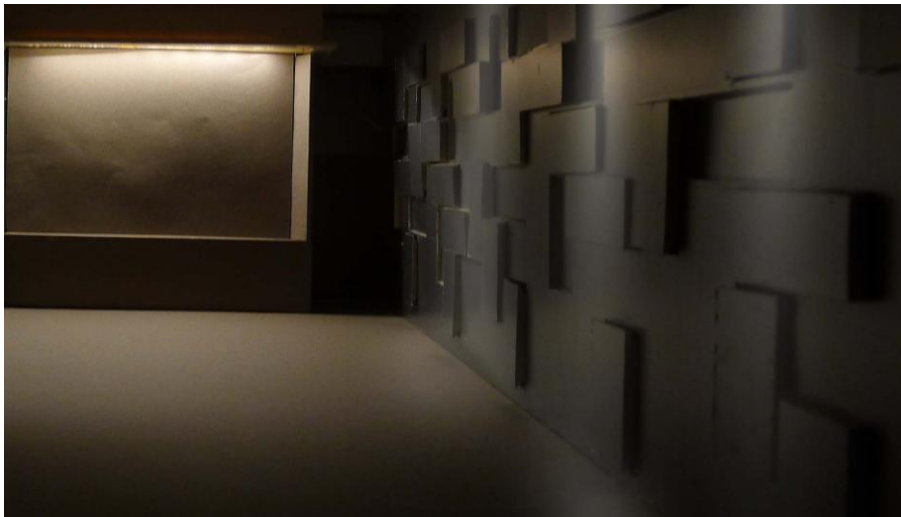


Figure 6.46 : Lighting the wall structure with wall washers (Gültekin, 2014)

Another way of manipulating perception to create pleasantness and relaxation would be using the architecture itself to emphasise the desired area as in the example of interior space concept for CREA light application from the research (Figure 6.47).

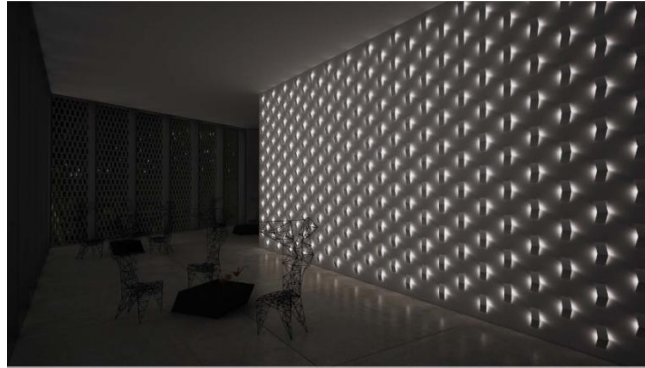


Figure 6.47 : Space concept for CREA light application (Url - 35).

To test this setting, LED stripes are fixed inside the wall which create a patterned shadow in the whole room. During the day, the wall looks like a brick- wall (Figure 6.48). At night it forms shadow installation. Rectangular shadows are formed on the walls, floor and the ceiling creating a visual interaction between shadow plays of daylight during the day and artificial light during the night (Figure 6.49).



Figure 6.48 : Wall application on 1/10 scaled model (Gültekin, 2014)

On Vertical illumination with non-uniform light distribution with backlighting, emphasize the wall and room as a whole with a play of shadows. Focus of perception is not only the wall, but also the space as a whole. Vertically illuminated wall is also maintaining a low level of diffuse light to the space which strengthen the spiritual ambiance (Figure 6.49).



Figure 6.49 : Shadow installation, 1/10 scaled model (Gültekin, 2014)

Moreover, illumination of the wall with a special property, vertical spatial borders are emphasized. Another addition of lighting the wall structure from the back was, enhancing the spiritual character of the space by attracting people's attention right in the entrance (Figure 6.50).

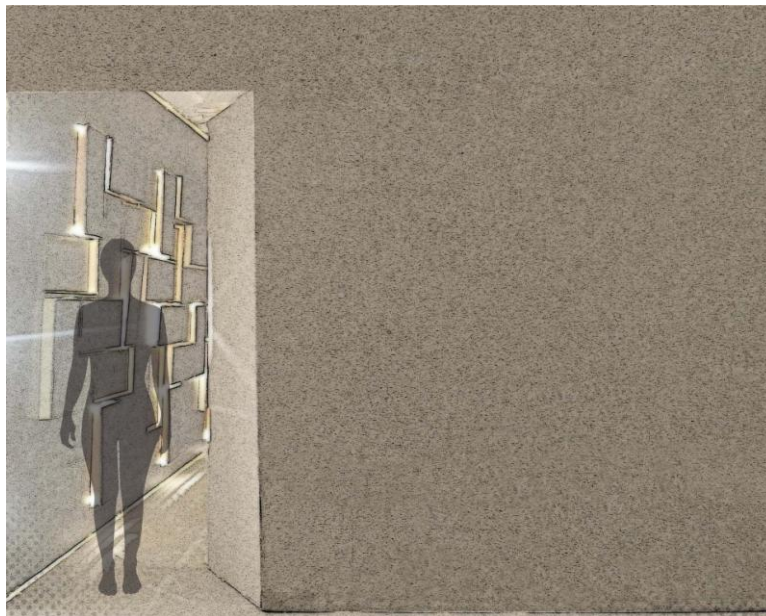


Figure 6.51 : Sketch showing the entrance of the room with backlit walls (Gültekin, 2014)

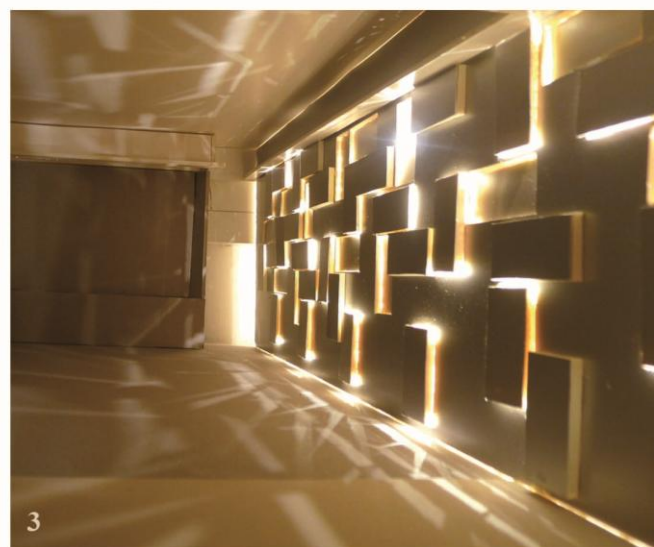


Figure 6.52: Intensity of shadows versus intensity of the light source from the wall
on 1/10 scaled model (Gültekin, 2014)

To test effect of intensity of light on spirituality, play of shadows with low intensity of light and high intensity of light are compared. It was observed that the lower the intensity the stronger the spiritual atmosphere was. High intensity of light is weakening the effect of shadows as well as exposing the whole space at once. Figure 6.52 shows photographs of the room with three different intensity of light.

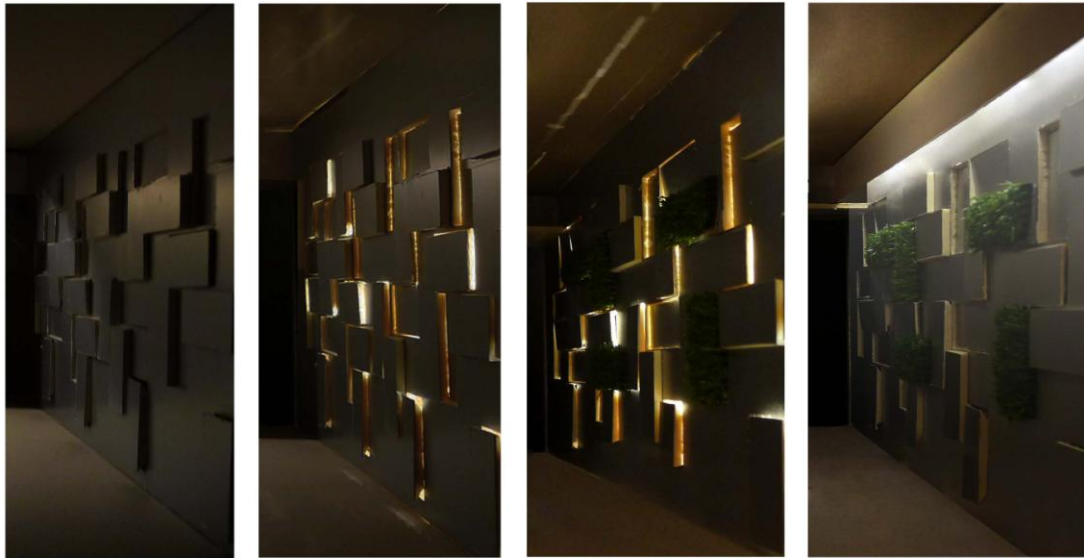


Figure 6.53: Lighting the wall structure with different light settings
(Gültekin, 2014)

Variations of lighting the vertical wall surface is shown on Figure 6.53. With each lighting setting the perception completely changes. Lighting the brick walls with uniform wall washing is also forming a pleasant atmosphere, however the light intensity is increased. Backlighting creates a more spiritual affect because of the shadow plays.

Light for Private Areas

According to Lam's theories explained on section 6.3. *Lighting Requirements of the Spiritual Contemplation Room*, lighting requirements of the Private Areas are listed as:

- Lighting should provide a tranquil atmosphere

- Lighting should support concentration and high level of privacy
- Intensity of light should be very low
- Privacy and clearly defined boundaries should be achieved

To achieve the steps above following tests are made.:

- ***Coloured light above Private Area Near Window***

The room divider diffuses the sunrays and define a private area in front of the window for people who would like to feel the presence and warmth of sun during contemplation. For the night atmosphere of Private area near window, coloured light application is tried. From the research it is known that colours have strong power on perception. This effect is also used to manipulate psychological perception and enhance spirituality in religious interiors. Multi - coloured light application of The Prayer Pavilion of Light from the research was designed with colour contrast of saturated colours to achieve an impressive composition (Figure 6.55).

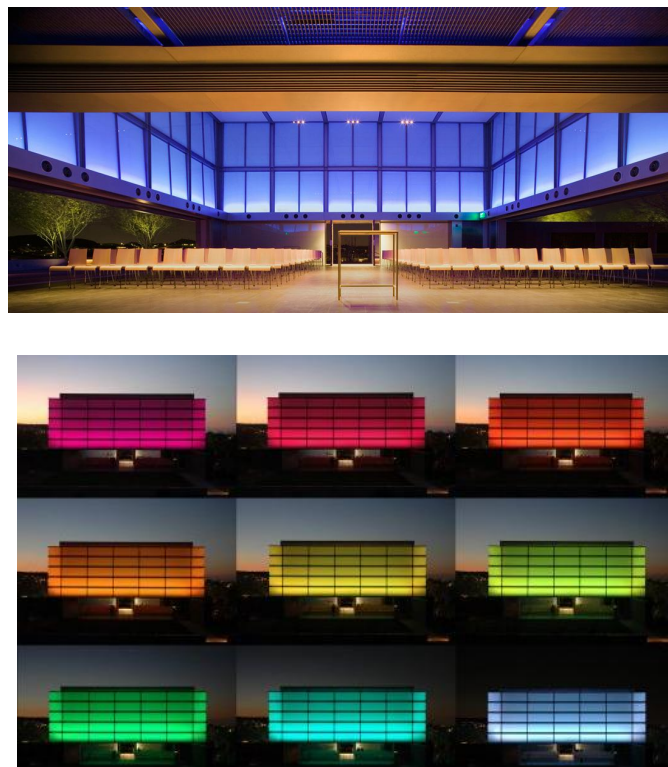


Figure 6.54 : Atmosphere of The Prayer Pavilion of Light under RGB LED light,
Phoenix, USA

In order to maintain a calming atmosphere on the area, a colour sequence ranging between pink and blue is applied. Colour choices are made according to colour theories of stated on section 4. *Perception of Artificially Lit Interiors*, re - shown on Table 6.1. According to the table except red and brown all the stated colours create positive impressions when used on the ceiling. So that, a changing colour setting is offered to achieve various atmospheres respectively for metal division element and translucent division element by applying only indirect distribution of light on the ceiling (Figure 6.55).

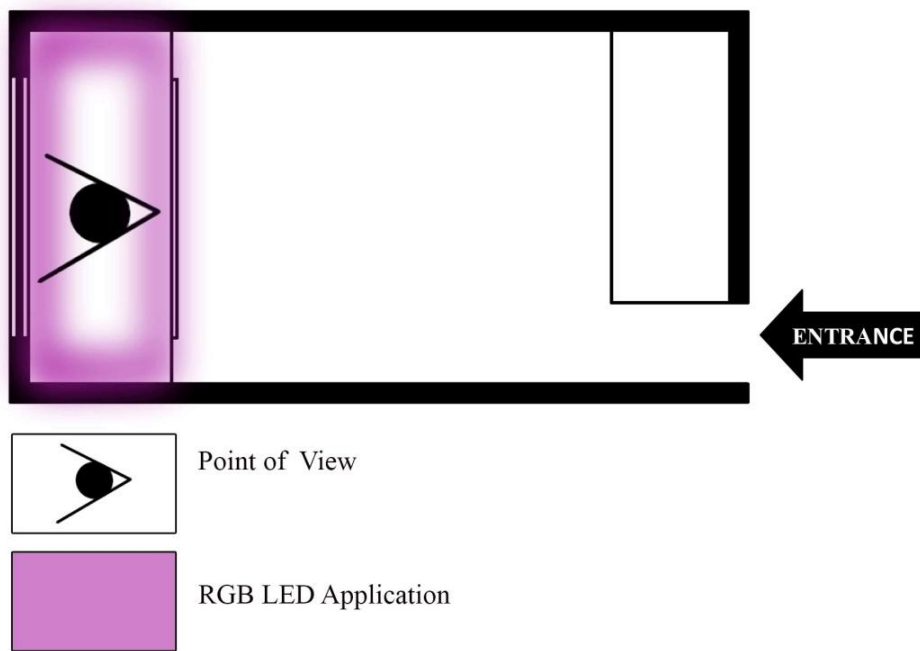


Figure 6.55: Indirect artificial light application on Private Area Near Window
(Gültekin, 2014)

When this theory was tested, the multicoloured light application changed the perception offering a lively interior with a dynamic atmosphere. However, because of applying only indirect light distribution on the ceiling , the area is percieved as dark and intense rather than calm and spiritual (Figure 6.56). Colour contrast of saturated colours of green and blue with a changing sequence created a strong composition as in the example of The Prayer Pavilion (Figure 6.54).

***	Ceiling	Walls	Floor
Red	Intruding, disturbing, heavy	Aggressive, advancing	Conscious, alert, perhaps pompous
Pink	Delicate, comforting	Aggression- inhibiting, intimate, too sweet if not grayed down	Perhaps too delicate, unfamiliar in this location
Orange	Stimulating, attention seeking	Warm, luminous	Activating, motion oriented
Brown	Oppressive and heavy (if dark)	Secure and assuring (if wood) ; much less so if paint	Steady, stable
Yellow	Light (if toward lemon), luminous, stimulating	Warm (if toward orange), exciting or irritating (if highly saturated)	Elevating, diverting
Green	Protective	Cool, secure, calm, reliable, passive, irritating if glaring (electric green), muddy if toward olive	Natural (up to a certain saturation point), soft, relaxing, cold (if toward blue – green)
Blue	Celestial, cool, less tangibly advancing (if light), heavy and oppressive (if dark)	Cool and distant(if light), encouraging and space deepening (if dark)	Inspiring feeling of effortless movement, substantial (if dark)

Table 6.1: Perception of colors on ceiling, wall and floor , information on table is derived from Colour , Environment and Human Response (Mahnke, F., 1996, p. 67-70).

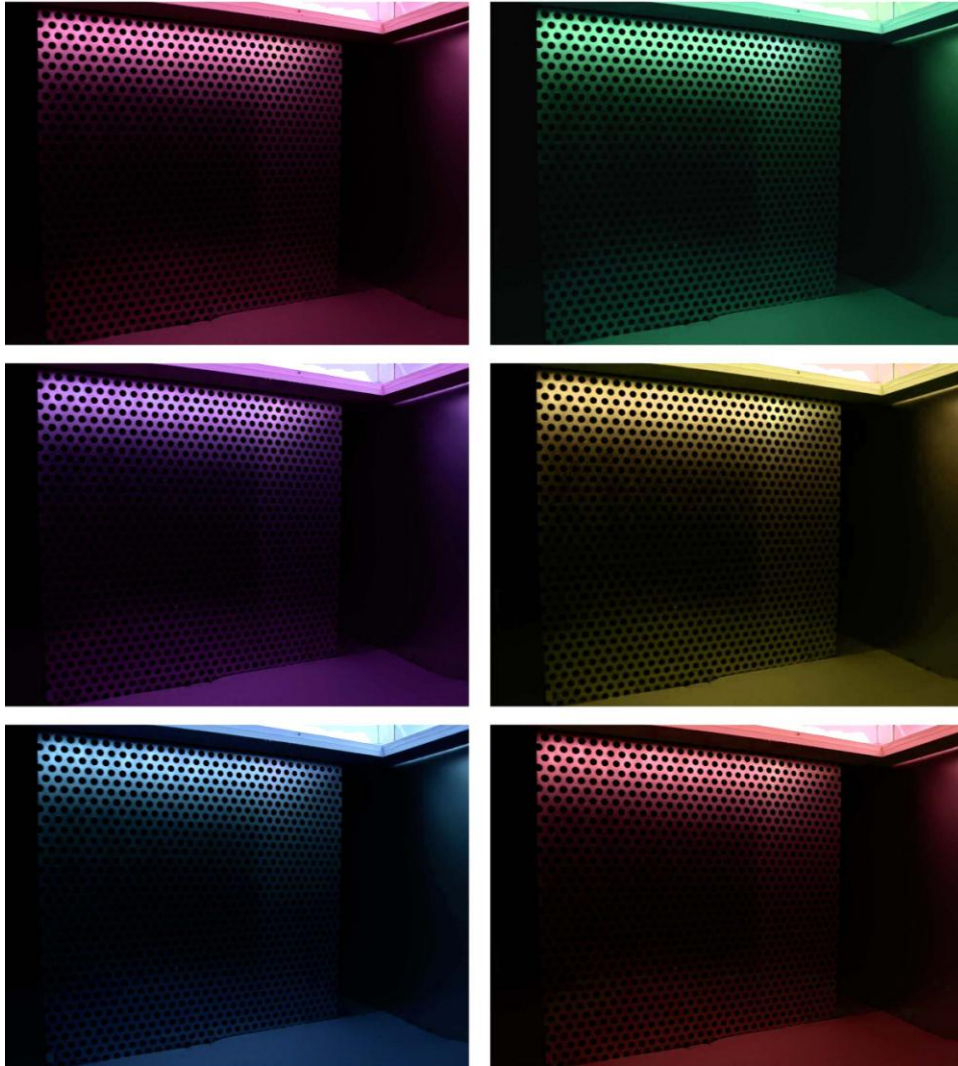


Figure 6.56: Perception created with a changing colour sequence on Private Area Near Window (Gültekin, 2014).

In contradiction to specular division element, translucent division element offered a softer and calmer atmosphere through soft diffusion of colours. The consequences resembled LOFT MV from the research, re-shown on Figure 6.57. Unlike specular division element, the atmosphere gained a vivid expression of liveliness with coloured light. As it could be seen from the photographs on Figure 6.58, the perceived atmosphere was strong but relatively softer and calmer when compared to Figure 6.56.



Figure 6.57: Perception created with multicoloured light application at LOFT MV, Brussels (Url - 67).

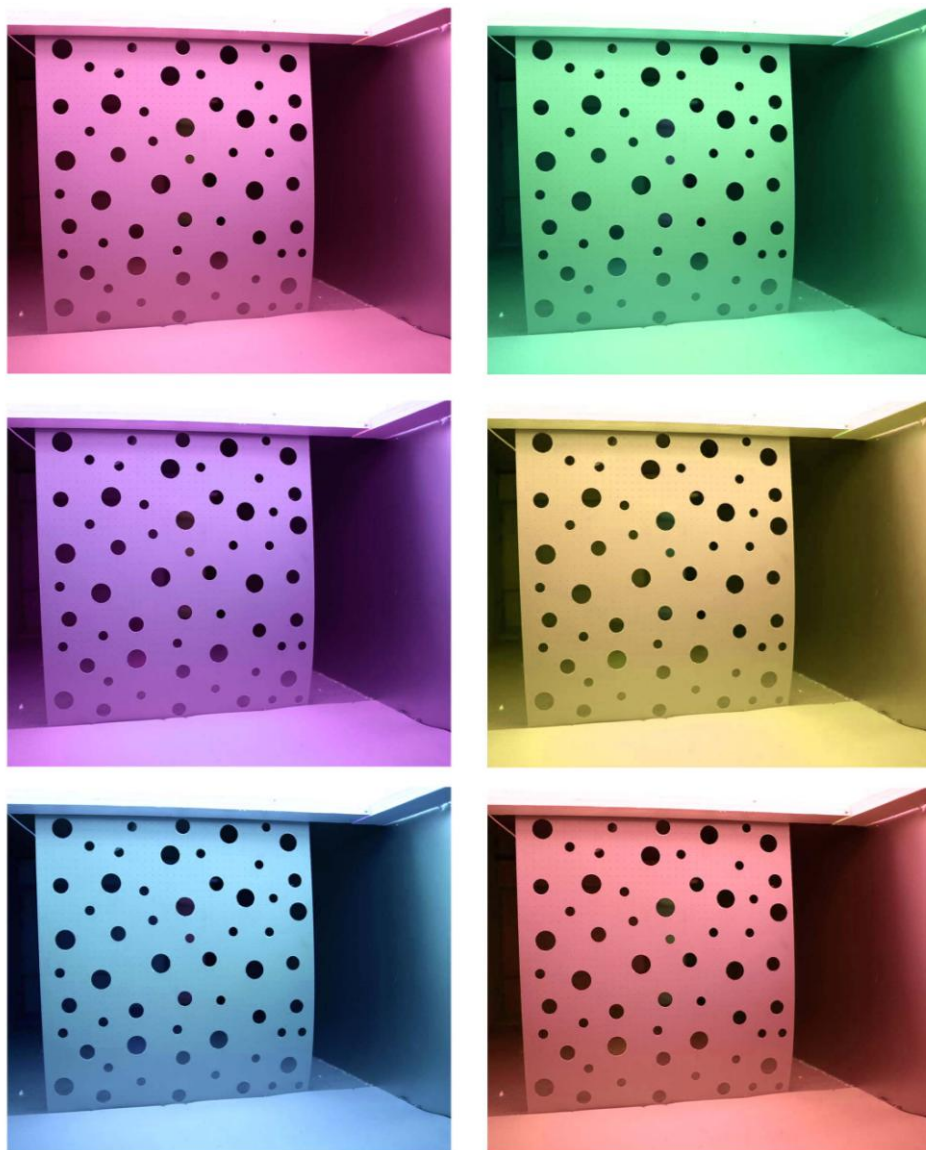


Figure 6.58 : Perception created with a changing colour sequence on Private Area Near Window (Gültekin, 2014).

- ***Application of warm colour temperature of white light above Private Area Near the Entrance with a very narrow beam and low intensity***

For the area sensation of intimacy, isolation and relaxation are the core perceptual points. From the research it can be summarized that impression of privacy is created with relatively lower levels of uniform illumination in user's zone and high non uniform illuminance level on walls as proposed by Flynn (Gordon, G., 2003). So that, Flynn's theory about keeping intensity of light in a very low level on the occupant's zone and non-uniformly brighter in the area surrounding the occupants - as re - shown on Figure 6.59 - is considered. Having high intensity of light on user's area would not be helpful to create impression of privacy. If the space was supposed to be used for another task such as reading or eating, ceiling mounted downlights would be suitable. However, for a spiritual contemplation room, with such a setting, the people would be highlighted or exposed and the atmosphere would be uncomfortable.

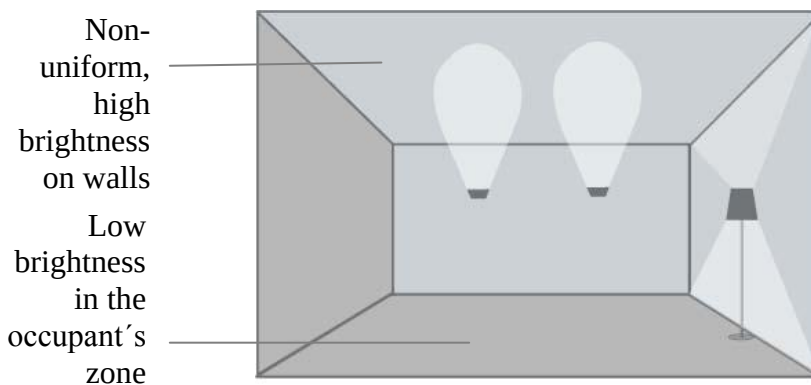


Figure 6.59 : Non-uniform, high brightness on walls surrounding the occupants and low brightness in the occupants' zone to achieve Privacy (Gültekin, 2014).

Need for Discernability is one of the most required Biological Need for a perceived surrounding environment. The interior space should be sufficiently visible for people to see and to perceive (W. M. C., Lam, 1977). So that, discernability of elements such as seating areas or furnitures is important for people to clearly orient themselves.

For the Spiritual Contemplation Room it can be said that not everything should be completely visible. Sustaining sufficient visibility of every single element in space would be uncomfortable as it would weaken the impression of the spiritual atmosphere. However, seating areas for example needs to be highlighted. It is possible to lead people in an interior space and guide them to follow a path. On Figure 4.8, from section 4. *Perception of Artificially Lit Interiors*, light is spread upward, forming a pathway to lead the occupants to the hotel lobby. Here, spatial distribution of light helps defining spatial borders and emphasising architectural elements in interiors (Figure 6.60).



Figure 6.60 : Indirect – concentrated upward light distribution forming a pathway to lead the occupants, Nhow Hotel, Milan, Italy (Lightlife, 2011).

In order to lead people to seating elements, downward concentrated lighting with very narrow beams are suggested. For Private Area Near Entrance, if it is assumed that there are some seating equipments in the space, highlighting them is suggested to attract people's attention. Figure 6.61 shows the setting without orientation lights. For this setting, the seating elements in the back of the room are not visually perceived (Figure 6.61). As mentioned before, the minimum value required for recognizing facial features is 20 lux (IESNA, 2000). Inside such a space people would not even realize there is a seating area. With concentrated downlights however, the cubes are emphasised with a very low intensity. Lighting the seating areas even with a low intensity would be enough for clear orientation (Figure 6.62).



Figure 6.61: Seating area in Private Area Near Entrance left in dark
(Gültekin, 2014)



Figure 6.62 : Seating elements highlighted with very narrow beams of warm white
light (Gültekin, 2014)

Even the floor can be highlighted to define a seating zone in a given area. On Figure 6.63, light beam is creating a spatial zone for people to contemplate. Locating themselves inside the zone people would also get the impression of being in their

own restricted territory. So, impression of personalisation and privacy would be achieved at the same time.



Figure 6.63 : Seating area enhanced with only light beams (Gültekin, 2014)

6.7. Resume of the results and suggestions for artificial light experiments

Results of the lighting experiments that were successful at achieving a spiritual, private and tranquil contemplation atmosphere are summarized as :

- Enhancing Assembly Area with a play of shadow of warm white light,
- Enhancing Private Area Near Window with indirect RGB LED's for relaxation and separation,
- Enhancing Private Area Near Entrance with non-uniform concentrated, lighting with very low intensity to emphasise seating area.

First of all , the reason why the listed experiments were successful at maintaining a spiritual contemplation atmosphere for each experiment is explained. Then, suggestions to improve the atmosphere and maintenance of spiritualism on,

- Private Area Near Window
- Assembly Area and

- Private Area Near Entrance for each experiment are made in this section.

Enhancing Assembly Area with a play of shadow of warm white light was the most suitable option to highlight Assembly Area because of the spiritual impression created with shadow play. Before, when the meditation circle is enhanced with direct and indirect light sources (Figure 6.64) impression of privacy was weakened. With shadow play however, general illumination intensity is lower and sensation of spirituality is stronger (Figure 6.65).



Figure 6.64 : Direct and indirect light distribution (Gültekin, 2014).



Figure 6.65 : Shadow plays on 1/10 scaled model (Gültekin, 2014).

- Affect of *Enhancing Assembly Area with a play of shadow of warm white light* to Private Area Near Window

When the interior is lit artificially via back lighting of special wall structure, on Private Area Near Window, the perforated metal room divider acted as a source of glimmer as it can be seen in Figure 6.66. Shadows created on the walls and floor supported the spiritual atmosphere of the area (Figure 6.67).

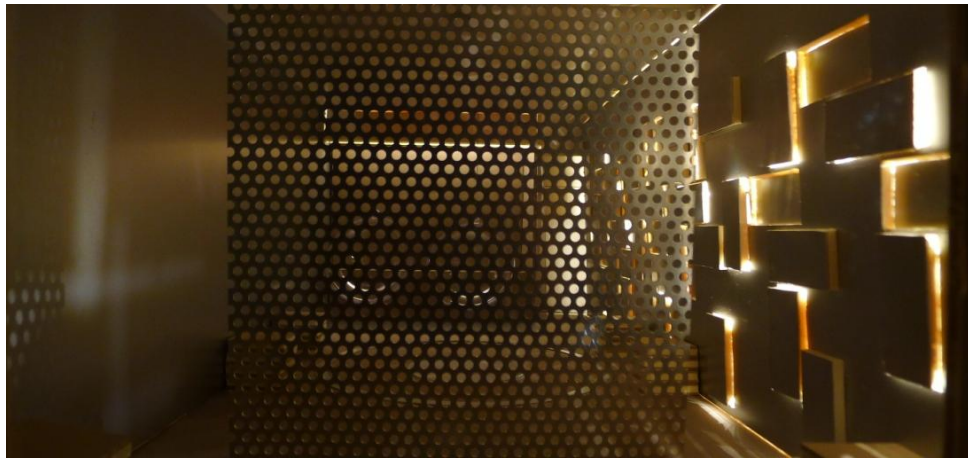


Figure 6.66 : Shadow plays on Private Area Near Window, 1/10 scaled model
(Gültekin, 2014)



Figure 6.67 : Room separation system composed of metal creates shadow plays
(Gültekin, 2014)

Enhancing Private Area Near Window with indirect RGB LED's for relaxation and separation

In the experiments, the area was highlighted with only upward distribution of light on the ceiling. (Figure 6.68). However, when the only light source in the room was uplighting, brightness contrast difference was too intense. With metal room divider the space was perceived as confined and disturbing rather than spiritual. Metal division element has specular reflection , so brightness contrast achieved was sharper when compared to translucent division element. Translucent material had better transmittency with diffuse reflection so, the light was distributed more evenly penetrating to the whole space. So that, the perceived atmosphere was calmer and more relaxing (Figure 6.69).

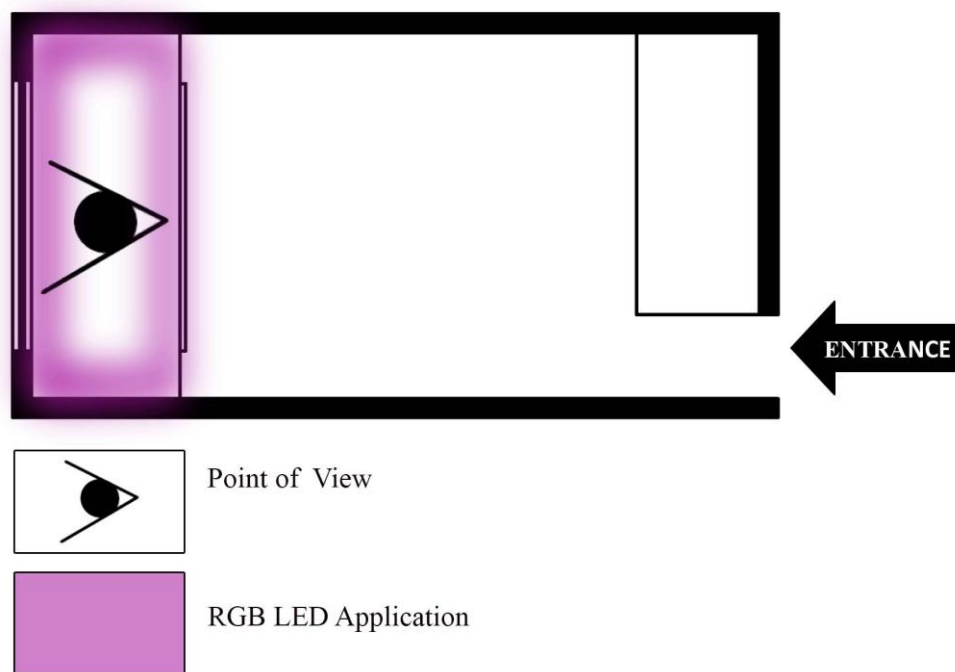


Figure 6.68 : Private Area Near Window (Gültekin, 2014)

To decrease high brightness contrast difference and increase the impression of a calmer atmosphere, upward indirect light distribution was kept as it is and the area is re-observed with additional lighting of specific wall structure (Figure 6.70). On Figure 6.70, it can be seen that when other light sources are involved, the perception created is much more softer and calmer. Specular division element's sharp effect is

softened. Intensity of coloured light is in balance with general lighting. Intimacy requirements of the Private Area Near Window is managed with specular division element and changing soft colour tints of light. Also, from Figure 6.70/2, it can be seen that coloured light is not interfering with the general lighting of the room.



Figure 6.69 : Perception of specular division element versus translucent division element in Private Area Near Window with indirect distribution of light (Gültekin, 2014).



Figure 6.70 : Coloured upward direct lighting and other light sources with specular room division element on Private Area Near Window (Gültekin, 2014)

For translucent division element, perception achieved on *Private Area Near Window* is quite different with the additional light source. Figure 6.71/ 1 and Figure 6.71/2 show the Private Area Near Window while Figure 6.71/2 shows the view from the entrance. The whole space has a soft pink colour when looked from the entrance. Because, diffuse reflection of indirect light sources on the ceiling, transmits light to the whole space. As shown on Figure 6.71/1, the light rays bounce from the translucent material penetrating into the space resulting the walls and the ground to have a pinkish colour. Metal doesn't let the light penetrate through itself, so when looked from the entrance gray metallic surface of the metal and then the pink coloured background is perceived (Figure 6.71/2).

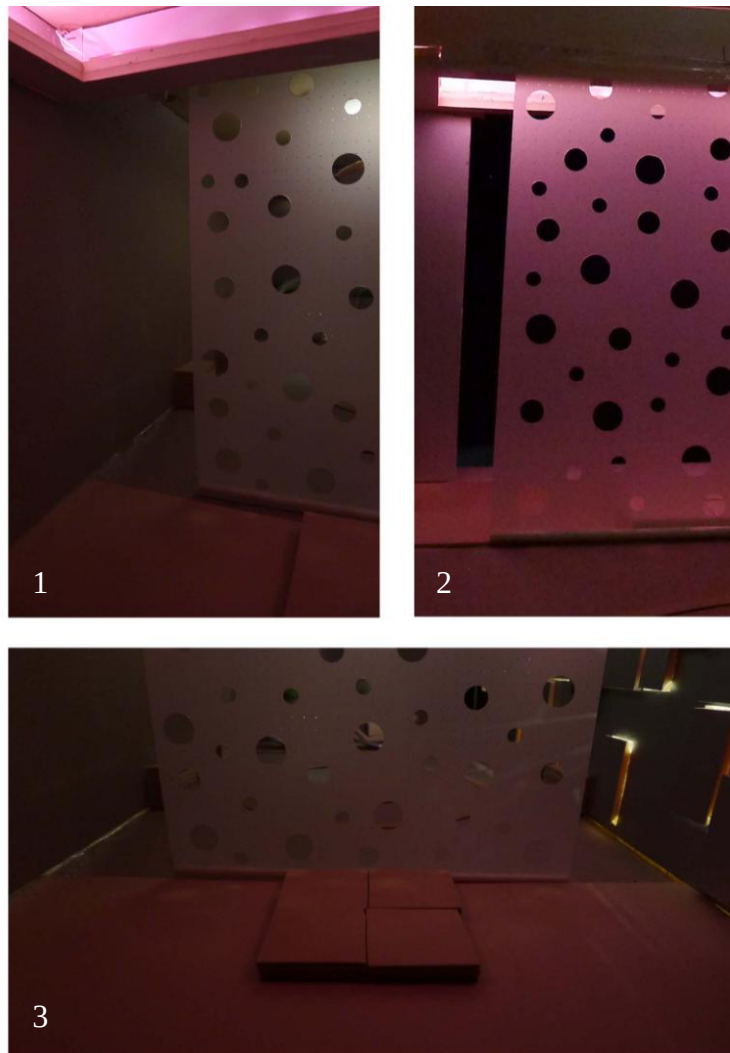


Figure 6.71 : Coloured upward direct lighting and other light sources with translucent room division element on *Private Area Near Window* (Gültekin, 2014).

Perception of the area is completely different under the same lighting setting when a single material is changed. Specular material is reflecting light causing great brightness contrast differences as well as shadow plays in space. However, translucent material is diffusing light equally in all directions. Translucent material, transmits the light through itself to the room. Right inside the Private Area however, the division element is perceived as a whitish pink because it has low reflectancy but high transmittancy. So, when looked from the entrance soft penetration of pink through the translucent material causes the room to be pink. In other words, coloured light is interfering with the general lighting of the whole room if the room divider is made of the translucent material (Figure 6.71/2).

When two different effects are compared, specular material created a more spiritual atmosphere on Private Area Near Window as people are able to contemplate under a magical shower of light. Also, right from the entrance people are attracted to the space with the changing light composition, but clearly see the people contemplating in *Private Area Near Window*. So metal perforation, would also help to protect private territory of the occupants near the window.

- Affect of *Enhancing Private Area Near Window with indirect RGB LED's for relaxation and separation* to Private Area Near Entrance

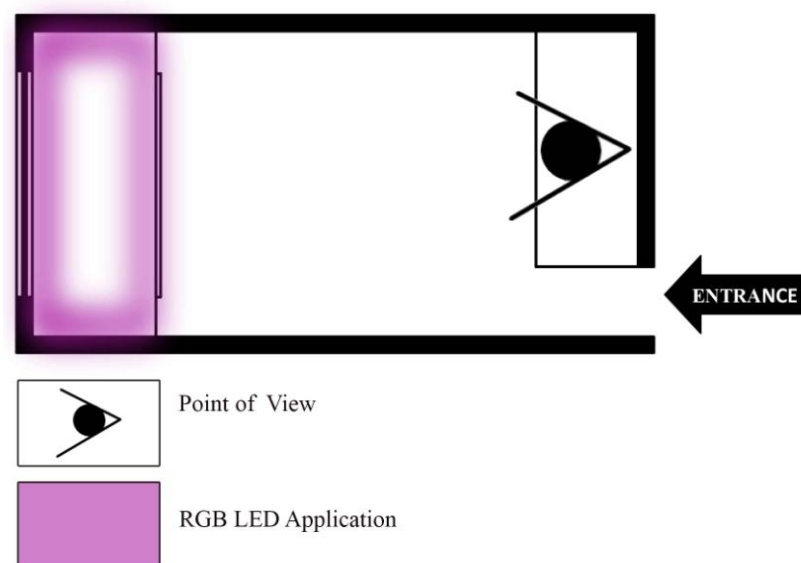


Figure 6.72 : The point of view of Private Area Near Entrance and RGB light application (Gültekin, 2014).

According to the lighting setting on rest of the room, the perceived atmosphere from Private Area Near Entrance will be changed. If the only light source will be upward indirect coloured lights applied above Private Area Near Window as on Figure 6.72. Private Area Near Entrance will be darker and the perceived atmosphere will be sharper and more intense (Figure 6.73).

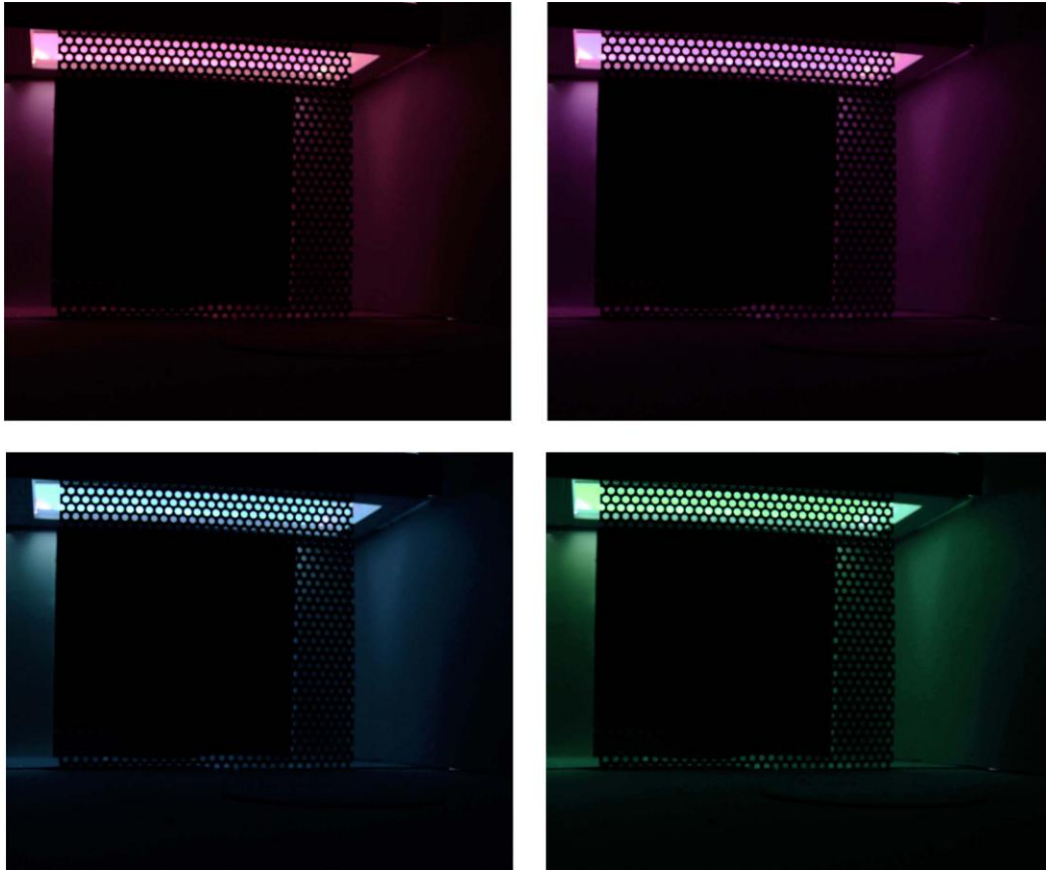


Figure 6.73 : Perceived night atmosphere from the point of view of Private Area Near Entrance with only upward indirect lighting on Private Area Near Window (Gültekin, 2014).

However, when the light from backlit wall structure is also added, the perceived atmosphere will be calmer with a more relaxing setting. Because, the colours will be perceived as softer and the atmosphere will be more spiritual (Figure 6.74). Changing surface textures will also affect perceived levels of brightness contrast. Perceived atmosphere will be different with different textures. Translucent room divider creates a completely different perception when compared to metal room

divider. Translucent material diffuse light into the space providing a colourful atmosphere. Transmitted light is destroying shadow interplays of backlit wall. So, the atmosphere achieved is quiet different. From Figure 6.74 and Figure 6.75, differences between percieved atmospheres can be observed.

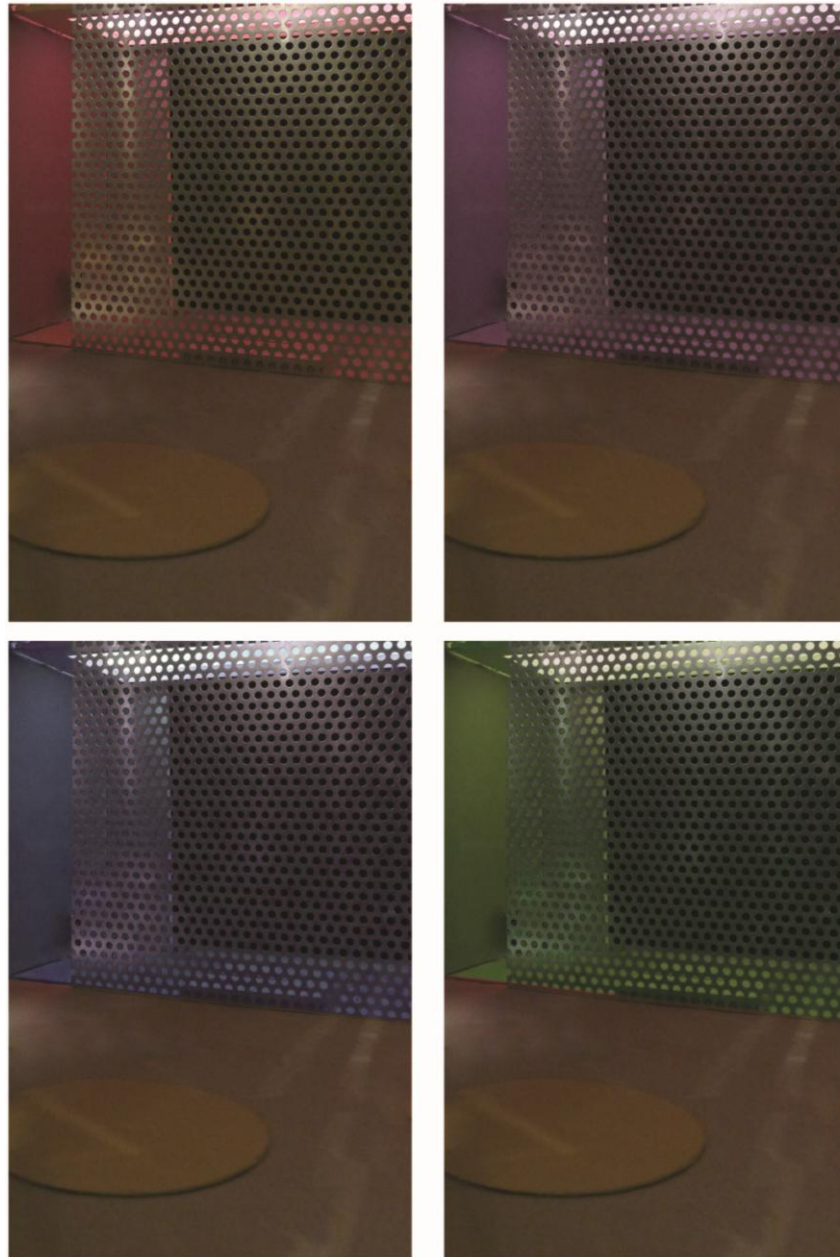


Figure 6.74 : Percieved night atmosphere under a coloured light sequence, from the point of view of Private Area Near Entrance with upward indirect lighting on Private Area Near Window and light from backlit wall structure (Gültekin, 2014).

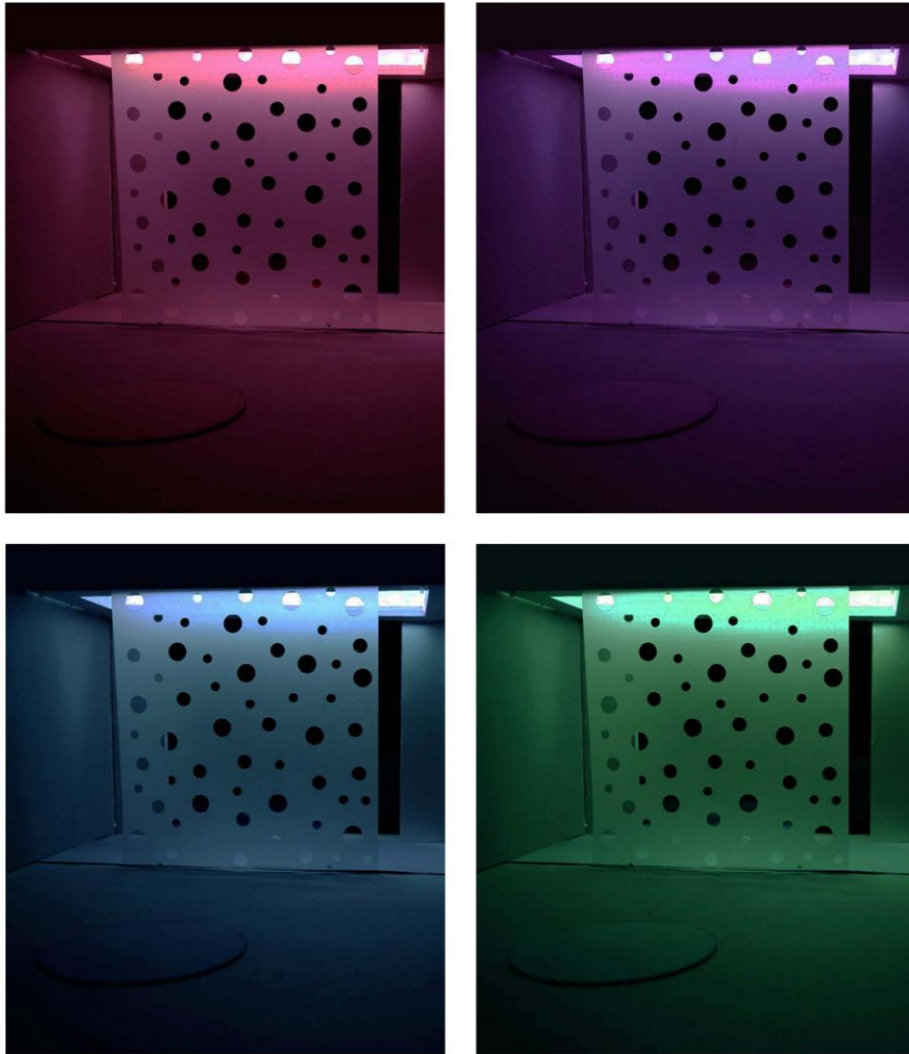


Figure 6.75 : Percieved night atmosphere from the point of view of Private Area Near Entrance with only upward indirect lighting on Private Area Near Window and translucent room divider (Gültekin, 2014).

Enhancing Private Area Near Entrance with non-uniform concentrated lighting with very low intensity to emphasise seating area

As it was explained before, Flynn’s theory about keeping intensity of light in a very low level on the occupant’s zone and non-uniformly brighter in the area surrounding the occupants was the best option for the Private Area Near Entrance. High intensity of light right above the users would destroy impression of privacy according to Flynn (Gordon, G., 2003). In contradiction to secrecy, people would feel like being exposed.

For artificial light atmosphere of Private Area Near Entrance, if the area is not sufficiently visible, to orient people, application of downlights with very narrow beams and low intensity was suggested for clear orientation (Figure 6.76).



Figure 6.76 : Downlights with narrow beams and low intensity (Gültekin, 2014).

Keeping the area without any additional light source would be better if there are any other light sources near by. When the wall structure is backlit with low intensity of warm white light, the general lighting of the room is sufficient to see and perceive the space. So without any other light source, keeping the area as it is would be a choice (Figure 6.77).



Figure 6.77 : Private Area Near Entrance is sufficiently visible via shadow plays (Gültekin, 2014).

7. CONCLUSION

The perception of the interior space and light could not be thought separately. If there is light in the space, people see, feel and perceive the space. Because of the result of illuminated space one can assess the impact of a space. This study aimed to find out impact of light on shaping people's perception in interiors. Functional tools of visual perception such as required illumination level for the specific task, intensity of light source or light reflectance of interior surfaces have generally been given great importance. However, psychological perception is not given much importance. There are many studies on affects of physical qualities of light on people, but very few studies about light's impact on visual and psychological perception of people and spatial experience. During the research impact of light on shaping people's perception was investigated through examples.

Sun has uncomparable influence on human life. Imbalanced rhythms of sun cause several health problems on people such as Circadian Rhythm Disorders and psychological problems. Consequently, interiors people live in are effected by unique characteristics of daylight. Relationship of daylight with spatial qualities of the space such as materials and openings are noteworthy in this regard. All those interactions change atmosphere / spirit of a spatial enclosure and perceptual reactions of the occupants within an interior.

Physical properties of light are explained in relation to visual and psychological perception. Spatial perception is influenced by the properties of artificial light physically and mentally. Especially artificial lighting design of an interior space needs to be planned considering the perceptual reactions of humans, simply because it is not naturally exist, it is artificial. Before traditional lighting scenarios were focused on only physical quality of artificial light sources. Nowadays, this idea started to change and a new perception oriented approach is also started being considered. Learning basics of perception oriented lighting established by lighting design professionals like Flyn and Kelly led to an understanding of importance of planning lighting design of an interior considering perceptual reactions of humans. This will make it possible to achieve desired interior lighting moods and impressions as well as opening up new areas for artificial light applications.

Four building types are investigated under two groups : *Function oriented* and *Atmosphere oriented* interiors. On this section integration of artificial light and daylight is investigated on several buildings. Each building is visited and observed on site. Visual experience and visually perceived qualities of the spaces and psychological experience of spatial atmospheres in association with lighting setting is investigated for each group. For all four buildings lighting has a special role on shaping people's both visual and psychological perception even if they represent different functions and designs. In general, the observations showed that, lighting design needs an individual adjustment according to its specific circumstances, such as the function, contrast, size and shape of the interior. When people's psychological and visual perception are considered together, the consequences are most satisfying. So that, no matter if the interior is function or atmosphere oriented; light, space and perception of the people should be considered together to improve the atmosphere of an interior space. Even if the interior is function oriented, considering psychological perception and spatial experience as well as visual perception helps to create more satisfying interiors.

Until then, the study was concentrated on existing interiors with lighting design solutions. In order to practise theoretical information derived from the research concluded above, on section *Experimenting possible lighting situations of a spiritual contemplation room*, (under titles of Daylight experiments and Artificial light experiments) two groups of experiments are done.

The lighting requirements of a conceptual spiritual contemplation room has been chosen for the tested settings because of the numerous examples of spiritual interiors designed with daylight and artificial light investigated in this study. Variety and vividness offered by daylight creates strong impressions in interiors affecting people's psychological perception. The results showed that rapidly changing quality of daylight, makes it impossible for a daylighting system to offer static solutions as artificial lighting systems do. Opening types, geographical location of the building, cultural background of the occupants and functional requirement expected from the lighting system have significant affects on shaping people's perception. For artificial lighting, however, there are several quantitative data and information that one can

implement to the required space. To create an impression or to direct people's perception with artificial light requires a much more complex process and plenty of experiments than daylight involving psychological aspects. Light reflectance and transmittance of surface textures have utmost importance for both daylighting and artificial lighting settings. Properties of materials re - shape the interior, increase the intensity of perceived light as well as subjective impressions.

The experiments are done on 1/10 scaled model. The outcomes of the study could be converted to 1 / 1 scale to achieve an other aspect. People could be observed during contemplation under different lighting scenarios. The occupants' perceptual reactions might be examined via surveys for each different lighting proposal to achieve a more satisfying spiritual contemplation atmosphere.

Light is a powerful tool to manipulate people's emotions affected by both subjective and objective dynamics. The study could be assumed as a pre - study for following research topics related to perception and light. It could be a starting point to start asking questions about light's power on shaping subjective impressions, emotions and spatial perception.

The study shows that understanding of an interior space shifts between the physical space and the perceived space. As Sullivan says form and function always belong together. However, light needs to be planned following the functional requirements of an interior space as well as human emotions. So that, the more is known about the effects of light on shaping people's perception in interiors the better solutions will be created to design physiologically and psychologically more satisfying interiors. This way, the spatial experience will be improved as well as well - being of people.

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