

Lighting in urban heritage:
case study of Chiapa de Corzo, Chiapas, Mexico

Dissertation

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Introduction.

“Architecture is the masterly, correct and magnificent play of masses brought together in light. Our eyes are made to see forms in light; light and shade reveal these forms; cubes, cones, spheres, cylinders or pyramids are the great primary form which light reveals to advantage; the image of these is distinct and tangible within us and without ambiguity¹”.

In recent years has increased the interest of lighting the urban heritage as strategy to improve the urban image and the economy of cities. Today lighting projects are being conducted by the use of technological advances in the field of lighting, which could help to highlight special features of architectural objects, among other benefits. On the other hand, if lighting is used inappropriately, it could produce irreversible damages, which can be avoided if the light designer takes into consideration important aspects, like those which are mentioned in this research.

When speaking about lighting in urban heritage, we refer to the architectural illumination of those historic buildings and monuments that integrate the heritage of a city. This lighting can be interior and/or exterior, depending on the needs of a project and the characteristics of the work. Although this research focuses on architectural exterior lighting, explains different types of lighting and its applications in architecture, features and differences between them this in order to clarify and establish concepts, which will allow us to approach to the topic of the current research, and therefore to have a better understanding of it.

This research presents an analysis of the lighting’s problematic in the urban heritage, beginning with the causes and consequences that the inadequate lighting generates in historic and/or emblematic structures, as well as in the environment. In order to understand the new trends in lighting design and its development, a study of lighting’s history was conducted, followed by the aspects to consider in the design of lighting, proposing a methodological basis for the illumination. Subsequently the case study is addressed, with the intention to illustrate the aspects described in this research. For this, it was decided to take as a case study two architectural works that integrates the urban heritage of the city of Chiapa de Corzo, Chiapas (*Mexico*).

This research is divided into three parts; two approaches and the case study. The first one refers to the conceptual approach, which is integrated by one chapter, named Topic’s definition. The second one is the contextual approach, which is comprised by two chapters;

¹Le Corbusier 1931, 29.

history of lighting and factors to consider in outdoor lighting design. The last part is the case study, where two examples were studied. This part is integrated by two chapters; case of study and the proposal of outdoor lighting.

Part 1.

Chapter 1: Topic´s definition.

1.1 The choice of study field.

The lighting in historic buildings and monuments has been used as a tool to enhance nocturnal image of cities. While it is true that this practice has been done about 100 years, in the last two decades has increased its use as urban strategy. However, today the topic of architectural lighting generally has been approached and studied by international organizations, like the International Dark-Sky Association (IDA) that seeks to create awareness in the preservation and protection of the nighttime environment.

In contrast to the above, National agencies responsible for the protection of urban heritage of Germany, France, India, Mexico, Thailand, USA, among other countries, and also international organizations like the United Nations Educational, Scientific, and Cultural Organization (UNESCO), International Council on Monuments and Sites (ICOMOS), International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) and the Organization of World Heritage Cities (OWHC), apparently do not consider lighting as an activity that warrants particular attention, because, until now, there are no rules, guidelines or methodological bases for proper lighting in historical sites. This is in spite of the fact that the lighting of urban heritage is an action which takes place directly on the works. A possible reason that explains this could be that; until today from the field of urban heritage, there are not studies and/or research that approach the consequences of lighting improperly historic structures, its damages, possible outreaches and repercussions, not only on the environment but also in the work itself. Due to the lack of knowledge in the field of lighting in urban heritage, it was decided to orient this research in this field.

One of the most important aspects of this research is the creation of a scientific methodological base for the illumination of historical sites, which so far is lacking. With this, the current research seeks to contribute to the knowledge in the field of architectural lighting of urban heritage and also its protection, starting from the hypothesis that lighting is a tool that promotes the appropriation of spaces and architectural objects, which also could work as a connecting element between the culture of the past and the present, being the driving force that allows to the people to identify them with the architectural work, and in this way to reinforce the identity of the cities.

1.2 Research questions and the goal of the dissertation.

International organizations responsible for protecting historic sites, usually set the standard for the creation of laws and regulations of each country in the field of conservation of the national heritage. These laws prevent for example that, in an arbitrary manner; actions that endanger the physical integrity of historic buildings and monuments, through mutilation or even additions of architectural elements. However nothing is mentioned about the possible risk of an inadequate lighting, not just from the point of view of structural damage, but also from alterations in the perception of the work, therefore, one of the questions in this research would be; is it possible to alter negatively the image of historic buildings and monuments through inadequate lighting to the degree of distorting the perception that people have of the work? And if so, what are the causes that generate it? The answers will help to demonstrate the importance of a proper lighting, and therefore the need to establish standards at national and international level, in order to regulate lighting projects in historical sites.

Today, practically all over the world there are people who are dedicated to architectural lighting, and have carried out projects in historical sites; however, do these designers take into consideration criteria to protect not only historic buildings and monuments, but also the environment? Regarding to the work, what are the consequences that may generate the inadequate lighting of urban heritage to the environment? These query lead us to question, then what are the factors to consider for a proper illumination of urban heritage?

The above questions lead us to set the main goal of this research; to establish a scientific methodological base for lighting in urban heritage. In order to achieve it, it is necessary that using a conceptual approach to establish and define the differences between lighting concepts in the context of urban heritage. As well as through a historical approach, to study the history of the lighting concept and its transformations, this with the intention to give a clearer understanding of current trends in lighting design in historic buildings and monuments. Another goal is to propose a set of lighting principles that contribute to the urban heritage conservation.

The answers to the research questions, as well as the development of the goals will help to demonstrate that, it is possible to reconcile the architecture of the past, environment and technology, this without harming the epidermis and the image of the buildings and monuments. It will be also proved that it is not necessary to illuminate the entire work to highlight its architectural character.

1.3 Methodology.

1.3.1 Research approach.

As was mentioned in the introduction, the research is divided into three parts. This in order to understand more broadly the research object, for it was divided into two approaches and at last was boarded the case study. The approaches are integrated by conceptual and contextual approach.

- Conceptual approach.

The purpose of this approach is to clarify the concepts that have been used and to define in what sense are handled along the research. Through a deep theoretical support, this approach will help us to understand conceptually the object of study.

- Contextual approach.

The aim is to place the object of study in a given context. In this case through the historical context we can have a clear idea of it throughout its development along history and thus understand it.

- Case of study.

Finally at this point is where conceptual and contextual approaches converge. Together give a more precise idea of the object of study. To place it specifically in a particular case helps to understand it more broadly and thus corroborate and discard ideas or even theories.

The research was conducted under a qualitative approach since this methodology supports theories based on praxis and personal interpretations. This approach helps to understand and to describe not only the object but also the context that influences it. The main objective of qualitative research is to bring the researcher into the world to understand, describe and explain the phenomena from inside².

All the above was mainly achieved through two analyzes, which were:

- Analysis of experiences of individuals or groups.

In this case it was studied the experiences of lighting experts from different countries, in order to understand the complex world of lived experience from the point of view of those who work directly with architectural lighting in a context of urban heritage.

- Analysis of texts, images and videos related to the illumination of monuments and historic buildings.

²Flick2007, 8.

Under a constructivist approach, both analyzes look for as a main aim build the knowledge, taking into consideration the fact that perceptions of reality may change throughout the process of study³. This gives a broader overview of the topic and enriches the results. These two studies were used as a way of analogy to a possible solution to the issues raised in the field of lighting in urban heritage.

The data and knowledge acquired were used to develop the structure and questions for interviews with experts in the area of lighting in urban heritage.

1.3.2 Interviews.

This tool was especially highly relevant to the research because it was sought to obtain the knowledge and experiences of the interviewees regarding lighting in the context of urban heritage, and also to determine if lighting projects are being made under a perspective of environmental protection. The interviews conducted were technical.

The criterion for the selection of experts to interview is shown below.

- Professionals dedicated to the field of lighting design.
- Experience in lighting projects in monuments and/or historic buildings.
- Priority was given to those designers who are recognized internationally for their works by associations like; Illuminating Engineering Society (IES), International Association of Lighting Designers (IALD), International Commission on Illumination CIE.

The experts interviewed were chosen from 3 different continents and from 5 countries, in order to know their experiences in the field of lighting in urban heritage.

Sample Integration				
Continent	Country	Name	Profession	Design experience
America	Mexico	Enrique Quintero	Architect	31 years
	USA	Paul Marantz	Architect	55 years
Europe	France	Victor Meesters	Architect	6 years
	Germany	Gordon Selbach	Architect	6 years
Asia	India	Jaspreet Chandhok	Architect	12 years
		Vilas Prabhu	Electrical Eng.	26 years
	Thailand	Dr. Acharawan Chutarat	Architect	20 years

Table 1⁴. Sample integration of interviews.

³Mertens 2010,18.

⁴Own elaboration.

The interview revolved around four main points, as it is shown below.

- To define the concept of lighting in the context of urban heritage.
- To determine which factors influence the process of exterior lighting design.
- To determine if current lighting projects provides as an aim the protection of monuments and buildings.
- To know if there environmental protection measures are implemented in lighting projects.

1.3.2.1 Interview structure.

- Duration.
30 – 45 Min. aprox.
- Registration Technique.
Electronic Recording.
- Technique of report.
Structured summary of the questions on paper.
- Place, date, time.
Skype was used as a tool for the interview. Date and time was determined by the expert.
- Call.
 - a) Was contacted via email.
 - b) Email was sent to formalize the conditions of the interview.
 - c) Reminder via email was made one day prior to the interview.

Interviews were planned systematically. Electronic recorder was used as a registration technique with the agreement of the interviewees. All interviews were transcribed.

1.3.2.2 Questions.

Through the following questions are sought; to define concepts, to determine the current state of lighting projects and learn about new trends and challenges that must be faced by lighting designers.

1. How would you define lighting in the context of urban heritage?
2. What are the factors that you considered in the design of outdoor lighting in urban heritage?
3. How could the surrounding context help or obstruct the lighting design?
4. What theoretical conservationist criteria do you apply for the protection of urban heritage in your lighting designs?
5. What measures do you implement to avoid light pollution?

6. What is your opinion regarding the use of media facades or video mapping?
7. What is the new trend in lighting technology of urban heritage?

The information collected from the interviews was processed by the software Microsoft Office Excel 2007, in order to translate the obtained data into percentages, which are found in chapter 3. This helped to reinforce and clarify concepts, and to determinate which factors most be considered in any lighting project in the context of urban heritage.

1.4 Conceptual approach.

1.4.1 Lighting in architecture.

“Light has always been recognized as one of the most powerful formgivers available to the designer, and great architects have always understood its importance as the principal medium which puts man in touch with his environment”⁵

Light plays an important role in the life of human being. Through it we can appreciate the natural and artificial environment around us, see their different colors and perceive their spaces and forms. Therefore light is essential to obtain the necessary information⁶ to develop any human activity.

The development of human activities depends directly on light, but what happens when the night appear? Or when we are inside of closed spaces without any source of light? Inevitable, in the darkness objects lose their shapes and volumes, affecting notoriously the visual performance and as a consequence of it human activities are also affected. Against this condition and in order to counteract the lack of light, the human being creates technology and also new areas of knowledge as the lighting field.

Lighting is based on a systematically structured set of knowledge from physics (optics), chemistry (materials´ behavior), psychology (perception) and philosophy (aesthetic), to study different forms of production, control and light´s applications. Its applications within architecture are wide as the architecture itself. It can be classified according to:

- Architectural space.
- Architectural object.

⁵Lam 1992, 10.

⁶The eye is the most important sense organ in the human body, handling around 80% of all incoming information. Without light, that would be impossible (Licht.wissen 2008, 4).

This classification is given within the framework of any urban context, however this research focus in the historic urban landscape⁷, specifically integrated by buildings and public spaces with historic values, as well as monuments.

1.4.1.1 Architectural space.

Space is boundless and it is a three-dimensional extent in which objects and events occur and have relative position and direction⁸. In architecture, referring as a physical space, it is the three-dimensional scope where volumetric forms are expressed with a particular intention.

Within architectural space and in terms of physical aspects, we found that there are two different spaces that integrate it. They are known as the interior and exterior. The first one refers to the space contained by walls, roofs and floors. It means that the interior space is materially defined by volumes, this with the main intention of harbor in human activities. In contrast, the exterior refers to that space which lacks of roofs. In other words, it is located outdoors. Lighting responds to this physical classification of architectural space, therefore we found interior (also known as indoor lighting) and exterior lighting (or outdoor lighting).

1.4.1.1.1 Interior or indoor lighting.

Each interior space designed to be used in order to perform any human activity has its own functional and spatial characteristics, which are crucial in lighting design. Therefore and as the name denotes interior lighting is responsible for providing adequate light to ensure visual comfort and a well-disposed psychological environment, which influence the way how tasks are developing.

To determine the quantitative and qualitative aspects of interior lighting, there are standardized recommendations, like those made by Illuminating Engineering Society of North America⁹ (IESNA), who based on different studies has published their suggestions of light

⁷The historic urban landscape is *“the urban area understood as the result of a historic layering of cultural and natural values and attributes, extending beyond the notion of “historic center” or “ensemble” to include the broader urban context and its geographical setting”*(UNESCO 2012, 52).

This wider context is integrated by physical aspects of the site such as its topography, geomorphology, hydrology, etc., as well as its built environment (historic and contemporary), its infrastructures, open spaces, land use patterns and spatial organization, perceptions and visual relationships. It also includes social and cultural practices and values, economic processes and the intangible dimensions of heritage as related to diversity and identity (Idem).

⁸Encyclopaedia Britannica 2014.

⁹The light levels recommendations made by IESNA are published in Lighting Handbook 2000. These suggestions are applicable to any interior space.

levels for different human activities, as well as aspects that should be taken into consideration to improve visual comfort¹⁰. These aspects are mentioned as follows.

- To identify the visual tasks to be performed and then determine the characteristics of the lighting needed to allow a high level of visual performance of the tasks.
- To eliminate flicker from the lighting.
- To reduce glare through lamps selection and placement.
- To consider the density and extent of any shadows.
- To reduce reflections.

As we can see the studies and recommendations are mainly centered in visual tasks and lamps (selections and placement). The aim undoubtedly is to generate a propitious environment to develop any specific human activity. To achieve this environment is also essential that objects that are in interior spaces maintain four attributes over any lighting conditions. These attributes are: Lightness, color, size and shape. The lighting type normally used to keep them is the horizontal¹¹ lighting.

1.4.1.1.2 Exterior or outdoor lighting.

In the absence of natural light during the night, along with the needs for outdoor activities, as well as security, have been the main causes that have motivated to the specialists to create artificial ways of exterior lighting. Then we can define that outdoor lighting is the fact of provide illumination to those spaces without roof.

Regardless of the urban context, the main objective of outdoor lighting is similar to interior lighting, i.e. to provide artificial light in architectural spaces at times when natural light is scarce or absent. There are differences between them beyond spatial characteristics, therefore their applications are varied. These differences are mentioned below.

- Outdoor Lighting in contrast to the interior is not designed to create enabling environments where a single task can be performed. Usually in the outdoor spaces various activities take place. Therefore there are different visual requirements and as a consequence also luminous.
- In indoor spaces are lighting levels generally higher than outdoor, because as it was previously mentioned, in interior are performed specific activities which normally require more lighting intensity. However there are cases in outdoor, like sports areas

¹⁰ IESNA 2000, 134

¹¹Horizontal lighting is the one which illuminates horizontal planes like roofs and floors.

(arenas, stadiums, tracks, etc.) where a certain concentration of lighting levels are needed more or equal than in the interior.

- One of the characteristics of interior lighting that distinguishes it from the exterior lighting is that the prevalent lighting type is horizontal, while in the exterior dominates the vertical lighting¹². This difference lies in the fact that generally interior spaces require a special type of lighting with more functional features, this means more utilitarian. While outdoor spaces need lighting that allows us to perceive proportions, deep and dimensions of space, as well as to reveal us forms that integrate the architecture.
- The interior light has less impact on light pollution in comparison with the outdoor. So we can say that it is not a factor to be taken into consideration in interior design, while exterior lighting has a significant influence on the environment, that's why it is necessary to apply certain techniques in order to minimize its effects.
- Lamps and outdoor lighting fixtures should be designed preferably to resist the weather.

The previous points can be summarized in the sense that the main differences between the indoor and outdoor lighting focus on the different tasks that are carried out in both spaces. In interior the illumination that is generally used is to see, while in exterior their applications are different, for example lighting is used as well as to see, but also to: contemplate architectural objects, to convey a message, as publicity, as strategy of city marketing, as an instrument of evocation and to reinforce the identity. All these applications of lighting in the context of historic urban landscape are described in chapter tree.

1.4.1.2 Architectural object.

If we start from the idea that Kahn had about architecture; "*Architecture is what nature cannot make*¹³", then we can define that architectural object is all structural unit made by human beings that has an architectural purpose, i.e. to configure the space in order to provide habitability to the people. These spaces are where users spend daily much of their time not just with the intention of protecting themselves from the weather, but also as created scenario where human activities are performed, as well as where our behavior and psychological mood are modified under the influence of a given built context.

The context of historic urban landscape is configured by different architectural objects, which build and grant its distinctive characteristics, highlighting within this context

¹²Vertical lighting illuminates vertical planes like walls and columns.

¹³ Kahn 1965, 305

particularly monuments and historic buildings that are linked each one through public spaces (see figure 1).

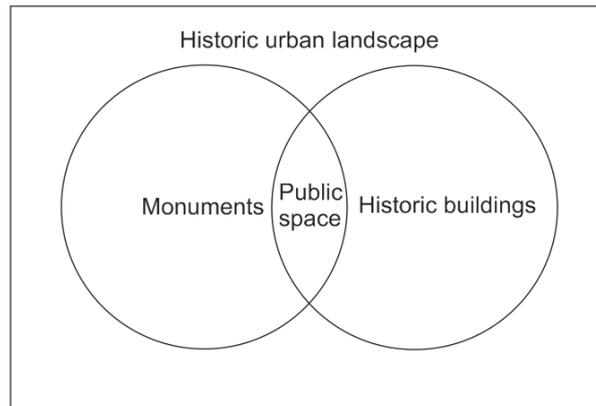


Figure 1. Configuration of historic urban landscape.

1.4.1.2.1 Monuments.

The term monument implies not only architectural works, but also sculpture, painting and other kind of cultural expressions with important values, for example artistic, historic, literary and social. That is to say that not that all works produced by humans are considered as monuments, only those who have given them as a social purpose of *“to stay alive in the minds of future generations”*¹⁴.

There are some countries like Mexico where the epoch of cultural production is relevant factor to determinate if the work is granted or not the category of monument. In Mexico the category of monument is divided in three groups; archaeological, historic and artistic. The first one refers to all movable and immovable property produced before the establishment of the Hispanic culture in the country¹⁵, as well as human remains, flora and fauna, fossil rest of organic beings that in earlier times inhabited the national territory and whose research, conservation, restoration, recovery or utilization have paleontological interest¹⁶.

Historic monuments refer to all goods linked with the history of the nation, from the establishment of the Hispanic culture in the country. The *“Ley Federal sobre Monumentos y Zonas Arqueológicas, Artísticas e Históricas”* (Federal Law about Monuments and Archaeological, Artistic and Historic Zones) determines that historic monuments are:

¹⁴ Gamboa 2002, 31.

¹⁵The establishment of the Hispanic culture in Mexico started in 1521 and ended in 1821 with the signing of the declaration of independence.

¹⁶Cámara de Diputados del H. Congreso de la Unión 1972, 5.

- *“The properties built between sixteenth and nineteenth centuries, intended to be temples and annexes; archbishoprics, bishoprics and rectories; seminaries, convents or any others engaged in the administration, divulgation, teaching or practice of a religious cult; as well as to education and teaching, welfare or charitable purposes; Ornaments and public service and the use of civil and military authorities. The furniture that are or have been in those buildings and relevant private civil works carried out in the sixteenth to nineteenth centuries¹⁷”.*
- *“The documents and records that belong or have belonged to the offices and archives of the Federation, States or Municipalities and curial houses¹⁸”.*
- *“The original manuscript documents relating to the history of Mexico and books, brochures and other printed in Mexico or abroad, during the sixteenth to nineteenth centuries by its rarity and importance to Mexican history that deserve to be preserved in the country¹⁹”.*

Artistic monuments are *“all movable and immovable property which has a significant aesthetic value²⁰”*. To determine the relevant aesthetic value of any good should have any of the following characteristics: representativeness, insertion into certain stylistic trend, degree of innovation, materials and techniques used. If the artistic monument is an immovable good, then it may also be considered its significance in the urban context. It's important to mention that works of living artists can not be declared²¹ artistic monuments, no matter if it has satisfied all these conditions

As can be seen, the term monument implies a broad concept related to cultural heritage. In Mexico the establishment of the Hispanic culture marked an important stage that is reflected in the architectonic, artistic and literary productions. That's why the years before, during and after the Spanish occupation formed the basis for defining and identifying the different types of monuments that exist in the country.

For purposes of this research, all the sculptures and architectural works, which are of outstanding national or universal value from the point of view of history, art or science, are

¹⁷Ídem, 7.

¹⁸Ídem.

¹⁹Ídem.

²⁰Ídem, 5.

²¹The commission responsible in Mexico to declare if a work is or not a historic or artistic monument is *“la Comisión Nacional de Zonas y Monumentos Artísticos”*, which is integrated by The General Director of the National Institute of Fine Arts and Literature, a representative of the Secretariat of Environment and Natural Resources, a representative of the National Autonomous University of Mexico and three people linked with art (designated by the General Director of the National Institute Fine Arts and Literature), in addition a representative of the Government of the Federal Entity where goods are located will be invited. Only the archaeological monuments don't need to be declared (*Ídem*, 6).

considered as monuments. In the case study, both architectural objects fulfill these characteristics, which are described in detail in Chapter 7 of this thesis. Moreover, according to the “*Federal Law about Monuments and Archaeological, Artistic and Historic Zones*” force in Mexico, both buildings are recognized as historic monuments, therefore they are under the federal protection.

1.4.1.2.2. Historic buildings.

Are considered historic buildings those “*that are significant in the history of architecture, that incorporate significant architectural features, or that played significant historic roles in local cultural or social development; may or may not be officially designated*”²². This definition doesn’t mean that all old and abandoned buildings are considered necessarily historic. For those which don’t have any of mentioned characteristics, could be denominated abandoned buildings.

The concept historic building may seem equivalent to historic monument, however if building is defined as “*ein sich über die Erde erhebendes und Räume umschließendes*”²³, and in addition it is designed to shelter different human activities, and to this definition is added the adjective of historic, then it is obtained architectonic work with history, i.e. works with importance in the history of architecture. While historic monument is a broader term that includes not only buildings with historic, artistic or scientific relevance, but also those works that are product of culture and also are outstanding national or universal value.

In outdoor lighting, whether a building is considered under the category of historic or monument, should be intervened under conservation criteria to ensure its protection, not only in terms of physical-structural aspects, but also conceptual. Seeking to highlight those characteristics that make the architectural work to be worthy of being the main actor during the night or be an integral part of the illuminated historic urban landscape.

1.4.1.2.3. Urban public spaces.

Public spaces are open places where people congregate themselves and perform different activities, whether walking, strolling, shopping, exercising , as a meeting point, and further characterized by having no restrictions to be accessed by the users, due to the fact that these areas are under public domain.

These areas are integrated by streets, avenues, roads, walkways, sidewalks, parks and squares. The lighting of these spaces is known as public lighting and its applications

²²GETTY 2012.

²³Kröner 2005, 203

depend on the functional and formal characteristics of each place, as well as on the activities that are developed in different public spaces.

The monuments and historic buildings that today are located in urban areas, are fixed elements that containing these urban areas and somehow try to oppose the urban dynamic, i.e. the contemporary transformations that take place in cities. Lighting serves as a linker element between the static of the mentioned architectural objects and urban dynamism, depending on the needs of uses of space. In concordance with this, three lighting types are distinguished: Light carpet, light zone and island light.

- Light carpet.

This type of lighting is defined as a carpet of light that comes from various points that covers the ground in a continuous and uniform way. It is characterized by giving the feeling of amplitude to urban areas, highlighting the size through horizontal light. It is used to emphasize the massive public character rather than to illuminate monuments and historic buildings, since they are illuminated only intrusively, that is to say indirectly. Generally light sources are high and therefore out of sight, allowing that the main actor is the public space. (see *image 1*).

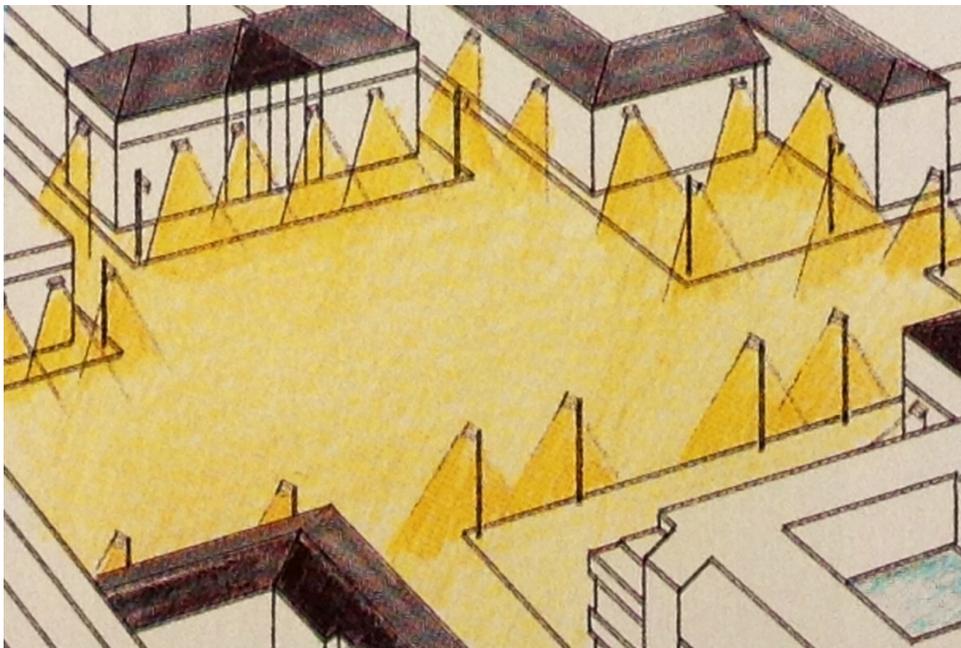


Image 1²⁴. Light carpet. The ground is illuminated in a continuous and uniform way.

- Light zone.

This type of lighting is used when the public space has the function of meeting center. For example, some squares have places for pedestrian circulation and others where people congregate themselves; this last one is where the light sources are installed,

²⁴FGL ,19.

which remain lit in contrast to the other areas that make up the public space. In cases in which the circulation areas need to be illuminated, then the meeting points where people gather are distinguished by variations in quality, color or hue of light, in order to define and prioritize the areas.

Another characteristic is that the light sources correspond to the human scale, this means that the lights are placed at low level, with the intention of creating an intimate atmosphere that encourages people to come together into the illuminated areas. Due to the light sources that are at low height with regard to buildings, reason why these remain dark or dimly lit, since some of them are illuminated in intrusive way and other are far away from the sources of light.

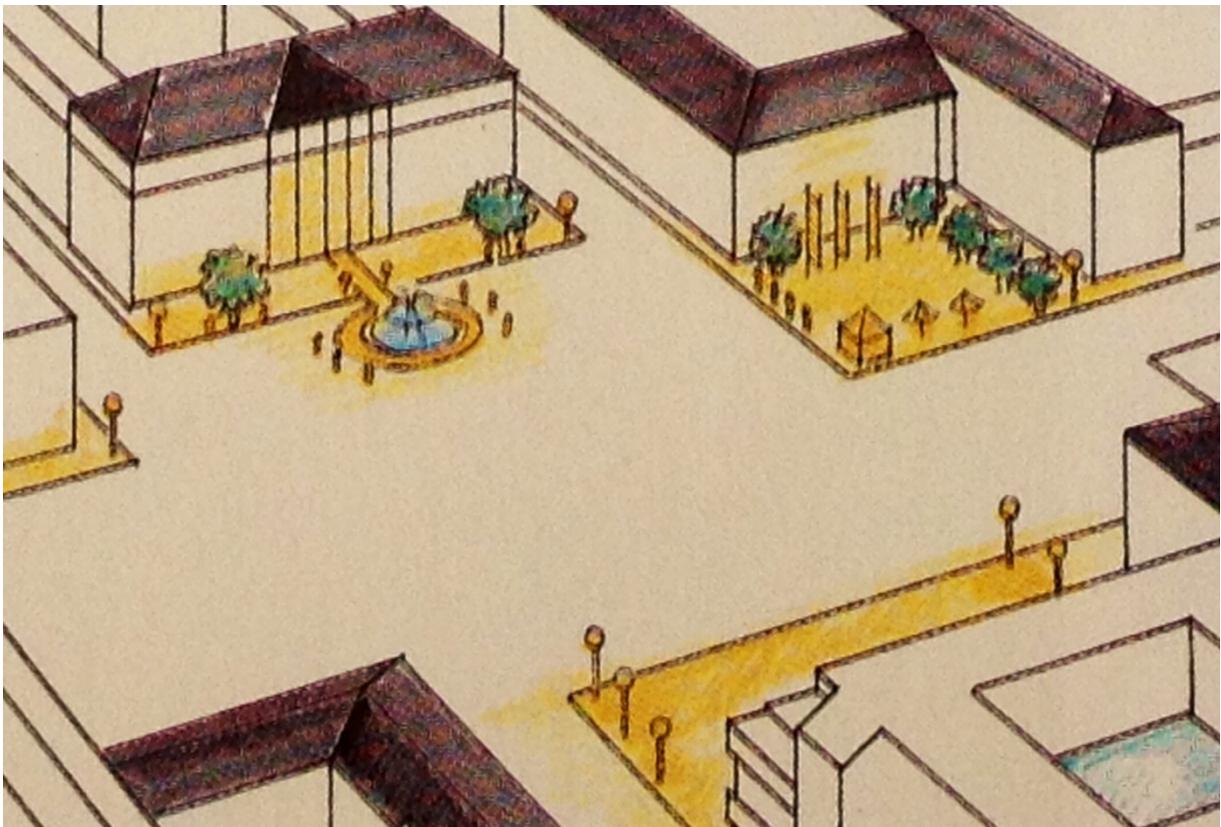


Image 2²⁵. Light zone. The meeting centers are illuminated, while the buildings and others areas remains dark or dimly lit.

- Island light.

This type of lighting is used when the public space contain or are bounded by architectural objects with historical or architectural significance, which are the main protagonists in the urban landscape. At night these architectural works are illuminated, highlighting through contrast from the surrounding context. The other

²⁵Idem.

spaces such as circulation areas that make up the urban space remain dark or dimly lit in comparison to the elements with greater relevance.

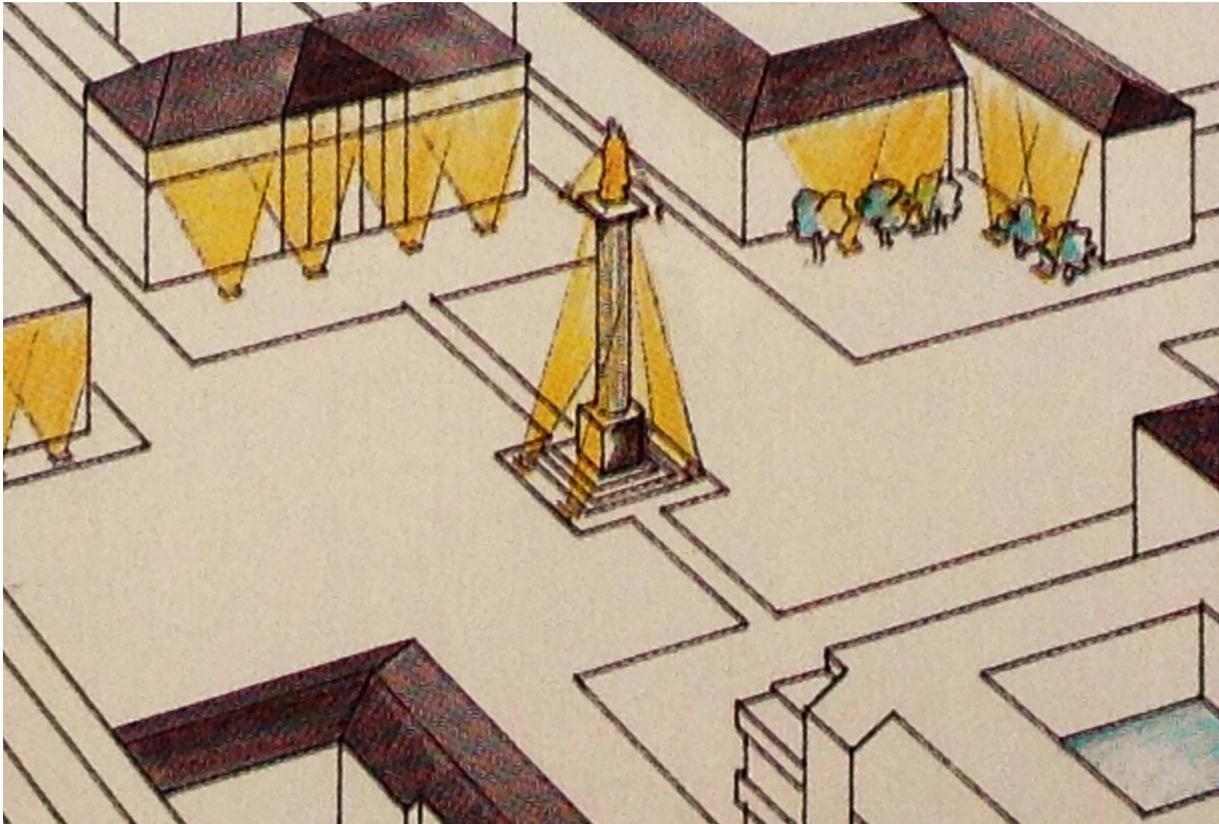


Image 3²⁶. Island light. Buildings, fountains and sculptures, with historical or architectural significance are illuminated, while the different elements that integrate the public space remain dark or dimly lit.

1.5 Lighting's problems in historical buildings and monuments.

Along the history and practically around the world, historic buildings and monuments have been designed to be seen during the day, in which daylight allows us to appreciate the forms and architectural elements that integrate the work. However, what happens when today these works are artificially illuminated? Of course, this is in order to enjoy the architecture during the night. Undoubtedly, it provides a new approach to the works, and certainly this architectural lighting has positive aspects, such as the social value²⁷, which as a consequence causes the identification by the society with the architectural object, generating a sense of appropriation, in turn ensures its conservation and permanence for the enjoyment of future generations.

In the other hand, when lighting projects are designed improperly, this has negative consequences that affect the architectural object, it has also socioeconomic affectations and even environmental repercussions. However, a question until now is missing, what are the

²⁶Idem.

²⁷ Rodríguez 2014, 93.

common causes that generates the improper lighting in urban heritage? Through the next diagram is mentioned the problematic of improper lighting, its causes and consequences.

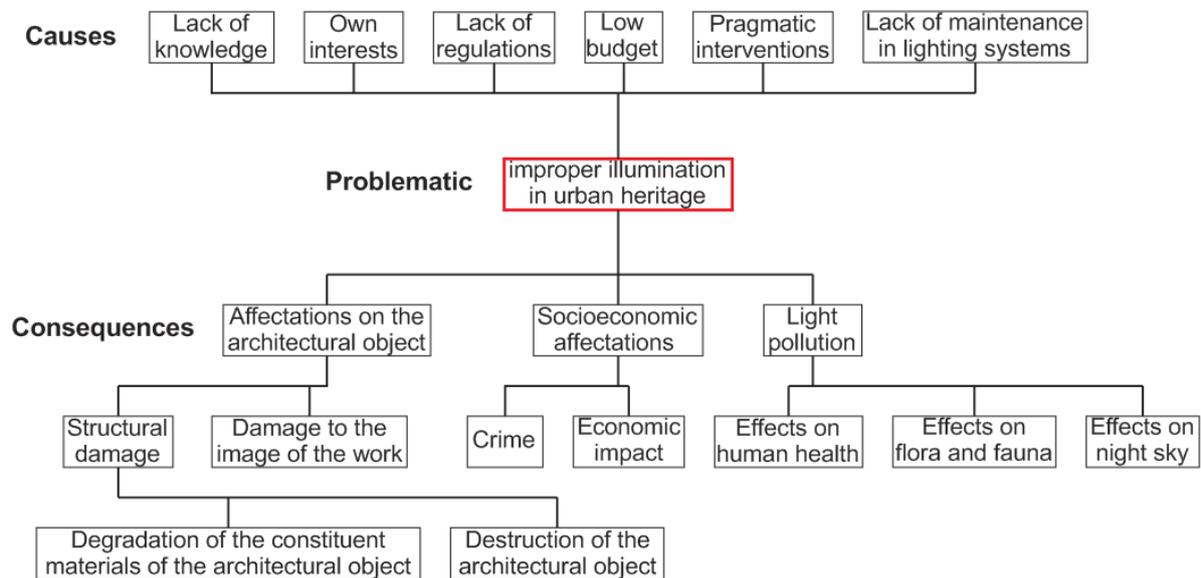


Diagram 1²⁸. The problematic of improper lighting in urban heritage, its causes and consequences.

Below are explained the most common causes that generates the inadequate lighting in urban heritage.

- Lack of knowledge.
This first point refers to the all unknowledge that exist about the characteristics of the monument or building and also of the properties of different lighting systems, criteria for intervention in monuments and historic buildings.
- Own interests.
When own benefits take precedence over common interests. This practice in some cases is closely related to corruption. The purpose is mainly to get full individual advantage sacrificing social and environmental benefits.
- Lack of regulations.
There are rules and criteria concerning to how to make intervention in historic structures, however the implementation of lighting systems are often not regulated, due to lack of knowledge of the authorities, low budget, disinterest, and in some cases are not considered as interventions in urban heritage.

²⁸ Elaborated by the author.

- Low budget.
When municipalities do not have enough budget to make a proper lighting project, then choose to get cheaper luminaires from the market, which are not always the most appropriate. The selection parameters are based on the price instead of the requirements and quality. Other problem is that the municipalities prefer to satisfy other city's needs, such as urban street lighting, water, sewerage, than to illuminate historic structures, therefore the city hall or municipality opts not to hire specialist in lighting and urban heritage.
- Pragmatic interventions.
Pragmatic interventions in some cases are related to the budget. In other cases it is simply the less complicated option (apparently), because for some owners (when the heritage is under the protection of the private sector) or for the community, to make a lighting project is only matter of to place luminaries that lights the monument or the historic building, that's why any electrician or in the worst cases, anyone without a proper knowledge of lighting and urban heritage conservation are being hired to design or simply to place luminaries.
- Lack of maintenance in lighting systems.
The lack of maintenance is due in some cases to; the low budget, lack of specialists in the area. As it was mentioned before, there are other city's priorities that come before. The lack of an adequate maintenance plan is also a common problem.

These causes are generating an inappropriate lighting of monuments and historic buildings, however they are not the only one, because these vary depending on the geographical and socio-cultural conditions of each place.

The improper illumination generates important consequences, which are classified and divided into three affections; on the architectural object, socioeconomic and light pollution.

- Affections on the architectural object.
An architectural lighting project in urban heritage is not only a set of proper wiring techniques. As it was already mentioned in this research, lighting is based on a systematically structured set of knowledge from physics (optics), chemistry (materials' behavior), psychology (perception) and philosophy (aesthetic), to study different forms of production, control and light's applications. In the case of urban heritage, it should be also based on conservation criteria that ensure not only the structural integrity of the work, but also to protect its image. When these precepts are

missing, then the work run the risk of degrading, destroying its structure, and affecting its image.

- Structural damage.
 - Degradation of the constituent materials of the architectural object.
Degradation begins when the surfaces are drilled in order to receive luminaires or electrical wiring (*see image 5-6*). These perforations can be turned into cracks, which are the basis for the filtration of moisture²⁹, creating a favorable environment for the biodeterioration produced by microorganism ³⁰ (fungi and bacteria), insects and birds, which generate alteration in the structure that eventually will degrade the work.

As an example of degradation of monuments is mentioned the case of Angkor Wat in Cambodia³¹. The government has promoted as a strategy to illuminate the ancient temples in 2006, investing more than 12 million³². To make the project it was needed to install luminaires and to open cavities to place electrical equipment. This aroused particularly the interest of conservation specialists, residents and visitors.

The specialists and the general public complained that the company in charge of the project was making holes in old walls. Authorities appealed the charges, denied that holes were drilled into the walls of Angkor Wat for the installation of light fixtures.

The curious thing is that the luminaires are placed on a particular distance from each other (*see image 5*). Moreover, visitors testified that pieces of stone were found on the ground, dropped down from the drilling to set up electric lights.

Angkor Wat is an example of how private interests take precedence over the preservation integrity of heritage.

²⁹ Del Pino 2003, 106.

³⁰ Idem, 128.

³¹.Angkor Wat temples dating from the Middle Ages and are the most popular attractions of Cambodia.

³²Palatino 2009.



Image 4³³. Architectural illumination of Angkor Wat temples, Cambodia, 2008.



Image 5³⁴. Lighting system of Angkor Wat temples. The luminaries are placed at the same distance from each other.



Image 6³⁵. Lighting system of Angkor Wat temples. Perforation of a lintel with ornamentation of high reliefs, made in order to place a luminary.

³³ HCAT 2008.

³⁴Phnom 2009a.

³⁵Phnom 2009b.

- Destruction of the architectural object.

The bad condition of the lighting system, produced by the lack of maintenance is a risk that threatens the integrity of the architectural elements that integrate the work. In some cases, like happened on March 22th of 1993 in San Cristobal de Las Casas, Chiapas, when an electrical failure of the illumination system caused a fire ³⁶ that devastated all wood roof structure, sculptures, paneling, altarpieces and interior decoration of the temple of Carmen, which dates from XVI century.

Another example of the bad condition of the lighting system is the case of the cathedral of Tuxtla Gutiérrez, Chiapas. The interior luminaries burned the finish, which is a thin layer that hides mural painting (see image 7 and 8).



Image 7³⁷. Mural painting of San Marcos Cathedral (08.12.2008), Tuxtla Gutiérrez, Chiapas.

³⁶Artigas 1993, 1.

³⁷Elaborated by the author.



Image 8³⁸. Luminaries burned the finish of the spandrel of San Marcos Cathedral (08.12.2008), Tuxtla Gutiérrez, Chiapas.

The bad practice of architectural lighting, together with others factors may cause the partial or total destruction of the work. When perforations are made on the structure with the intention of placing inside of the holes luminaries, this makes the structure weakens, causing over time the collapse of the architectural element. The risk is higher when the work is in a seismic place, like in the State of Chiapas (Mexico), where Earthquakes are common (see table 2). Of course, the architectural object's materials also play an important role.

Richter M. S.	Effects of the earthquake	Total of earthquakes
< - 3.5	Generally is not felt, but is registered	1690
3.5 - 5.4	Often is felt, but only causes minor damage.	5533
5.5 - 6.0	It causes few damage to buildings.	13
6.1 - 6.9	It may cause severe damage in areas where many people live.	6
7.0 - 7.9	Major earthquake. It causes serious damage.	1
8.0 - <	Great earthquake. Total destruction to nearby communities	0

Table 2³⁹. Earthquakes from 2010 to 2014 in the State of Chiapas, Mexico.

³⁸ Idem.

³⁹Elaborated by the author with data obtained from SSN 2014.

- o Damage to the image to the work.

It is important to mention that in this point we don't refer to the physical damage of the image, but in its image that we build of the work (perception).

To determine if there are damages to the image of the work caused by improper lighting, we must first understand how the sense of sight works. This sense allows us to perceive through the eyes the world around us, and at the same time is what establishes our place in the surrounding world⁴⁰. To achieve the vision process, it is necessary the interaction of three elements; light, the object and the observer⁴¹. Therefore, if this interaction allows to the observer to recognize objects and spaces, then, what happen when lighting is inadequate? Undoubtedly, we can deduce that when there are absence of the necessary conditions of lighting, then the brain is not able to be adequately stimulated by the outside world, hence it generates altered images of objects.

As it was already mentioned in this research, the historic buildings were designed to be seen by daylight, at night, the designers have had to rely on the use of technology and certain techniques in order to appreciate the work overnight. However, a question is still missing; how could produce lighting damage to the image to the work? At least there are five causes that generate this kind of damage.

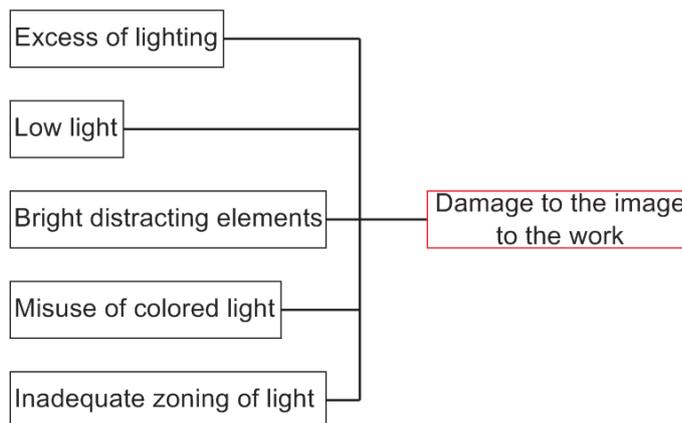


Diagram 2⁴². Causes that generate damage to the image to the work.

1) Excess of lighting.

When the luminous flux emitted by a light source hits the surface of an object, then an optical effect known as brightness occurs. The

⁴⁰Berger 2000, 1.

⁴¹ Rodríguez 2014, 36.

⁴² Elaborated by the author.

intensity of the brightness depends on the intensity of the luminous flux and the material properties, such as color and texture⁴³.

When the brightness is excessive, it produce glare, which may cause; asthenopia ⁴⁴ , headache, binocular problems ⁴⁵ and persistent afterimages that temporarily generates blurred vision⁴⁶, affecting the perception of the image.

2) Low light.

Regarding to this point, it is when the luminous flux of a light source is insufficient to visualize the object and its properties. This condition can also cause temporary eye problems such as asthenopia, binocular vision problems and even headache⁴⁷.

3) Bright distracting elements.

Those light sources that are visible in the composition of façade's lighting distract the observer, avoiding the proper reading of the work. This because the eye responds by constricting the iris, reducing the amount of light which falls on the retina, reducing simultaneously the visibility of other objects in the visual field⁴⁸.

This kind of distraction distorts apparently the image of objects, commanding attention and forcing viewers to make sure that the surface or element has another form⁴⁹. For example, the uneven illumination of a planar structural surface distorts its apparent form, due to the patterns and gradients of incident light.

4) Misuse of colored light.

Starting from the fact that colors have different effects on people⁵⁰, then we can deduce that the colored light could alters the image works. This is due to the ability that have the colors to influence feelings.

⁴³The material properties are explained in chapter 3 of this research.

⁴⁴Asthenopia are eye disorders, which produce; seeling of heaviness in the eyes, eye strain, eye redness, ocular itching, increased lacrimation, headache, decreased visual acuity and blurred perception of objects.(Chakman 1983, 49).

⁴⁵Binocular problems are eye disorders that produce; eye discomfort, double vision and headache (Skeffington 2010)

⁴⁶Munoa 1997.

⁴⁷García 2014.

⁴⁸Lam 1992, 38.

⁴⁹Idem.

⁵⁰Heller 2004, 17.

The effect of each color is determined by the work's properties, context⁵¹ and its functions. For example, it is not the same to illuminate daily with psychedelic colors⁵² the façade of a bar, than to use those colors for the façade of a temple. The use of this light may suggest that the function of the temple has changed, therefore the colored light changes the image that the people have regarding to the work. When this kind of illumination is used inappropriately (according to the color's meaning that the culture where the work is placed), then it could damage the image.

5) Inadequate zoning of light.

Regarding to this point, the surfaces with more illumination tend to highlight from the lighting's composition, becoming then elements that distract the attention of the observer. This causes that the viewer doesn't achieve to see the work as a whole, fragmenting visually the image of the architectural work.

- Light pollution⁵³.

Light pollution is defined as; *"The emission of luminous flux from artificial sources during the night whose intensities, direction, and/or spectral ranges are unnecessary for the activities foreseen in the areas to be illuminated"*⁵⁴.

Light pollution is any adverse effect of artificial light, which includes sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste⁵⁵. Its main affectations can be divided into 3 categories:

- Effects on human health.

Studies conducted by Eva S. Schernhammer of Harvard University, and also from the *Agence Nationale de Sécurité Sanitaire* of France, have found that light pollution has a substantial effect on human health, such as alterations in the circadian system, risk of cancer and toxic stress in the retina.

- Effects on flora and fauna.

Regarding to the fauna, the lighting's excess creates imbalance in ecosystem, because different types of insects and animals feel attracted by light, affecting and changing the circadian system of animals and their life span. The flora

⁵¹Idem, 18.

⁵²The features of psychedelic colors are: bright and/or highly contrasting colors and the use of kaleidoscopic, fractal or paisley patterns.

⁵³In chapter 3 of this research addresses deeper the issue of light pollution and its implications.

⁵⁴Schwarz 2003, 97.

⁵⁵IDA 2014.

has established its biological cycles during the day and night. At night, when plants are exposed to prolonged periods of light, it produces alterations in their natural biological process.

- Effects on night sky.

Light pollution directly affects astronomers, because the glow that is produced by the lights of the cities, doesn't let the scientists visualize celestial bodies.

- Socioeconomic affectations.

Inadequate lighting of urban heritage generates social affectations such as increase in crime and economic effects.

- Crime.

The historic centers of many cities around the world have often historic buildings and monuments, which have no night activities so they tend to be completely uninhabited. Such scenarios may attract groups of people with intent to commit a crime in any way.

It is true that there is no timetable for criminal acts, however studies related to the effects of public lighting in criminal acts carried out by the Institute of Criminology of the University of Cambridge resulted that in properly lit areas decreased the delinquency between 41% and 43%⁵⁶. The study concluded that the public lighting cost is exceeded by 2, 4 and 10 times by the cost of losses generated by crime in one year, so we can say that lack or inadequate lighting of monuments and historic buildings are propitious scenarios to commit a crime.

- Economic impact.

Historical buildings and monuments considered urban heritage are usually holders of a social value. To illuminate them, seeks to emphasize the aesthetic, historical and symbolic attributes, with the intention of highlighting its main architectural features over other structures. This trend tends to generate economic benefits, since tourism is promoted, which can generate an economic impact. On the other hand, when the urban heritage is poorly lighted, then the effects on the economy are negative.

When the lighting design is inadequate, then the attributes are not correctly highlighted, which may harm the image of the architectural work. This will affect tourism, which reflects negatively on the economy. Another problem is

⁵⁶ Painter 2000, 3.

that the improper design can generate light pollution, this results in waste of energy, impacting also the economy.

Part 2. Contextual approach

Chapter 2. History of lighting.

2.1. The beginnings of lighting: the necessity of security as responsible of the transition from interior to exterior lighting.

Lighting began since the first time that humans started to control fire, in order to illuminate closed spaces where they dwelled, as well as when they needed to light their night hike. For this human beings initiated using wood pieces as torches. Later around 70,000 BC appeared the first lamp made of shells and hollowed rocks plugged with dried plant matter or animal fat⁵⁷. Between XVI-XIII centuries BC Mediterranean culture like Canaanite developed a new lighting system based on baked clay, oakum and oil, known as “*lucernas*”⁵⁸. They were open cup shaped or bowl lamps with high rim, this last characteristic was made to prevent that the oil exceeded or pour. This last discovery allowed to the people to carry light efficiently from one place to another, and in later centuries gave way to multiple lamp designs using different materials, that besides baked clay, it was also used metals and glass.



Image 9⁵⁹. Canaanite baked clay oil lamp between XVI-XIII centuries BC.

⁵⁷Fiell 2006, 8.

⁵⁸ Museo de Tierra Santa 2014.

⁵⁹ Idem.

During many centuries after the discovery of baked clay oil lamps, it was continued the use of torches to illuminate not only interior spaces of small shacks, but also of temples, palaces, forts, castles, mausoleums and amphitheatres, i.e. monumental works with civil, religious or military importance. In a special way, buildings and walls that intended to protect small settlement, towns or even cities needed to be illuminated, mainly in their exteriors in order to avoid that they were surprised by any military incursion of their enemies.

Over the years some settlements became in towns and later cities, which probably not only increased the number of inhabitants, but also emerged problems that occur in many cities, such as insecurity. Possibly this has been one of the causes that gave rise to public lighting, applying the technology already used in interior spaces. For example, one of the earliest known records of public lighting is the candle lantern which was placed in front of the Grand Chatelet in 1318 in Paris⁶⁰. This kind of artificial source of light was also used in interiors.

In some cases exterior artificial sources of light had differences of scale and proportions, regarding to those used in interiors. For example, the Mesoamerican city "Tenochtitlan"⁶¹ had lighting in its streets, temples, palaces and in the entrances of some houses. The illumination system was based on torches and braziers made of baked clay, which according to the Codex Borgia, they used wood as a combustible to which was added *copal*⁶². This public lighting was also described by an eyewitness, Fray Juan de Torquemada, who wrote:

*"por lo menos en cada calle andaban mil hombres barriéndola y regándola, poniendo de noche por trechos grandes braseros de fuego, y en el entretanto que unos dormían, velaban otros; de manera que siempre había quien de noche y de día tuviese cuenta con la ciudad y con lo que en ella sucedía"*⁶³.

De Torquemada mentioned and remarked the size of the braziers and the surveillance system that the city in that time had, this apparently amazed him. The same lighting system used in interiors was adapted to be used in the exteriors, and in the case of the temples, bonfires were placed outside of them and burned all night. The priests were only

⁶⁰ Nature 1933, 888.

⁶¹ Tenochtitlan was the capital city of the Azteca Empire founded in 1325 and conquered in 1521 by the Spanish. By the time that the conquistadors took the city, there were approximately 560.000 to 700.000 inhabitants, who dwelt between 80,000 and 100,000 households (Soustelle 1970, 9).

⁶² Codex Vatican illustrate that to the braziers was added a rubber ball on fire, while the Codex Bolonia said that the material used was white fragrant resin, named copal (Campos 2005, 65).

⁶³ de Torquemada 1519, 164.

the people responsible for keeping the fire lit, while unmarried young warriors were in charge of bringing firewood to them⁶⁴.

The braziers with *copal* (white fragrant resin) not only were used to illuminate interior or exterior spaces, but also had a use for purposes related to the cosmology of the inhabitants of Tenochtitlan. Even today it is used by most of indigenous groups in Mexico, in order to clean the spaces from evil spirits and to purify their souls. Copal gives off a white smoke accompanied by a fragrance that perfumes the environment, surely both households and streets should have had a fragrant smell would also have the particularity to keep away flying insects such as flies and mosquitoes.

Undoubtedly the lighting system used in the old Tenochtitlan should have made a difference between the characteristics of lighting prior to colonization regarding to illumination systems based on oils or other fuels used in the same period in European towns or even cities. For example, in the XVI century in the Spanish city of Cadiz glass lanterns with candles made of tallow were used to light streets and exterior spaces, which were placed at 25 varas (Yardsticks) between each one⁶⁵, i.e. approximately 20,9 m. This kind of public lighting was also used in other cities like Paris.

When Tenochtitlan falls also its lighting system falls. It was not until 1773 when the Viceroy of New Spain Don Joaquin Montserrat issued a *bando* (proclamation) addressed to the inhabitants.

*“Por el presente mando a todos los vecinos de esta ciudad, estantes y habitantes de ella, sin excepción de persona alguna, que dentro de quince días, contados desde hoy en adelante, **pongan una luz proporcionada dentro del farol**, o como mejor les pareciere, en uno de los balcones o ventanas principales de la casa en que vivieren, todas las noches, desde las oraciones hasta después de la queda, que son dadas las diez, para que de este modo estén uniformemente iluminadas las calles, y por este medio (acordado y consultado por la fiel ejecutoria de esta nobilísima ciudad) **se eviten los insultos, pecados y perjuicios a que la oscuridad alienta y provoca**”⁶⁶.*

This *bando* proves that the traditional lighting system used by the inhabitants of Tenochtitlan fell in disuse, because after they lost the war, braziers were no longer used to

⁶⁴ Carranza 1998, 17.

⁶⁵ Idem 19.

⁶⁶ AGN, bandos, vol. 5, exp. 76, fs. 258 (see annex I)

illuminate exterior spaces. Otherwise the viceroy had not commanded to light lanterns and placed them at night, in order to illuminate streets and facades. The proclamation also ratifies that the insecurity during the night was one of the main factors that promoted the uses public lighting in the city, because as the Viceroy said; *darkness causes and encourages insults, sins and prejudices*.

Lighting was initially conceived mainly with purposes that only intended to illuminate spaces, however, due to the insecurity on the streets, to its function was added of being an instrument that facilitates the surveillance, in order to avoid insecurities or at least to reinforce the feeling of being safer when the people were walking in public places in the evenings. Another proof of this, is the fact that an ordinance of Louis XIV in 1667 where he commanded to increase the number of lamps in the street. He insisted that they should be lit even in moonlight. Two years later, a medal was struck to commemorate the securing of the safety of Paris at night⁶⁷.

2.2. The stage lighting as predecessor of the exterior architectural lighting.

Between the centuries XII-XIV almost all the theatric took place inside of palaces, temples and even in some universities. These architectural spaces were illuminated by different light sources, which are divided into natural and artificial. The natural came from natural sunlight filtered through windows, while the artificial proceeded mainly from torches, oil lamps and candle lanterns. In the case in which the performances were more sophisticated or complex and therefore they needed more space. Then ephemeral theaters were built, facades of important buildings and gardens were used also as stages.

The open air performances were limited by the hours of light in the day and of course on the weather, therefore architects like Andrea Palladio designed a special building known as *Teatro Olimpico* in 1580-1583, in order to be used for plays. However theatrical events occasionally continued taking place outdoors, of course when the occasion warranted it and the weather was propitious. When both conditions coincided, then it could make spectacular plays. The facades of the buildings and ephemeral structures were filled with colors by fire and especially fireworks. All this were one of the main advantages of performing outdoors theatrical representations regarding to those which were conducted in indoors.

Generally, when ephemeral structures were used, were in order to be consumed by fire as the final climax event⁶⁸. The people who were responsible for pyrotechnics should be

⁶⁷Nature 1933, 888-889.

⁶⁸Ackermann 2006, 24.

experts in this field; therefore, in time of peace artillerymen were hired for this duty⁶⁹, especially during XVI-XVIII centuries, who in some cases studied or were members of the military school for artillery. However civilians with knowledge of pyrotechnics could also apply for the job.

It is important to mention that these theatrical representations were the center of attention instead of the buildings, which were only a part of the scenery. Nevertheless the use of fires and fireworks marked the beginning of the stage lighting, because for the first time studies and techniques for artistic outdoor lighting were conducted and implemented, of course in order to create a propitious environment to the development of the plays.

Also with these same intentions of creating an adequate environment to the development of the plays, Sebastian Serlio wrote in 1584 his book entitled "*Tutte l'opere d'architettura*", where he explained "*de' lumi artificiali delle Scene*". In this work he described how to produce diverse colours of light and even the use of string light projectors.

"Di dare il modo de come fi fanno i lumi artificiali di variati colori trasparenti: Perche primieramente dirò del colore celeste"⁷⁰.

"Ma le accadrà tal fiata un lume grande y gagliardo, fara da metterui di dietro una torcia, dopo laquale fia un bacino da barbiere ben lucido y nuouo, la reflectione del quale farà certifplendori, come di raggi del fole"⁷¹.

After Serlio there were also more people who wrote about lighting like Nicola Sabbattini. He in 1638 published his book "*Pratica di Fabricar Scene, e Machine ne`Teatri*" he gave some ideas and advice to improve the lighting not just for the spectators but also for the benefit of the actors. For example in the chapter XVI named "*Come, e da qual parte si deve pigliare el lume per colorire la scena*", he wrote:

"Ma se si pigliarà illume dall` una delle bande, dalla destra, ò dalla sinistra, le cafe, la prospettiva di mezo, il piano del palco, tutta la scena mostrerà assai meglio, che in alcuno delli due sodetti modi, e riuscirà di gusto compiro di chila mirara, essendoui de chiari, e de gli scuri, cosi proportionatamente partiti frà loro, che la faranno più vaga, come appare in questa terza figura, quindi second noi, e secondo la commune approuamo, che tale sarà la più lodata maniera di pingerla, e di pingliare illume"⁷²

⁶⁹Engler 2013, 12.

⁷⁰Serlio 1584, 52.

⁷¹Idem.

⁷²Sabbattini 1638, 22.

Most Sabbattini contributions in the field of lighting focus on the production and control and effects of light sources, as well as also avoiding the risk to get burn with them, especially with candle wax.

Joseph Furttenbach, contemporary of Sabbattini, also contributed in the decade of XVII century to the lighting field. He proposed the use of two types of reflectors, in both cases, the lights are directed to the stage by a metal box in which a plug is inserted (see image 10). This invention was the main source of illumination from XVII to XIX centuries. He also introduced, developed and applied in his lighting designs the concept and the technique of footlights and sidelights.

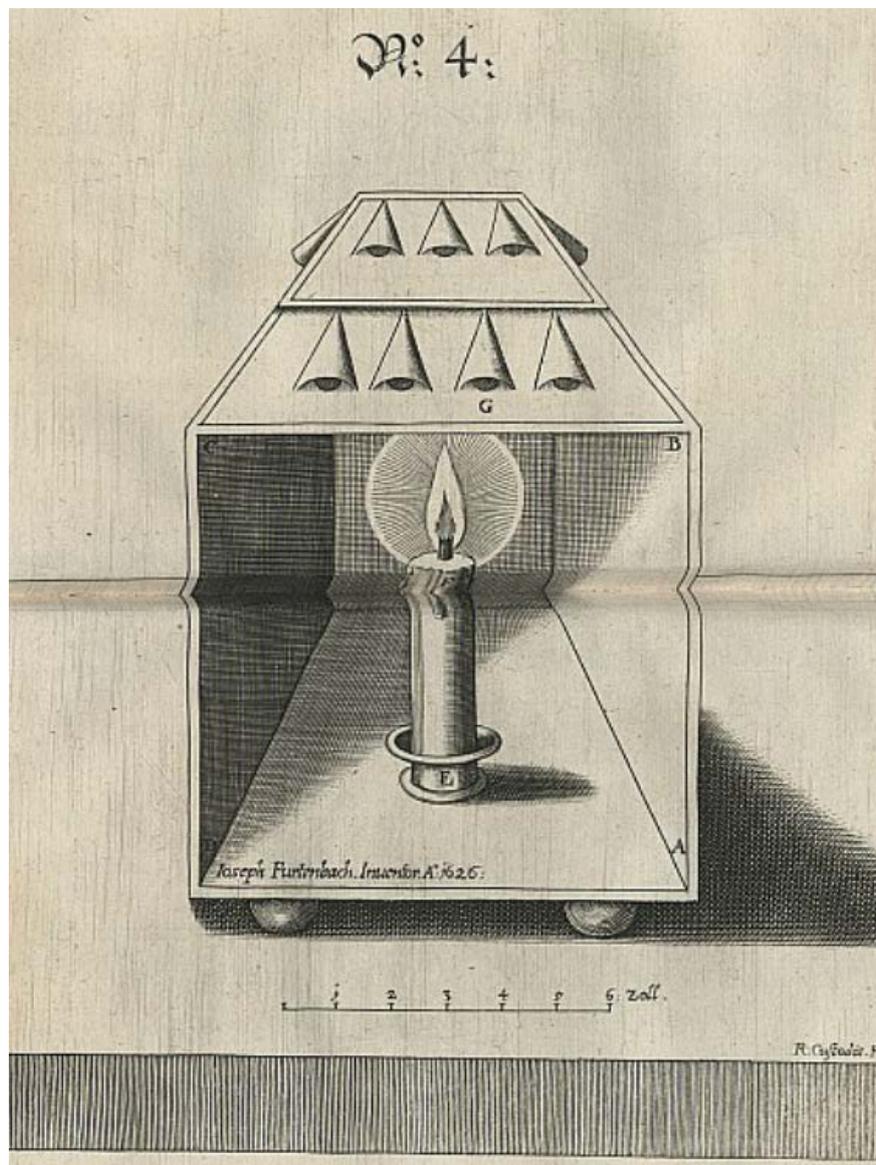


Image10⁷³. Furttenbach's projector, 1626.

⁷³Saur 2008.

The lighting technology suffered some changes during the XVI and XVII centuries, but it was not until 1783 when Jean-Robert Argand improved the oil lamp, enhancing in notable ways the techniques of lighting. The main grant of Argand, was the fact that his lamp was consumed in a cleaner way than before and it was ten times brighter⁷⁴, in addition to this, it had a glass casing that could be easily coloured, changing the perception of the environment, according to the theatrical representation.

The developments and improvements of the recourse of lighting during the Baroque period, was not the exclusive use of theatres. It started to be used also in some occasional Baroque festivals, where the main buildings were illuminated with different light colours through torches, fireworks, candles, oil lamps and probably even with projectors that were developed from ideas originally conceived for scenic lighting.

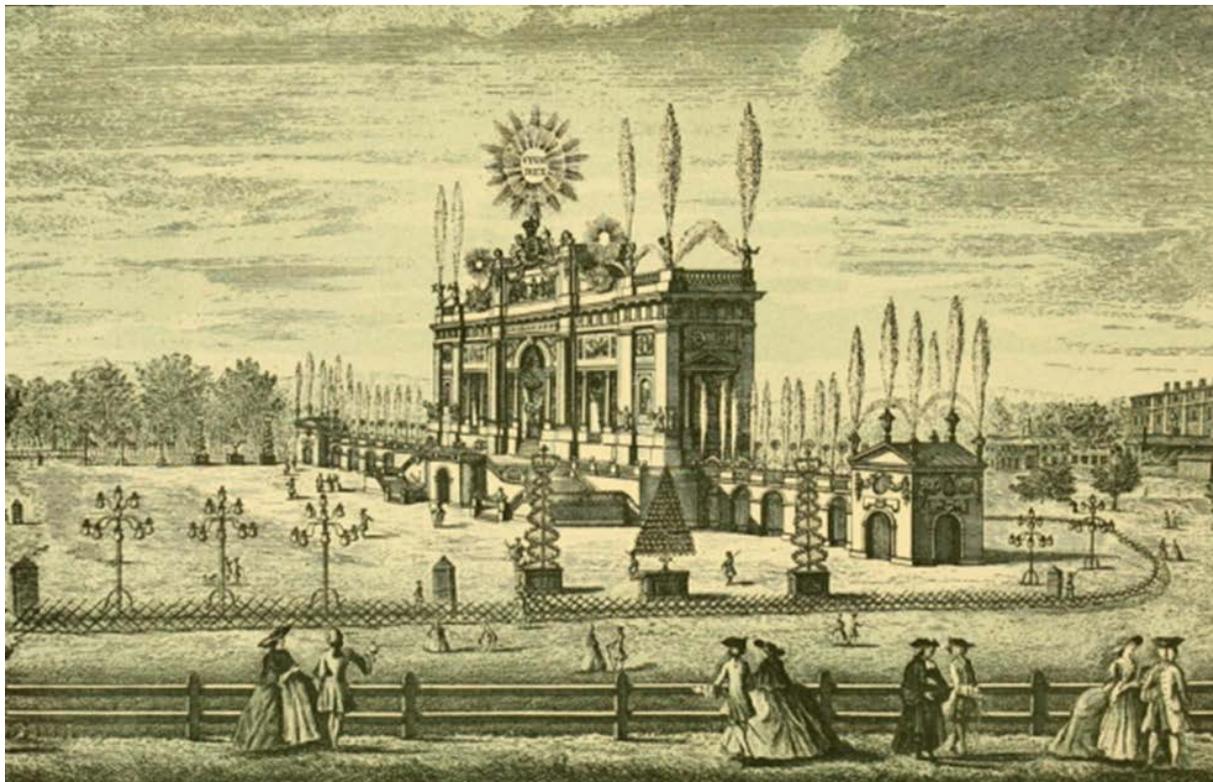


Image 11⁷⁵. Lighting project, where fireworks and torches were used. Engraved of XVII century made by the English School.

Although an idea is already successful, this can be adapted and even improved, in order to be able to retake it and then apply it in/under different conditions. Such is the case of the stage lighting, which initially emerged as a response to a specific need. However, the technology developed for the theater area was also applied in architectural lighting and

⁷⁴Nockin 2010, 57.

⁷⁵d'Allemagne 1891,329.

festivals. Today we can state that such technology has been surpassed by far, but some techniques and concepts like footlights and sidelights of Furtttenbach are nowadays the basis for the design of indoor/outdoor architectural lighting.

2.3. Outdoor lighting in public spaces, historic buildings and architectonic monuments.

In Rome from the XV-XIX century during some occasional festivals, the authorities used to illuminate the main historical buildings of the city, such as St. Peter's Basilica, Castle Saint Angelo and the Coliseum. These architectural structures were illuminated through candles in their openings and for the outdoor it was used torches and fireworks, in order to reveal their forms at night. Goethe wrote in 1787 a letter to Frau von Stein; "*Die unzähligen Lichter gestern Abend waren noch ein tolles Spektakel*⁷⁶".

Goethe was amazed of both, indoor and outdoor lighting. He expresses his astonishment in his travel diary, writing: "*... über zwey hundert Wachskerzen brannten um und neben dem Hoch Altar so daß die ganze eine Wand mit Lichtern besetzt war und das Schiff der Kirche vollkommen erleuchtete. Eben so waren die Seiten Gänge und Seiten Altäre geziert und erhellet*⁷⁷".



Image 12⁷⁸. Illumination of St. Peter's Basilica in Rome, about 1800-1825.

⁷⁶ Goethe 1908, 404.

⁷⁷ Idem 289.

⁷⁸ Neumann 2002, 9.

After the discoveries and technological advances in the field of lighting made by: *Serlio, Sabbatini, Furttentbach and Argand*, appeared others significant developments in this area, which were a consequence of the industrial revolution. In this epoch lighting was the responsible vehicle of the concretion of new ideas that sought to respond to the needs, not just of the industry emergence, but also to the society, which has an evolutionary character and therefore changeable. Hence lighting must necessarily adapt to new requirements and applications, which is why illumination systems that were already known before XVIII century needed to undergo important changes.

In the previous context Thomas Drummond introduced the limelight in 1825⁷⁹. It was a lamp with a cylinder and a lens that produced a beam of light using a stick of lime in a gas flame, which was used for the first time in Philadelphia⁸⁰, USA. Four years later, in 1829⁸¹ were placed Argand burners (gas lamps) in the Place du Carrousel in Paris. It was the first time that this city used this kind of lighting system in public spaces. The Argand burners gave about 10 candles power, which increased from 14,000 to 21,000 between 1839 and 1870. This system was developing not only the features of the lamps, but also its applications in architecture.

Although the light produced by gas was a useful tool in lighting in the end of the XIX century, the researchers were looking for others sources of light as solution. One of them was Humphry Davy, who invented the electric arc. He used a fine platinum wire with electric charge producing the incandescence, but unfortunately his lamps never had commercial success. However his discovery helped Jean Bernard Leon Foucault to develop mechanisms for feeding carbon rods to make an arc light last longer. The idea was to produce a lamp more efficient that could be used in the intimacy of the space as well as in urban places.

One of the first urban spaces illuminated in the world with an important monument is placed in Paris. In 1844 an important lighting project made by Foucault included to light the Place de la Concorde and also the Luxor's obelisk⁸², both the square and the monument should be lighted with only one projection of light. The main intention of the project was to highlight the spot where Marie Antoinette and Louis XVI were executed. Foucault achieved it through a carbon arc lamp. It was based on of carbon rods through which a voltage was applied. It produced a spark to arc across the two rods, causing that the carbon vaporized and as a consequence it originated a continuous bright glow (*see image 13*).

⁷⁹ Castillo 2005, 131.

⁸⁰Nockin op.cit.

⁸¹Nature op.cit.

⁸²Mallet 2010, 148.

Later in nineteenth century with the important contribution of Edison based on the discoveries of scientists who preceded him as von Guericke, Davy and Swan came a range of possibilities in lighting equipment. This provided a new tool to the architecture which let us appreciate the architectural shapes, volumes and the public spaces during the night.

The lighting itself was a success well received by the International Community in the late nineteenth century. In some cases even the moment was immortalized. The amazement of the spectators was captured which was represented through paintings, engravings and photographs. It is important to mention that in the beginning historic buildings or architectonic monuments were not necessarily chosen to be illuminated.

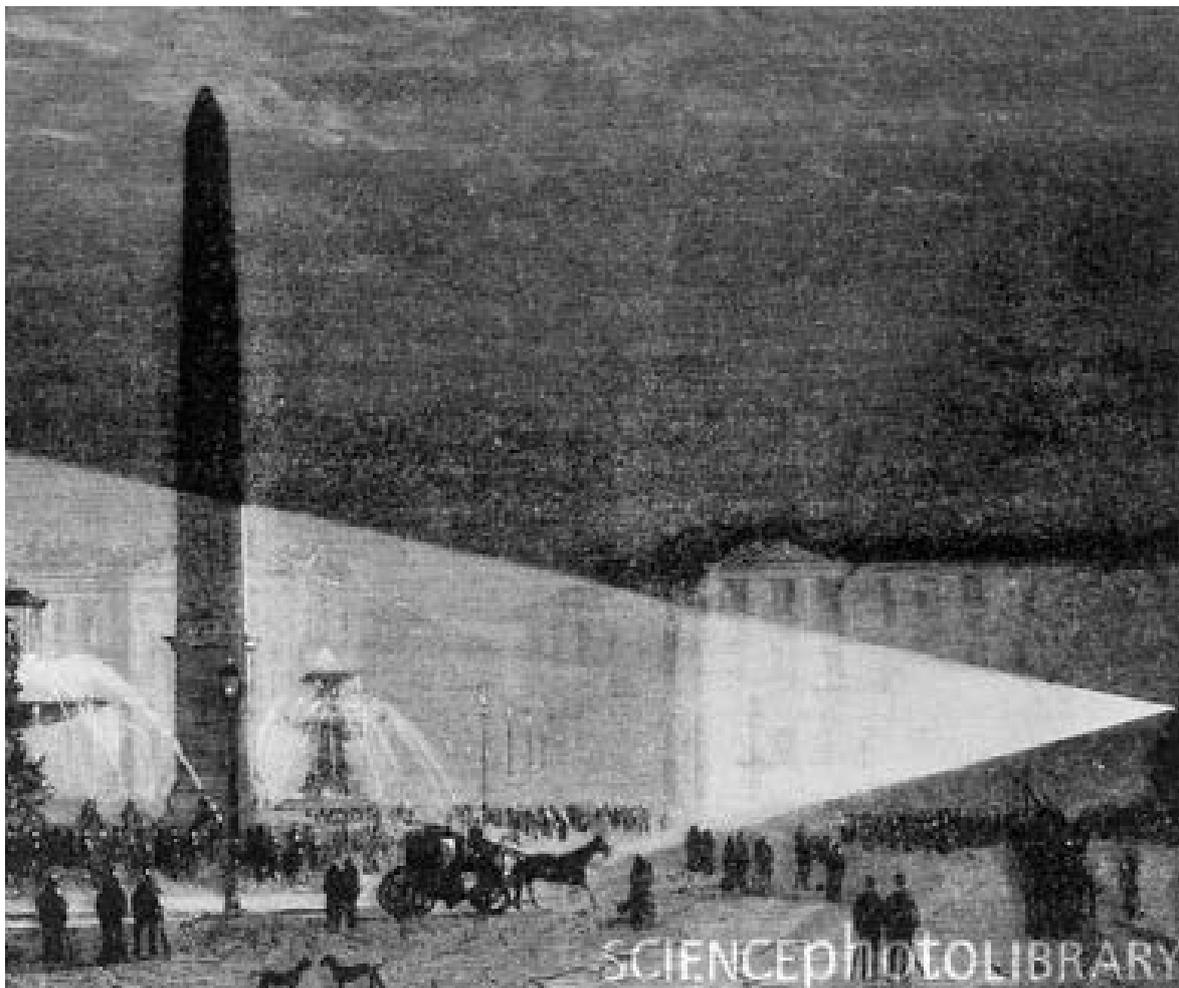


Image 13⁸³. *The first experimental street lighting in Paris, 1844.* Obelisk in the Place de la Concorde illuminated through carbon arc lamp by Foucault.

With the new technological advances in lighting, some cities started to implement the electrical lighting system for their public spaces, for example Berlin, Germany and Ginza, Japan. On September 20, 1882 *Potsdamer Platz* in Berlin was illuminated and in the same

⁸³Science Photo Library 1844.

year but in November Ginza was known as the first city without night. Later lighting came to spread especially in big cities of America, Europe and Asia, where began to implement quickly this new technology, not only to illuminate the main streets and avenues, but also some emblematic buildings, no matter if they were historic buildings, monuments or new constructions.

Soon the light became an innovative and essential tool for lighting urban places, new buildings and even monuments, such as: the statue of liberty (USA), the Big Ben (UK), the Eiffel Tower (France) and particularly Mexico used it to illuminate historic buildings, architectural monuments and sculptures.

The project of the Statue of Liberty by *Frederic Bartholdi* in 1886 considered for the illumination; floodlights on the torch's balcony, however, for security, it was determined not to be used. There was a fear that ships pilots passing the statue would be blinded. Instead, *Bartholdi* cut portholes in the torch (*which was covered with gold leaf*) and placed the lights inside them. Even a power plant was installed on the island to light the torch and for other electrical needs⁸⁴. The light designer took into consideration important factors related to the geographical location, high, and contrast of the night with light to show the monument. One of the main advantages of this project was the fact that, the sculpture not only could be appreciated with aesthetic purposes, but also practical, inasmuch as it served as a light house for ships.

For the inauguration of the statue was decided to celebrate it using fireworks and through artificial lighting that could highlight the aesthetics of the work. However this served to discover some aspects that were not taken into consideration in the original lighting project, like the colour and materials of surfaces. For the lighting design was contemplated eight light projectors placed on torch's balcony (as the original lighting project) and six next to the base, which projected footlights. In this regard the New York Times wrote:

“After a rest of several weeks Liberty resumed her task of enlightening the world last evening. Her torch was lighted before the sun went down, and shortly after dark the lights on the fort began the illumination of the pedestal and the lower portion of the statue. The head and shoulders were obscured, although the lower lamps gave a clearer light than formerly. Many people went down to the Battery to witness the reillumination, while in various parts of the city people watched the light from their roofs. The illumination as seen

⁸⁴Harris 1985, 133–134.

from the Staten Island ferryboats was very brilliant. Many of the passing tugs saluted the illuminated goddess with their whistles⁸⁵.



Image 14⁸⁶. Original illumination of the Statue of Liberty in 1909. The photo was taken from the Hudson River during the Hudson Fulton Celebration.

⁸⁵The New York Times 1886.

Due to the color and materials of the surfaces of the work, combined with the misuse of footlights, some parts of the statue not only glittered more, but there were other elements such as the head and shoulders that remained in darkness. On the other hand the pedestal was not flooded with footlights projectors. To this element were placed light bulbs in order to show its contour.

Another important monument which was also illuminated is the Big Ben in London. In the year 1903 the main streets near Thames River in London were already lit by electricity. The Big Ben couldn't be the exception. It changed its original gas system, which was through the use of pipes that ran up on the surface of a wall behind the clock. For each dial there was a pipe with a gas burner (see image 15). It is important to mention that only the clock faces were lit instead of the all monument, in this way people could see the hour from the distance through the contrast produced by light and darkness.

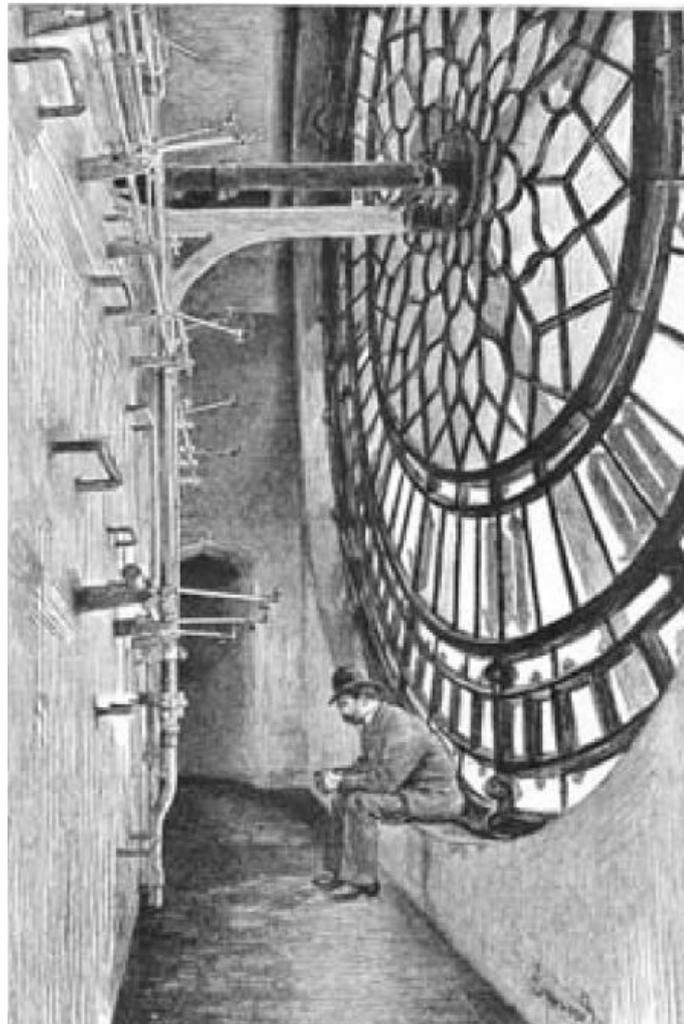


Image 15⁸⁷. Pipes and burners placed on the wall, 1887.

⁸⁶ Neumann 2002, 12.

⁸⁷McKay 2010, 1769.

The Big Ben's lighting system used in 1906 was Bastian's mercury vapor lamps⁸⁸, but this system was not the definitive to be used. Experiments were conducted in order to improve the colour of light emitted and to reduce the cost production, maintenances and consumption⁸⁹.

During the same period and also in a European city took place a perfect occasions to show to the world the new advances in technological aspects of illumination. It was the *Exposition Universelle* in Paris 1890, where the main symbol for this event was the Eiffel Tower. For the first time the electricity was openly celebrated in this universal exposition by an international public, who were witness of the reflected of the progress and the modernity.

"which were powerfully effective symbols of progress, or in the form of spectacular electrical experiments centered on the Eiffel Tower⁹⁰".

The lighting project of Eiffel Tower contemplated the use of searchlights on its top, in order to mark focal points, looking like a lighthouse. The lighting technique implemented was to place small sources of light at equidistance from each one of them through the edges of the tower, in order to draw with light and highlight the three dimension of the structure. This technique is called contour lighting (see image 16).

⁸⁸Bastian's mercury vapor lamps consisted of a sealed evacuated glass tube of about four feet in length. Inside the tube there was a steel anode and a cathode of a pool of mercury (McKay 2010, 1773).

This invention relates to electric lamps of the character known as vapor lamps or mercury vapor lamps or vapor arc lamps and. Comprises an exhausted or any other suitable chamber for containing arrangement and operation being such that when the current is first sent through the lamp and through the mercury connecting the afore said electrodes or contacts thereby the mercury is automatically caused to recede or divide into separate bodies or caused to recede from one of the contacts and thereby the mercury is vaporized and the arc is struck or luminosity produced and the length of the arc or luminous space is extended or prolonged up to any practical length within the limits of the lamp (Bastian 1916).

⁸⁹McKay 2010, 1768-1773.

⁹⁰Ackermann, 2006: 12



Image 16⁹¹. *Eiffel Tower illuminated at Paris Exposition 1900.* Technique implemented was contour lighting.

Before the illumination of Luxor's Obelisk in the Place de la Concorde in 1844, and especially of Eiffel Tower, lighting was viewed as a system rather than a medium. Both projects marked the beginnings of a new era in the conceptualization of architecture at night,

⁹¹ Rau 1900.

transforming light into an important tool that lets to the architects to show to the world not only their creations after twilight, but also those works designed by people who preceded them. In the past architects usually haven't thought about how their buildings could look at evenings. After the technological advance of lighting, it is possible to contemplate how public spaces, historic buildings, architectonic monuments and sculptures during the hours of darkness.

“After 1900, the lighting was a way to beautify and redecorate monuments of urban heritage⁹²”

2.3.1. Historic buildings and architectonic monuments transformed into lit scenario in Mexico. Commemoration of the centenary of independence.

In Mexico, especially during the presidential term of General *Porfirio Díaz* (1877-1911), who felt the commitment to show to the countries of the world and their investors⁹³ that Mexico was an important nation, pioneering, and above all reliable. The main objective was to gain international prestige, to thereby attract more foreign investment⁹⁴.

The primarily strategy implemented by *Díaz*, was to create a National Construction Model with Historical Consciousness through the use of media propaganda, extolling the civil and religious buildings, no matter if they were a new creation or historic buildings⁹⁵. To achieve it, he used the new technology applied already in some European cities like Paris, Berlin, among others. *Díaz* was the first president of Mexico who gave to the power sector a public nature service.

In 1910 took place in Mexico two important events. The first one was the centenary celebrations of the Independence of Mexico from the Spanish crown and the second one was the close path of Halley's Comet, which would be seen from the city of Mexico. Therefore, *Díaz* devised to take these two events directly onto the streets, through the architectural and artificial lighting and then to settle the name of Mexico in the list of countries

⁹²Narboni 2003, 17.

⁹³The three main investor countries in Mexico during the first decade of the XX century were United States, England and France. The main investments of these three countries were in the field of mining, metallurgy and railways. United States Invested in this first decade 506,165,000 dollars and were the owners of the companies responsible of providing electric power to Mexico. The Guanajuato Power and Electric Company and Michoacan Power Company, which represented interests of General Electric Company started their operations in 1902 (Blanco 1996).

⁹⁴ Briseño 2004, 96.

⁹⁵ibidem, 100.

with the best Technology in the World⁹⁶. To accomplish these objectives, Díaz April 1st 1907 created the *Comisión Nacional del Centenario de la Independencia*⁹⁷.

Approximately 200,000 light bulbs were used for the lighting projects in Mexico City. These projects were the National Palace, the Cathedral, The building of *Compañía de Luz Eléctrica y Fuerza Motriz*, the Drugstore *Labadie*, the Store *La Mexicana* and the avenues; *5 de Mayo*, *16 de Septiembre*, *San Francisco* and *el Monumento a la Independencia*. It is important to mention that these buildings were only remained illuminated during the festivities, because in those years "...many buildings were only lit temporarily due to high cost of electricity or difficult technical conditions⁹⁸". However it was not an impediment to spare no expense for the festivities.

The population in Mexico was completely amazed to see the buildings illuminated in such way at night, since the people were used to see the urban spaces and buildings lighted through gas lamps. The feeling of admiration was reflected in written words as it is shown below:

"La ciudad se envolvía en un manto de brocados cintilantes, de pedrerías que fulguraban como collares de esmeraldas, como sartas de diamantes, como hileras de rubíes: un verdadero manto de luz, cuyas inmensas lenguas de fuego ascendían al cielo, cual si la ciudad se consumiera en un vasto incendio ó consagrara en una pira colosal el recuerdo de sus héroes⁹⁹".

The amazed eyewitness described his impressions of the lighting system, which was in that time a new way to light public spaces and buildings. He compared the light bulbs with gemstones like emeralds, diamonds and rubies. Possibly due to an analogy that he made between the colours of the gemstones (green, white and red) and the colours used in the national flag. He also said that the sky was covered by a light blanket, similar to tongues of fire, which ascended to heaven, making the comparison as the city was on fire. Undoubtedly, this spectacle transformed the way that the inhabitants saw the architecture and how they conceived the city at night, all these thanks to the lighting.

- The National Palace.

The type of lamps used for all projects were Incandescent bulbs. They were placed consecutively and at equidistance from each one of them over the edges of the building, highlighting the jambs of the openings, as well as the parapets and moldings

⁹⁶Idem

⁹⁷ C.N.C.I. 1907, 1.

⁹⁸Ackermann 2006, 12.

⁹⁹ García 1911, 150.

of the façades. The portal of the main entrance to the building is also hierarchized through lights. This element plays an important symbolic role even today, because there is where the president of Mexico speaks to the people. In the presidential balcony is hanging a bell, which marked in 1810 the beginning of the independence. It is ringed every September 16th as a commemoration. The technique implemented to illuminate the building in 1910 was contour lighting.

An eyewitness left us in writing his impressions:

“Sencillo y majestuoso, fastuosamente iluminado con numerosas estrellas radiantes, y como una joya engastada en el centro, arriba del balcón principal, la campana de Dolores, entre un resplandor ardiente¹⁰⁰”.



Image 17¹⁰¹. National Palace in 1910. Illumination technique used was contour lighting.

- The Cathedral.

The Cathedral is located in one of the borders of the main square of Mexico City. Due to its height and location characteristics was practically visible from any point near to the square. Further in 1910 its dimensions compared to other buildings stood from the cityscape.

Light bulbs were placed according to the details of the two towers and the dome. In this way an effect of solidity was produced. However the openings remained without illumination and with it the impression of slenderness was given; thereby a harmonious balance was achieved. Due to the height of the building, the illuminated

¹⁰⁰Ibidem, 151.

¹⁰¹ Lara 1910.

elements highlighted from the dark heaven, this created a contrast made of light and dark. From the composition was protruded a flag, which was made through small bulbs. The details of the belfry were also illuminated and the technique used was also contour lighting.

For the illumination of this building were used 10 arc lamps and 16 000 incandescent lamps¹⁰². This represents almost the double of lamps used on the National palace. The light was used to convey the message that the president brought the progress to Mexico.

“La catedral se iluminaba con claridad insuperable, como si los hombres hubieran formado con sus débiles manos un nuevo astro rival del sol”¹⁰³.

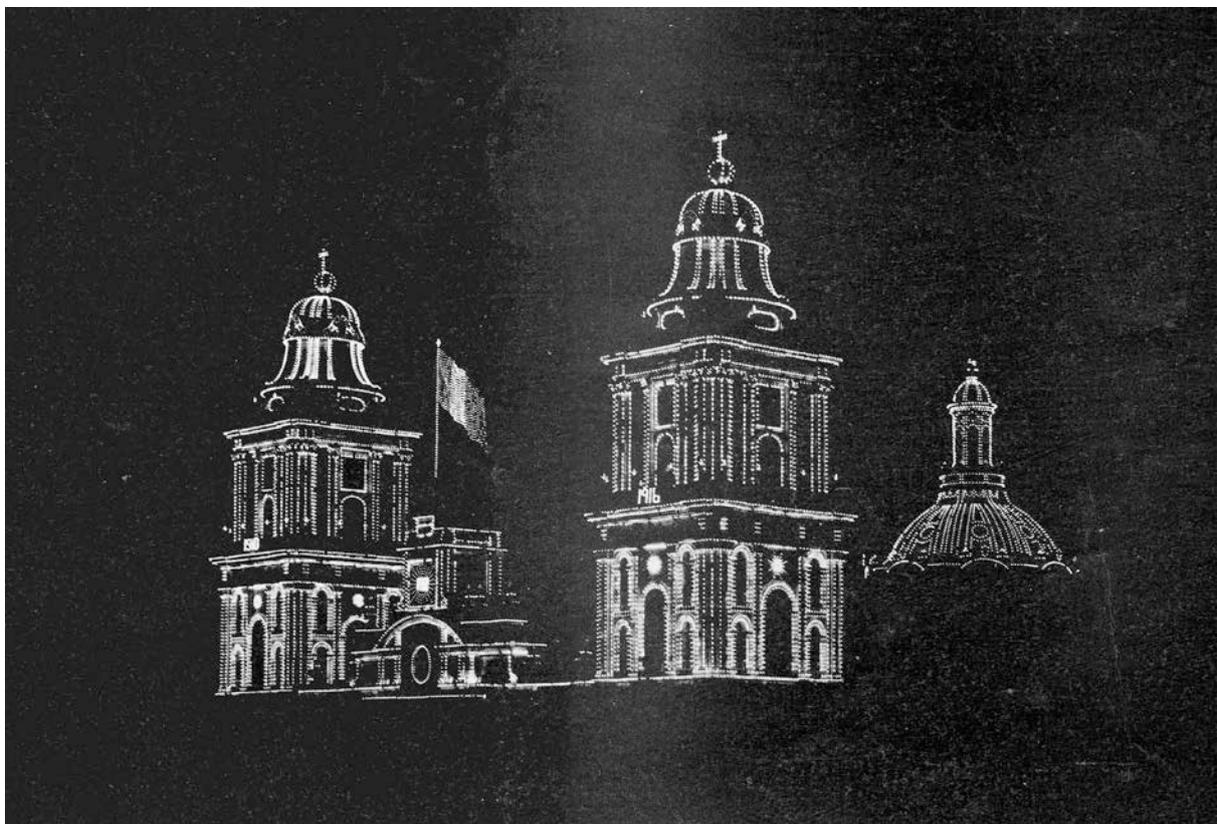


Image 18¹⁰⁴. Cathedral of Mexico city, 1910. Only the elements that crown the building were in detail illuminated.

- The building of *Compañía de Luz Eléctrica y Fuerza Motriz*.

This company was one of the responsible for generating and distributing the electricity in Mexico. The building composed by three bodies and divided by moldings, which were illuminated highlighted them. The contours of the openings of the second and third body were remarked. On the bay of the main entrance was

¹⁰² Briseño 2004, 103.

¹⁰³ García 1911, 151.

¹⁰⁴Lara 1910.

written the years 1810 and 1910 through light, making mention of the centenary of the independence. Also the words *Luz y Fuerza* were emphasized. The national emblem crowned the bay. Strings of lights hanged from the streets and from the building's facades.

“Ostentaba un adorno luminoso, prodigio de colores y rematado por un escudo nacional de grandes proporciones; en el centro de la calle, la misma Compañía hizo colocar numerosos hilos con focos eléctricos, que figuraban un enorme dosel de trono¹⁰⁵.



Image 19¹⁰⁶. The building of *Compañía de Luz Eléctrica y Fuerza Motríz*, 1910. The moldings which divided the bodies of the building were highlighted. Contour lighting as technique.

- The drugstore *Labadie*.

Even though the drugstore belonged to the private sector and surely the owner paid for the electricity, the façade was exuberantly illuminated. Necklaces of light hanged from the moldings and openings. There were created organic forms with light, giving all these the appearance of a waterfall of light and colour that was falling from the

¹⁰⁵García 1911, 152.

¹⁰⁶ Lara 1910.

walls. Maybe that is why it was described as “*Era de arte Nuevo*”¹⁰⁷, because the design was not fully understood.

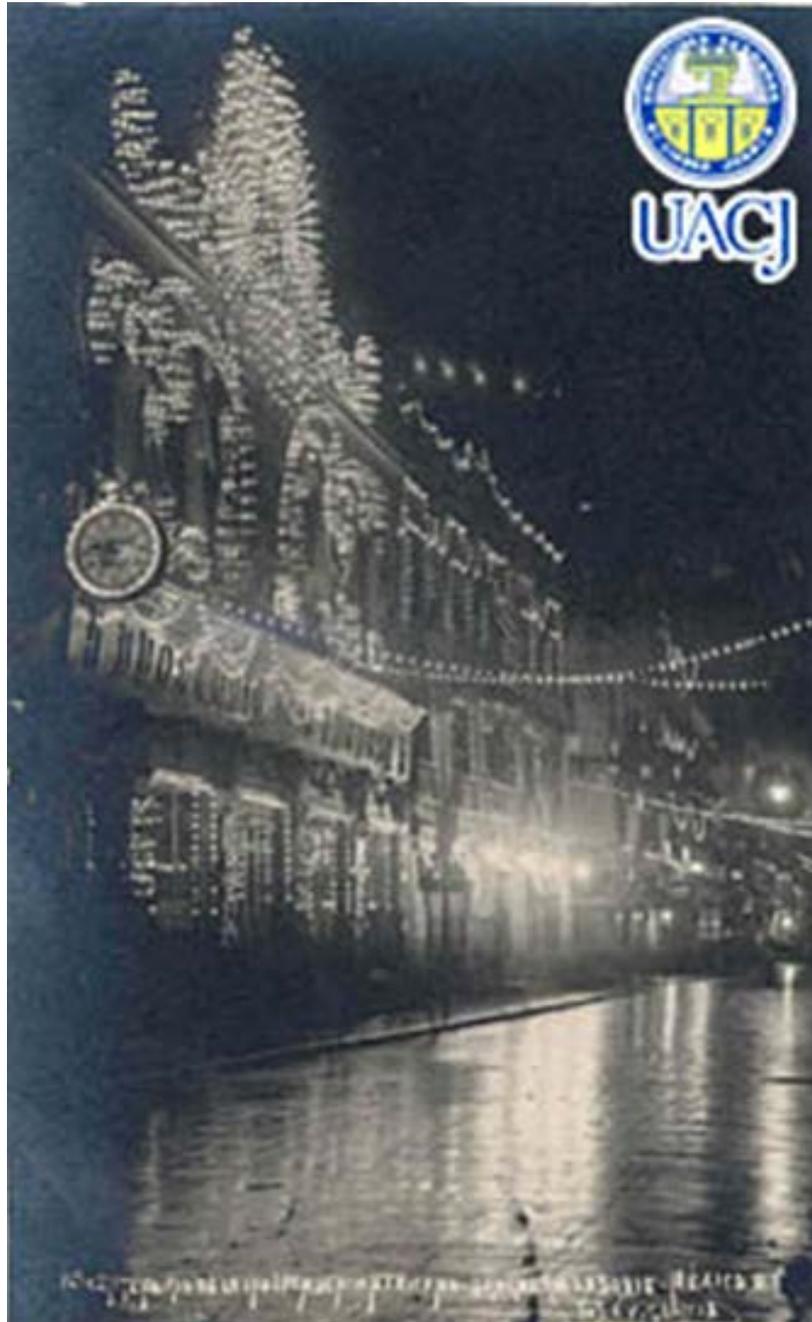


Image 20¹⁰⁸. The drugstore *Labadie*, 1910. Organics forms were drawn by light.

- The Store *La Mexicana*.

This store contrary to the drugstore *Labadie* was modestly illuminated. Only its moldings and some details that formally defined the building were highlighted. The possible reason could be the fact that the cost of the electricity was paid by the

¹⁰⁷ García 1911, 152.

¹⁰⁸ U.A.C.J. 2010.

owners and not by the government. However the *Compañía de Luz Eléctrica y Fuerza Motriz* donated lamps to the people who asked for them, in order to dress with light the city¹⁰⁹. That is why many important stores took the opportunity to acquire free lamps and used also to light the names of their stores.

The impression of the eyewitness about the illumination of the building was: “Aparecía envuelta en una brillante aureola¹¹⁰”.

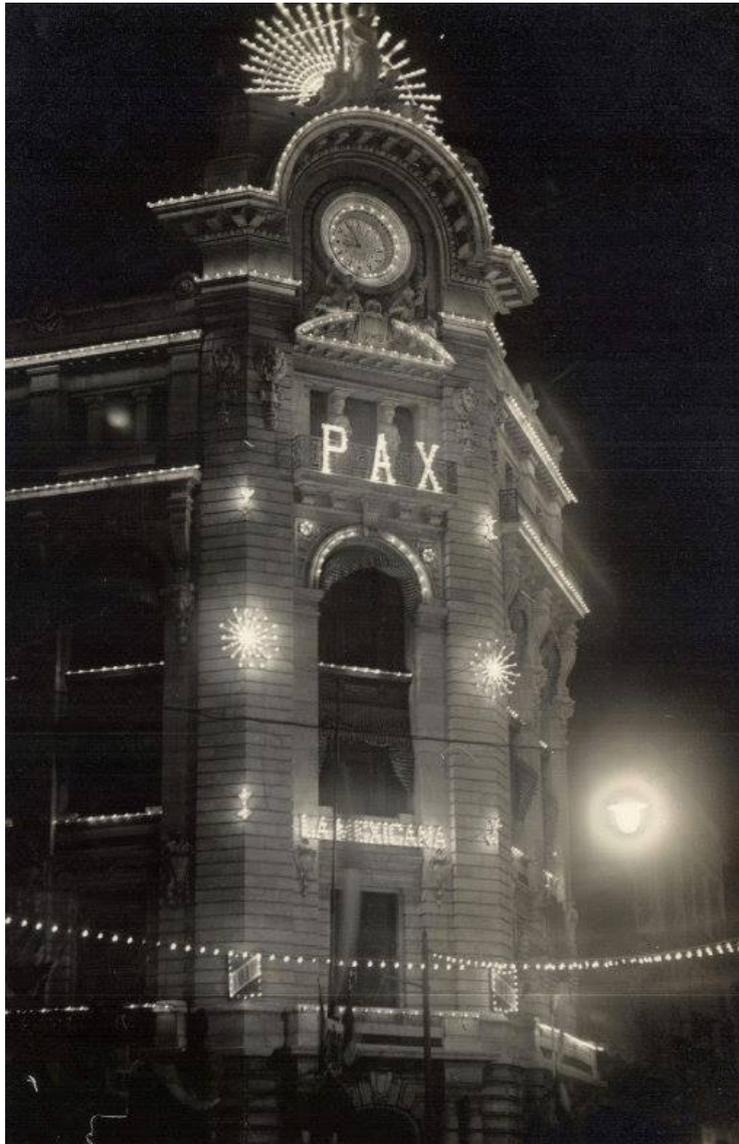


Image 21¹¹¹. The Store *La Mexicana*, 1910. Only some details were illuminated on the facades.

¹⁰⁹El Imparcial July 20, 1910.

¹¹⁰ García 1911, 152.

¹¹¹ U.A.C.J. 2010.

- Avenue 5 de Mayo.

In this avenue highlighted the illumination of the *Compañía de Luz Eléctrica y Fuerza Motriz* in comparison with other buildings. In the center of the public space was hanging a necklace of light, giving the aspect of a lighted tent or crown.

Along the avenue buildings were modestly illuminated, however the lighting was described as good and exuberant, maybe because the *Compañía de Luz Eléctrica y Fuerza Motriz* was there and its illumination was a heavy element in the lighting composition of the public space.

“Se distinguía por el buen gusto y la profusión de luz”¹¹².

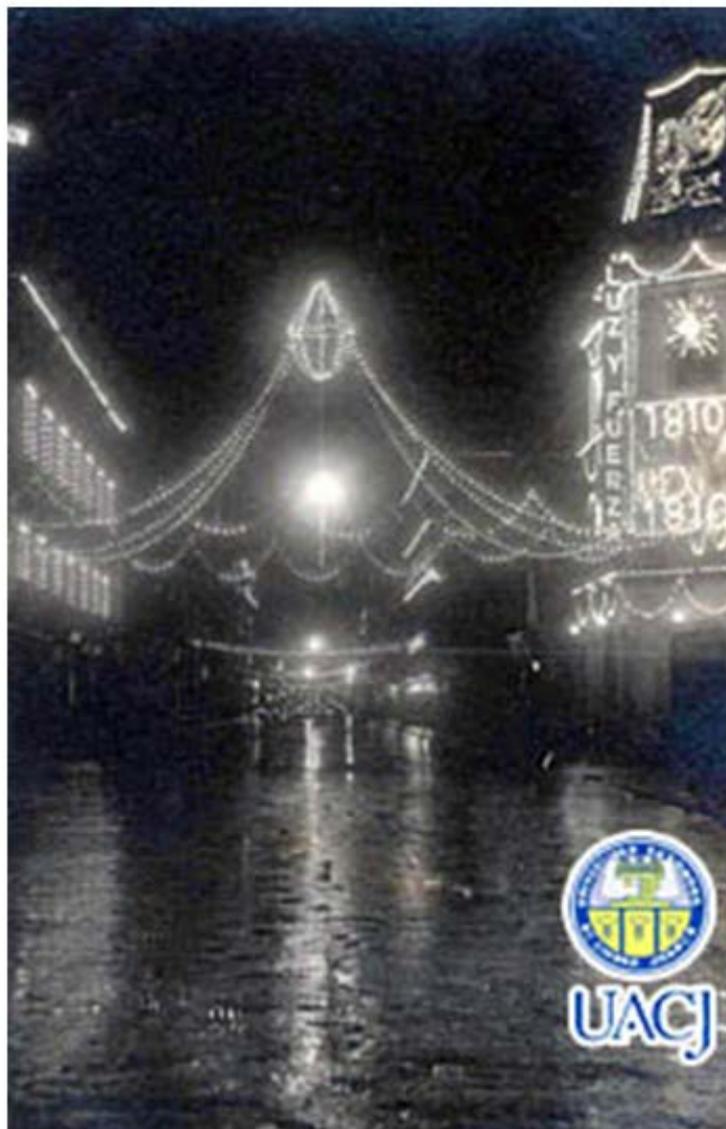


Image 22¹¹³. Avenue 5 de Mayo, 1910.

¹¹² García 1911, 152.

¹¹³ U.A.C.J. 2010.

- Avenue San Francisco.
In this avenue were located the Store *La Mexicana* and drugstore *Labadie*. Both buildings were the most and best enlightened. Along the avenue and between the facades of each side that contained the public space were hanging necklace of lights that according to the eyewitness had the three colours of the national flag, which gave the impression of joining the buildings.

“A lo largo de la Avenida de San Francisco, se caminaba como entre dos murallas de fuego, y los infinitos foquillos que cruzaban sus guías en las esquinas, formaban arcos con los tres colores de la bandera de México y se extendían sobre los detalles de las fachadas de los edificios, cuyos perfiles recortaban en perfecta claridad¹¹⁴”.

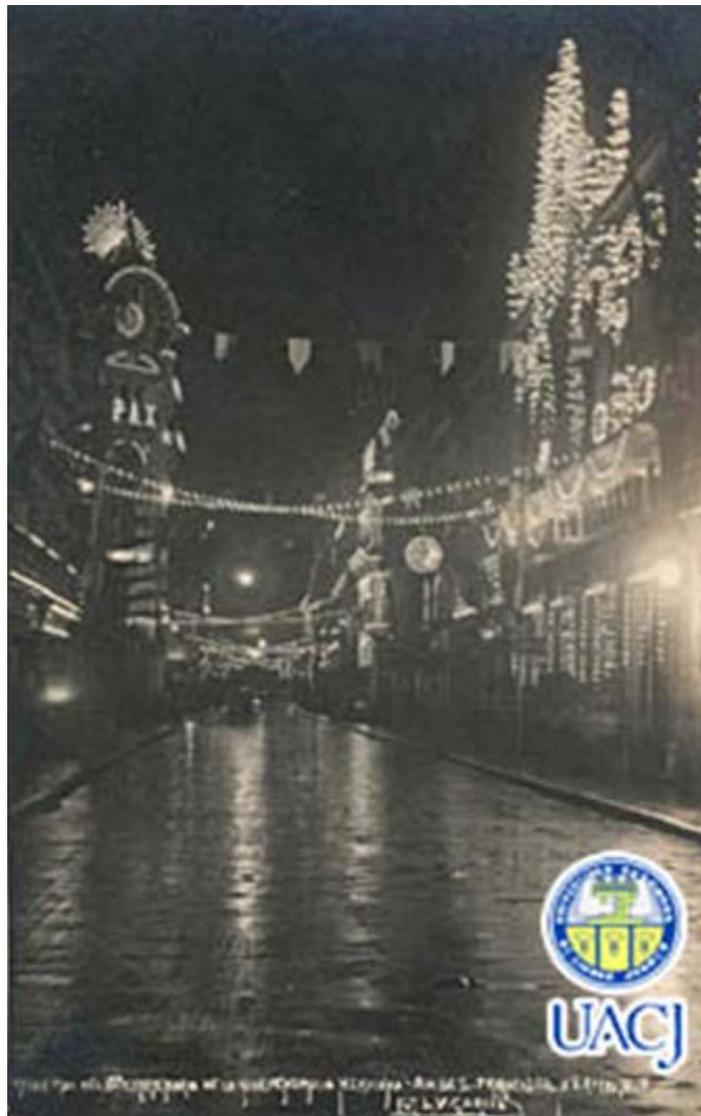


Image 23¹¹⁵. Avenue San Francisco, 1910. Necklace of light were hanging from one side of the avenue to the other side, linking the buildings through the colours of the national flag.

¹¹⁴Ibidem, 151.

¹¹⁵ U.A.C.J. 2010.

- Monumento a la Independencia.

The monument illuminated almost entirely. In the base, shaft and capital were placed hundreds of light bulbs to mark the forms and thus give a three-dimensional appearance. The main sculpture, which is located on the capital were placed four light projectors, one on each side to illuminate in an ascending way, this in order to print a dramatic effect.

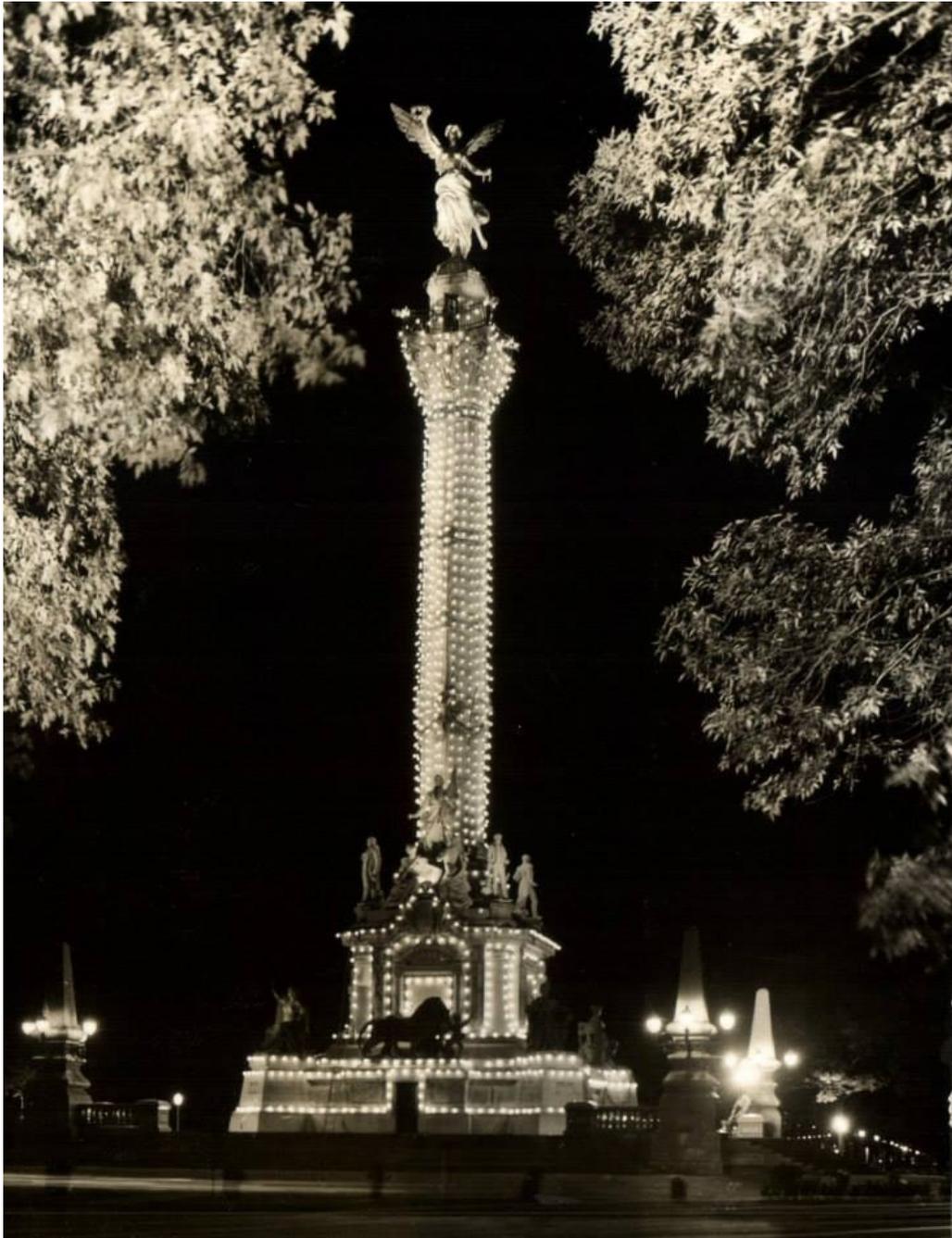


Image 24¹¹⁶. Monumento a la Independencia 1910. Technique used was contour lighting and light projection.

¹¹⁶ Lara 1910.

Undoubtedly, this commemoration of the Independence left a big impression on the inhabitants and visitors of that time in Mexico City. People could be witnesses of the technological advances in the field of lighting and the transition from the old lighting system based on gas and oil to the electricity, which exceeded the lighting power of known sources. Besides it was safer and was more versatile in applications.

“Este hermoso teatro, donde había venido desarrollándose la serie de festividades cívicas nacionales del Centenario, sobrepasó en belleza y esplendor a todo lo previsto¹¹⁷”.

The system implemented for the lighting during the commemoration of the first centenary was based mainly on incandescent light bulbs, which were used to achieve a tridimensional effect in darkness through the technique of contour lighting. This concept was already used for the illumination of the Eiffel Tower 10 years before.

Buildings with an important history for the people of Mexico were illuminated, for example the cathedral and the government palace, however the lighting project of the city was not only destined to buildings or monuments, but also public spaces like the two avenues, which were already mentioned. It can be said that through light President Díaz wanted to convey a feeling of nationalism and pride of being Mexican, since Mexico was in the technological vanguard.

The artificial light started to model the facades by strongly emphasizing their sculptural structure, and step by step the life started to move deeper into the evening hours, and finally the architects began to take the nocturnal appearance of their buildings into consideration, even the historic buildings and architectonic monuments. However, in those days not all the buildings and architectonic monuments that integrated the urban heritage were illuminated.

2.4. The urban heritage as a new advertising model during the night.

The word advertising is defined as: *“the techniques and practices used to bring products, services, opinions, or causes to public notice for the purpose of persuading the public to respond in a certain way toward what is advertised”¹¹⁸*. According to this, it is a means used to promote a good in order to sell it, or seeks to encourage people to do something or even to believe in a particular cause.

¹¹⁷Idem 154.

¹¹⁸Encyclopaedia Britannica Inc. (2014).

Advertising is not a new way how to persuade people. Throughout history it has undergone significant changes as a consequence of technological advances. For example, before the XV century, the traditional way to advertise was by word of mouth. After this XV century with the development of printing, the word as a main tool of advertising turned into written expression on paper for persuasion. Later the electric power boosted innovative ways that opened an array of possibilities for the application of lighting as a marketing tool.

Lighting as advertising not only allows promoting products for consumers, but also has been used as political propaganda and even as strategy that offers cities. In any case, over the years the historic buildings, emblematic constructions and architectonic monuments have been used as illuminated scenarios and large-scale advertising models.

This new use given to architectural works with social and/or historical value has resulted with profound changes in the conception of works at night, likewise a possible devaluation of the architectural object. In order to understand the roll that plays historic buildings, emblematic constructions and architectonic monuments used as: nocturnal advertising structures, political propaganda and as a tool of city marketing. That is why, in the next three sub-sections of this research, these three types of advertising are exemplified.

2.4.1. Architectural works used as nocturnal advertising structures.

In the decade of 20's, the illumination had been turned into an ideal medium for the commerce sector of the cities. To sell products was needed first to show them, and consequently it brought important changes to the architecture, not only to new architectonic productions destined to be used as stores, but also the image of some emblematic structures. These structures were used as advertising objects and in some cases as structural supports for advertising.

One emblematic work which today is considered as one of the symbols that represent France is the *Tour Eiffel*. While it is true that it was not contemplated as an urban heritage in the first quarter of the XX century, it was already considered as a symbol of modernity and technology. Probably it was one of the reasons why it was used as a structural support for the advertising of the company *Citröen*.

The Italian *Ferdinando Jacopozzi* named the "*Light Wizard*"¹¹⁹, designed the advertising of the company *Citröen*. For this he used 250 000 lights in six different colors¹²⁰, which were programmed. *Jacopozzi* was sponsored by *André Citröen*, who supposed to

¹¹⁹The Northern Times 1932, 6.

¹²⁰ Neumann 2002, 116.

financial all his works for ten years, of course, if *Jacopozzi* got success with his advertisement.



Image 25¹²¹. *Ferdinando Jacopozzi* 1925, Lighting of Eiffel Tower with Citroën advertisement.

¹²¹ Chris 2012.

Soon shop owners were using advertisements as the skin of the architecture, and this new trend spreads like a virus in the main European cities, such as Berlin and Paris, just as happened in the United States of America. As a result the luminous signs began to transform radically the image of this important cities, where the mains avenues started to look as a Rococo light style. It didn't matter if it was a new building, historic structure, or even an emblematic one. Traders just wanted to catch the attention of possible future costumers. One could say that under this context born finally the Light Pollution.



Image 26¹²². Broadway at night. Photo taken in 1926.

The critics and architects found in this new trend of advertising a dilemma. They opened a debate concerning of how new advertisements could integrates to the architecture, and how they should respond to this new form of expression and communication, since it has been discovered a new language that allows due to its versatility to change the appearance of the building during the night. One of these critics was Walter Curd Behrendt, who wrote in his book; *Sieg des neuen Baustil* that until the first quarter of the XX century, no one has been given too much attention to lighting as an effective tool in architectural design. Behrendt

¹²²Gellhorn 1926,135.

said that lighting is an important means that may facilitate the interpretation of the spatial function, spatial movement and even to highlight spatial relationships.

Behrendt exemplified his comments citing the case of a commercial building (*Haus Scharlachberg*), which was remodeled by Hans and Wassili Luckhardt and Alfons Anker. It is located at Kurfürstendamm 211 in Berlin, built in 1897 by Wilhelm Klopsch in historic style¹²³. In 1927 began the remodeling that included a completely radical change of the image of facades. The new style adapted to the work is named *New objectivity* (*Neue Sachlichkeit*). The project also contemplated to remove the tower structures and add walls, cornices and balconies, which were combined with continuous horizontal bands. The ground and first floor have turned into commercial portals, highlighting big shop windows on the ground floor.



Image 27¹²⁴. Building at Kurfürstendamm 211 in Berlin, Original appearance of the building before 1926.

¹²³Berlin 2014.

¹²⁴Abload 2014.



Image 28¹²⁵. Unfinished renewal of the building, the photo was taken between 1927-1929.



Image 29¹²⁶. Finished work. The photo was taken in 1929.

¹²⁵Neumann 2002, 32.

¹²⁶Neumann 2002, 32.



Image 30¹²⁷. The building was affected during the Second World War. The photo was taken in 1946.

What captured the attention of Behrendt was not the style in which the building was renovated, but rather how was achieved the fusion between the illuminated signs with the elements of the facades. To do this, the horizontal bands that run along the facades were used as blackboards, where messages directed at potential consumers were written with light. Lighting was not only used as advertising, but also to accentuate the horizontality of the building, highlighting the lines that integrate the last body. The main facade was hierarchized through a play of light and illuminated geometric shapes that crown this façade.

Behrendt was aware that when the luminous advertisings are not integrated into the architecture, it could cause formal problems to the works. In this sense he expressed his concern, which was shared with others critics like Max Landsberg and Hugo Häring. Landsberg thought that the most beautiful cityscape, the most beautiful building disappears in the night behind its lights¹²⁸, while Häring claimed in 1927:

“Die Reklame ist auf dem Wege, die Architektur zu verdrängen..., man könne gar von einer »Zerstörung der Architektur« durch die Lichtreklame sprechen,

¹²⁷Abload 2014

¹²⁸Landsberg 1927, 35.

denn ... das Geschäftshaus hat keine Architekturfassade mehr, seine Schale ist lediglich Gerüst für Werbemittel, Schriftschilder, Lichtreklame.¹²⁹

"dass das Nachtlichtbild der Schaufenster und Geschäftshäuser werbeträftiger wirkt als das Tagbild"¹³⁰.

These concerns were undoubtedly the source of inspiration that led the architects to transform what for someone was a problem into advantage, thereby creating buildings that at night were self-luminous sculptures, giving the appearance of being gigantic public lamps. As an example of this kind of integrations between light and architecture is mentioned Le Pavillon des diamantaires of Jacques Lambert, Gus Saacke and Pierre Bailly. This Pavilion was built under the character of being an ephemeral architecture for the Exhibition of Decorative Arts of Paris in 1925. The concept of this work is clear; it is a diamond, which at night is illuminated from the interior, thus imitating the brightness of the gem that characterizes it.

The type of works as the case of the Pavillon des diamantaires, where the building complies not only with the aspects of harboring and shelter the activities that take place inside of it, but also the treatment of light lets that its structure also serves as a huge advertisement, which transmits a clear message (type of commercial activities) to potential consumers. This kind of solution reduces the number of advertisements, thereby avoiding the saturation of information in the streets.

¹²⁹Häring 1927, 5-8.

¹³⁰Häring 1928, 7.



Image 31¹³¹. Le Pavillon des diamantaires at night illuminated from its inside to the exterior.

¹³¹Ackteon 2013.

2.4.2. Historic buildings and architectonic monuments used as an advertising tool of city marketing.

The concept of City Marketing is relatively new. It was used and approved for the first time in *Frankenthal* (Germany) in 1987¹³², in order to be used as a new model for building and housing. Today this concept implies to be used as a management tool of postmodern cities that goes beyond the civic involvement, re-design of the city and strategic planning, in order to achieve the "*ideal city*". One of its aims is to find an own identity that denotes its values, projecting to inhabitants and visitors the qualities and resources that the city has, such as its historic buildings and architectonic monuments.

Although the concept of City Marketing was used for the first time in 1987, it could have its origins hundred years earlier, possibly dating back to the first international fairs of the late XX century. These fairs were created under a character of institutional promotion, which had the function of revealing at national and international level, the new industry products and technological advances of the participating countries. These events usually attracted many people; therefore it was a good opportunity to promote the qualities and resources of the city, with the intention of boost tourism. In order to achieve it, buildings with a certain social value were used as illuminated scenarios, where lighting dressed them with sheets of lights, highlighting their architecture. In other cases ephemeral structures were built like the Tour Eiffel, which was thought to be dismantled when the fair was ended. Anyway, these structures were also bedecked with lights.

One of the first international fairs where the advances of lighting were used and demonstrated in the exterior of architectural structures took place in 1890 in Paris. The second in the world and first in the Americas was Chicago World's Fair in 1893. In this event participated about 70,000 expositors of 46 nations¹³³. For this occasion it was necessary to design a propitious urban space, which project was assigned to Frederick Law Olmsted, America's foremost landscape architect, who was responsible for laying out the fairgrounds. The exposition's buildings were designed by architects Henry Ives Cobb, Richard Morris Hunt, Charles McKim, George B. Post, and Louis Sullivan¹³⁴. Planners selected a classical architectural theme for the fair. It's important to notice that more than 200 buildings occupied the exposition's grounds.

The new buildings with white stucco that were built and those already in the grounds where the fair would carry out were illuminated by the company Westinghouse Electric which

¹³²Zerres 2000, 23.

¹³³Chicago Historical Society 1999.

¹³⁴Idem.

used more than 90,000 lights for this event. This represented at that time more than 3 times the illumination used for the entire city of Chicago¹³⁵. The electric illumination should astounded viewers, since it was the first time that the people saw such kind of spectacle of light.

"If evenings at the fair were seductive, the nights were ravishing. The lamps that laced every building and walkway produced the most elaborate demonstration of electric illumination ever attempted and the first large-scale test of alternating current¹³⁶".

"These were important engineering milestones, but what visitors adored was the sheer beauty of seeing so many lights ignited in one place, at one time. Every building, including the Manufactures and Liberal Arts Building, was outlined in white bulbs. Giant searchlights -- the largest ever made and said to be visible sixty miles away -- had been mounted on the Manufactures' roof and swept the grounds and surrounding neighborhoods¹³⁷".

"Large colored bulbs lit the hundred-foot plumes of water that burst from the MacMonnies Fountain." ... it "was like getting a sudden vision of Heaven¹³⁸".

The illuminated white of the buildings created a contrast between them and the dark of the sky. The lighting technique implemented was streets lights for streets, walkways and squares. For the buildings light bulbs were placed on the parapets and moldings, in order to highlight the stories of the buildings, in the same time to give scale, delimiting the heights. In the case of The Grand Court of Honor Building, the ribbings of its dome were remarked by light bulbs. The fountains were also lighted, contributing to the new night landscape of the city. The monumental urbanism promoted the primacy of urban vista over architectural coherence, which is a mark of the modern imaginary of urban space. Lighting accentuated the monumental architecture in Chicago, contributing to the beautification of the city, which years after would know as City Beautification Movement.

The fair not only brought artificial light to the people, or showed the possible applications of electricity to be used in architecture, but also granted those attributes that characterized Chicago and that contributed to build the concept of ideal city, which is one of the main aims of City Marketing.

¹³⁵ Adams 2004, 48.

¹³⁶ Larson 2003, 254.

¹³⁷ Idem.

¹³⁸ Idem.

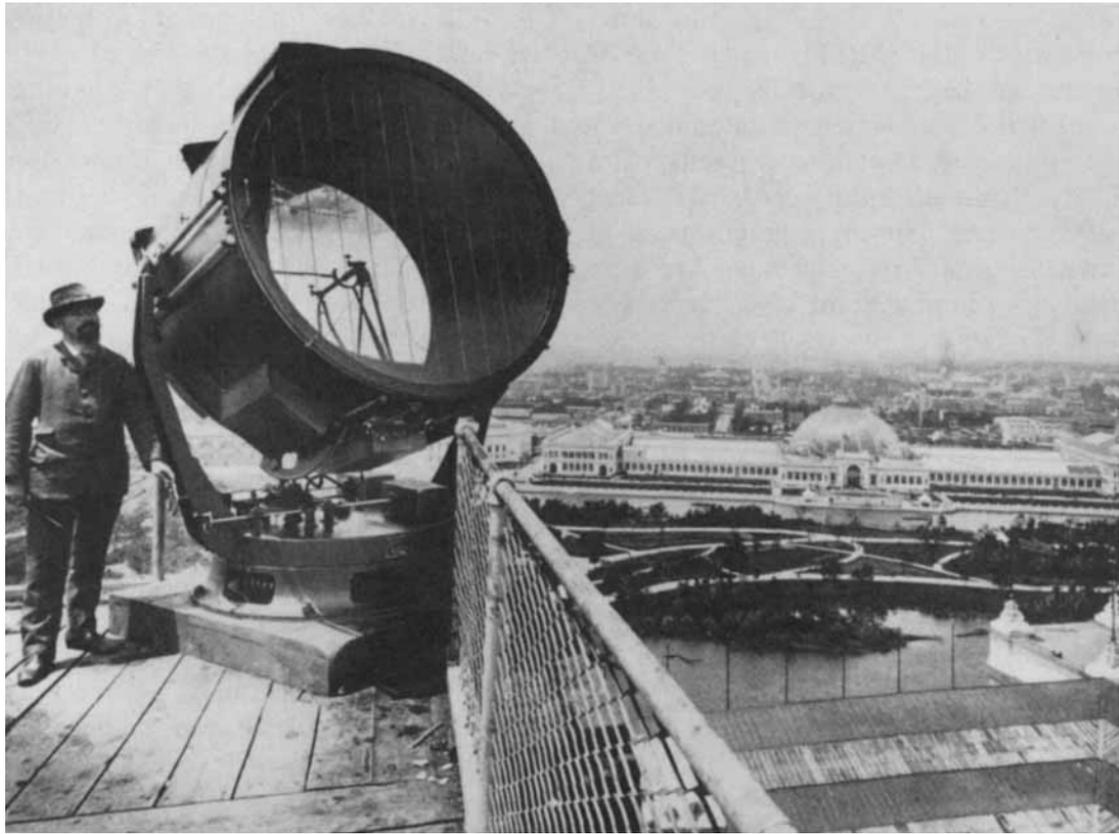


Image 32¹³⁹. Carbon Arc searchlight on the roof of an Exhibition building, Chicago's world fair 1893.



Image 33¹⁴⁰. Searchlight on the roof, illuminated buildings and fountain in Chicago's world fair 1893.

¹³⁹Barret 2011, 65.



Image 34¹⁴¹. The Grand Court of Honor Building at night, Chicago's world fair 1893. Contour lighting technique used to delimiting the heights.

After the Chicago's world fair, the people of the first quarter of XX century were the next witness generation that rediscovered the architecture during the night, using the knowledge that was developed in the lighting field. It opened more opportunities to appreciate and perceive the architectonic forms. Not only the world fairs were the ideal stages to prove and improve the lighting techniques and its advances. Soon new events known as festivals of light were carried out in some cities. The aim for these festivities was to illuminate historic buildings or architectural monuments, in which the people identify themselves, or those structures with social value. For this it was used lighting to highlight the architectural forms and details throughout the night.

"In den 20er Jahren des 20. Jahrhunderts waren in Europa <Lichtfeste> weit verbreitet. Obwohl es sich nur um temporäre Veranstaltungen handelte, konnten die umfassenden Lichtinstallationen doch die Nachwirkung einer Stadt sichtbar verändern¹⁴²."

Although the festival of lights were already know in Europe, they were developed by fireworks, but in the beginning of XX century the electricity brought other tool that allowed to be used more time than the fireworks. These festivities took place from few

¹⁴⁰Bookdrum 2013.

¹⁴¹ CodyP 2009.

¹⁴² Schmidt 2006, 19.

days to one month, after that all the equipment were dismantled and sometime reused for the next year. One of the cities that celebrate it was Vienna, which in 1927 illuminated its Town Hall through the use of footlights and light projectors. It created a game of contrast between light and shadows. The openings of the building were lighted from inside, used as a visual base background and figure (see image 35).



Image 35¹⁴³. Town Hall of Vienna in 1927. Illumination technique footlight and light projectors.

In 1932 took place the Light-week in Zurich, where not only the technological advances in lighting field were showed, but also the new architectural trends of the modern movement. During this week both topics were integrated, reinforced by different cultural events that carried out in the illuminated streets.

The companies AEG and Siemens were convoked by *Zentrale für Lichtwirtschaft*, in order to participate in the lighting project of the city¹⁴⁴. Both companies had already cooperated in the festival of lights of Berlin in 1928, and due to the experiences that they had, was decided to invite them for this event. This event would promote the image of the city and therefore favoring the tourism industry of Zurich, that's why they had an important role in organizing the Light-week.

The main idea was that the Light-week would become in the city's Great festival that contemplated multiple activities, therefore was necessary to design a program which were

¹⁴³ akpool.de 2011.

¹⁴⁴Bignens 2013, 14.

integrated by fireworks, open air concerts, acrobats, balloons for children and aerobatic squadron¹⁴⁵. All these activities would make more attractive the event, reinforced by lighting as the main show, where besides of illuminating the public spaces, also the light was used to adorn the public fountains, monumental buildings like temples and schools and new buildings.

The new buildings which corresponded to the modern movement were filled with light. The large transparent surfaces were illuminated from interiors, radiating light to exteriors, giving the impression of being huge lamps. The contour lighting technique was also used in some buildings, in order to give the effect of lightness in the structures.

Lighting played an important role for traders not only during the event, but also daily after the Light-week. A new publicity tool was discovered, which helped to show the products at night through the store windows and due to the versatile characteristics of light, allows the names of companies and shop signs to shine overnight. This highlighted the land-use, changing the nocturnal aspect of city centers. This excessive use of lighting, especially in big cities like Berlin, London and New York, triggered a pollution problem and marked the beginning of what today is known as light pollution.



Image 36¹⁴⁶. Zurich Light-weekin 1932. Footlight and projectors illuminated historic buildings and monuments of the city. Also searchlights placed on some roofs were used to light the sky.

¹⁴⁵ Idem.

¹⁴⁶Ibidem, 17.



Image 37¹⁴⁷. Zurich Light-week in 1932. Buildings were illuminated from indoors to outdoors. Contour lighting technique was also used and the store signs with light were placed on the facades.

One of the important contributions of Zurich in the field of lighting was that in 1928 developed laws, in order to regulate the outdoor lighting. The office in charge to regulate that the lights do not alter the image of the buildings, through the control of excessive illumination on the surfaces of the facades was named *Städtische Amtsstelle für Aussenreklamen*¹⁴⁸. This initiative grew out of the experiences of cities like Berlin, London and New York, where there were no regulations and therefore cities kept excessive light at night.

In events like world fairs and light festivals surely large sums of money were invested, in order to beautify the city, although this was only for a short time. Undoubtedly these festivals over the time had generated large profits that make cities fully profitable business that transforms this events into an advertising tool, which is known today as a strategy of city marketing.

The city marketing focuses in city-center as main point of identification, where economic and cultural activities take place. To achieve the ideal city it is needed to pose strategic plans formulated from an interdisciplinary perspective. One of these disciplines as it is already mentioned is lighting, which helps to make attractive not only the cores of cities, but also an entire region for investors, tourists, citizens and local partners.

¹⁴⁷Bleuel 2013, 26.

¹⁴⁸Ibidem, 16.

“Die Anziehungskraft und die Bedeutung des Stadtzentrums als Ort des Einkaufens, der Arbeit, der Kultur, der Bildung, der Freizeit und des Wohnens soll gesteigert werden. Das erfordert das noch stärkere Abstellen der Angebots- und Leistungspalette der Innenstadt auf die Bedürfnisse und Anforderungen der aktuellen und potenziellen Nutzer sowie die Erhaltung der lebendigen Nutzung- und Wirtschaftsvielfalt“¹⁴⁹.

Lighting also helps to reinforce the sense of identity, builds the pride of a community, increases the economy, providing new employment opportunities, maintaining stability and expands the horizons of the city. As a contemporary example we can mention the case of Berlin Germany, which since 2005 celebrates each year a festival of lights. Its aim is to transform the city (landmarks, monuments, buildings, streets and squares) into an illuminated stage by the use of polychromatic lights, where buildings and architectonic monuments are the main actors. National and international light designers create light shows, in order to tell stories. Although the festival has a duration only of ten days (every year), it attracted in 2013 about 2000,000¹⁵⁰ visitors.



Image 38¹⁵¹. Berlin “Gendarmenmarkt“, Festival of Lights in 2013. Light projectors have been strategically placed, in order to impregnate an atmosphere of drama. To achieve it, projectors were used in an ascendant way, technique known as footlight.

2.4.3. The exterior lighting of historic buildings and architectonic monuments used as political propaganda.

Light along history in some cultures has had an intimate relationship with the divine and has symbolized the power, reason why it has been used by some kings, emperors and political leaders as a sign of their status. For example, in Egyptian culture the god Ra was the sun, who was responsible giver of life, death and resurrection. The ancient Pharaohs were considered sons of Ra.

¹⁴⁹Zerres, Zerres 2000, 29

¹⁵⁰City Stiftung Berlin 2013

¹⁵¹Fotowahn_Berlin, Herrmann 2013.

In the middle of XVII century in France, Louis XIV was known as *Le Roi Soleil*¹⁵² (the Sun King). This name was given to him after a ballet (*Le Ballet de la Nuit*) written by Jean Baptiste Lully, where the king danced representing the sun, while ministers were the planets. In this event was celebrated the entry of the king into Paris, representing the triumph of light over darkness times. This reproduced the political situation that the country had in XVII century.

The artificial light was a key tool used to reaffirm and promote the victories and the power of France to the people. For example, in the *Place des Victoires* in Paris, the sculptor Martin Desjardins¹⁵³ made the statue of Louis XIV. The king appeared crowned by an angel and at his feet there were sculptures known as the four captives, representing the four defeated nations during the Franco-Dutch War (1672-1678). In the composition four columns were erected, on which were placed lamps to illuminate the public spaces and especially to the sculpture, creating a downward lighting on all four sides of the work. Possibly in order to reduce shadows on Louis XIV and in this way to show him in the center of the place as a divine being, to whom the shadows of the night were not able to reach him.

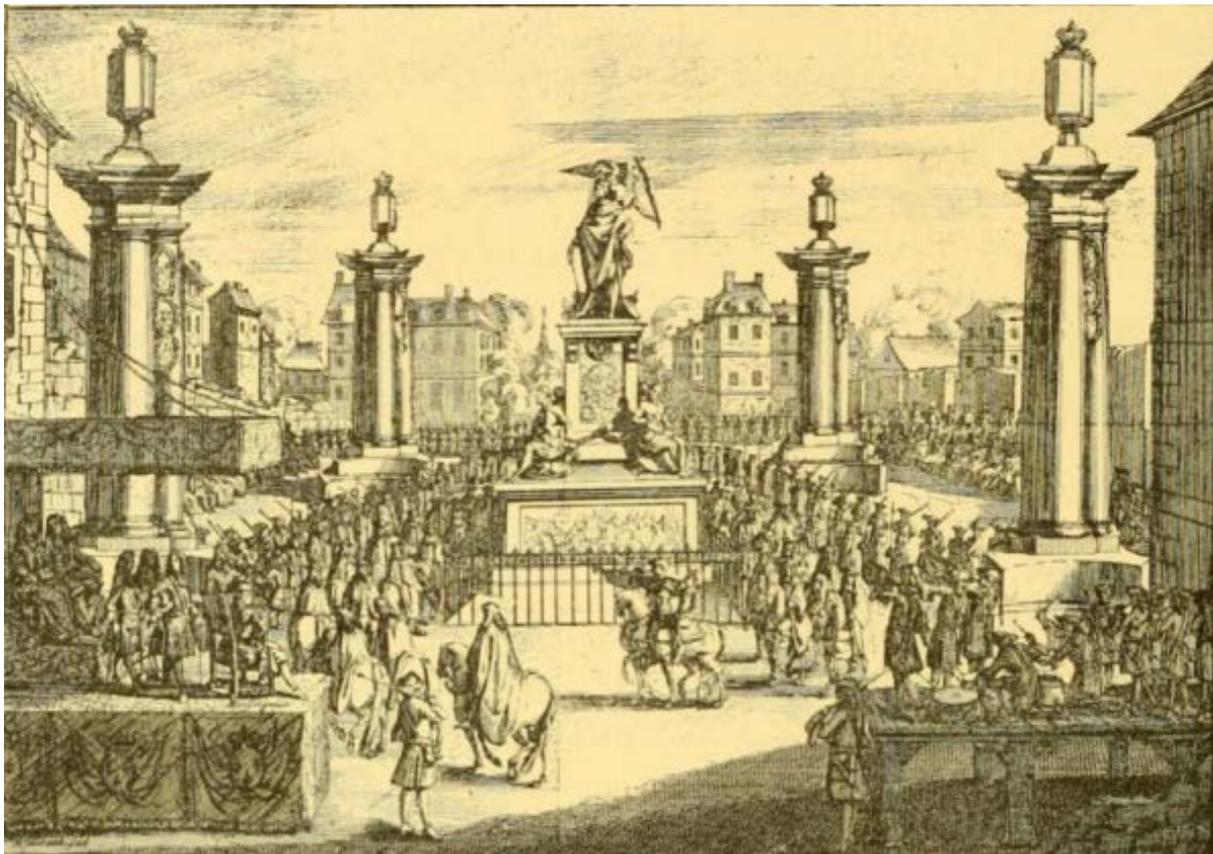


Image 39¹⁵⁴. The lighting tower as symbol of power, *Place des Victoires* 1686.

¹⁵²France culture 2013.

¹⁵³He was named also Martin Van den Bogaert.

¹⁵⁴d'Allemagne 1891,324.

Another character who used the light as a symbol of divine power on earth, and as a mean of psychological political propaganda was Adolf Hitler. He possibly based his political ideas on the history to discover the relationship between light, the divine and power, which used to his advantage in order to reassert symbolically his power. In fact, Hitler associated the Aryans as *Lichtbringer*, moreover Himmler named him as the greatest *Lightgestalten* of the history. The swastika cross used as a Nazi symbol has been used in some cultures, like Hindu to represent the solar wheel, which is related to the light.

The fire, lighting and architecture, was one of the combinations used by the Nazi party, in order to promote their political ideals. The fire "*sollte eine reinigende Funktion ausüben, wurde doch durch die Flamme ein ritueller Wirkungsraum geschaffen*"¹⁵⁵. The heat from the flame represented the feeling of security and social protection¹⁵⁶, seeking in this sense that individuals identify with society, who together give a better stability to the nation. That is why the flame was an attribute and a symbol of the people in the Nazi regime that was used not only to illuminate public spaces, interiors or as an ornamental element that crowned the roofs of some buildings, but also it was used in some rituals like solstice celebrations. This celebration had pagan roots, in which the ancient Germans have chosen the longest night of the year to celebrate the birth and gradual increase of light¹⁵⁷.

Lighting is a suggestive visual medium that was used by Albert Speer, who used the symbolism that represents the light for the Nazi party. One of his famous works was a show which he called the *der Lichtdom*. The concept based on the theatrical lighting¹⁵⁸, transformed the sky into a giant stage, where 130 reflectors¹⁵⁹ projected intangible colonnades of light that served as linker element between earth and sky, while serving as a framework for concentrated mass in the *Zeppelinwiese* in Nurnberg.

Der Lichtdom's columns were projected thousands of meters above the ground surface (eight kilometers¹⁶⁰), creating a light structure of large dimensions, even much higher than any architectural work could ever have. Eyewitnesses were astonished by this lighting project, who shared their impressions, like Sir Nevil Henderson. He expressed: *it is an ice cathedral*, while Peter Adam compared it with *a huge crystal rising into the sky*¹⁶¹.

¹⁵⁵Römhild 1992, 66.

¹⁵⁶Hoormann 2003,290.

¹⁵⁷Sala 2003, 360.

¹⁵⁸Hoormann op.cit., 293.

¹⁵⁹Karasek 2010, 29.

¹⁶⁰Idem.

¹⁶¹Hoormann op.cit., 296

The lights show of Speer was one of the biggest and most spectacular events of the Nazi era. It was an elaborated political propaganda that was loaded with symbolism that promoted the political ideology and had as main goal to persuade and convince the people of the greatness of Hitler and the superiority of the Aryan race. When the projectors were turned on the cathedral with ephemeral features arose, which had been designed to be perpetuate as a temple where cult to Hitler would held, who according to the National Socialists was the new messiah¹⁶².

Speer used for *der Lichtdom* warm light that represented the people and cold light for the government¹⁶³. The colors that he used were light blue tones, evoking the divine and cosmic, which contrasted with the red of the flags. To this flags were projected upward lights, in order to give the impression of being tongues of fire. In this show every element had a function and meaning, in order to create a propitious environment for Hitler, who was the central figure of this event.



Image 40¹⁶⁴. Lichtdom in Nurnberg 1937. Columns of light projected thousands of meters from the ground to the sky.

In the Nazi's architecture can be seen clearly the influence of Egyptian, Greek and Roman cultures. Possibly this typology was chosen because these three civilizations built

¹⁶²Bartetzko 1985, 55.

¹⁶³Hoormann op.cit., 296

¹⁶⁴Greg 2007.

great empires and even today there are remnants of its glory, which is represented through their architecture. Probably these arguments explain why Nazi's buildings are loaded with an expressive language, which turned into an aesthetic-politic model of the regime, in order to seduce, impress and intimidate the people.

The materials that characterize the Nazi's architecture are stones, like marble and granite¹⁶⁵. The idea was to use them in order to resist the passing of time, without wear that deteriorate them, turning the buildings and architectonic monuments into a stone document, which will give testimony over the years of the greatest of the Third Reich.

In this regard Hitler said:

*"Wir nehmen Granit, fabuliert er; dann würden die steinernen Zeugen der Bewegung gleich Domen "hineinragen in die Jahrtausende der Zukunft"."*¹⁶⁶

Nazi architecture was characterized by the horizontality of the buildings which was highlighted through the use of horizontal volumes, cornices along the entire facade, rows of windows, and the use of stony materials. All this combined could have two purposes; the first one could be to convey the message of a solid and stable government, while the second one could serve as a possible bomb shelter. The facades of the buildings were completely symmetrical and some buildings like the model of Speer's project *Grosse Halle* had classical elements like porticos and pilasters, which mostly responded to the Doric order.

The Nazis not only thought to erect new architectural structures, but also use historic buildings, especially those with history that exalt the ideals of the regime, such as the case of *Wewelsburg Castle*. According to Karl Maria Wiligutin this building will take place in the future the *Schlacht am Birkenbaum*. This could be a reason why Himmler chose this building in order to be used as a school for the S.S¹⁶⁷. Ancient constructions as *Wewelsburg Castle* needed to be adequate according to the intention of use, in addition to condition them with symbolic elements where lighting should play the role of the divine and at the same time give hope, promote and encourage nationalism in the German people.

The fire, artificial light, new buildings with classic reminiscences and old architecture were one of the main political propaganda that created the perfect scenario for the demagogic power and mass suggestion took effect on the people. For example, in 1936 the

¹⁶⁵In the beginning of the Nazi's regime were built buildings of reinforced concrete, glass and iron structures like the Central Electric of Emil Fahrenkamp and the Tempelhof Airport of Ernst Sagebiel. When the Second World War started these materials were used for military purposes.

¹⁶⁶Krüger 1989, 64.

¹⁶⁷John-Stucke 2011, 196.

avenue *Unter den Linden* in Berlin was decorated with columns on which Nazi symbols like the swastika and the eagle of the party were placed. The lighting technique used was ascending, which printed a dramatic effect. The buildings along the avenue were also illuminated.



Image 41¹⁶⁸. *Unterden Linden im Festschmuck, Olympiade 1936 ungebraucht*, Berlin 1937. Lighting technique used was ascending.

¹⁶⁸PhilafriendseShop 1937.



Image 42¹⁶⁹. *Westachse bei Nacht, Sonderstempel Berlin Deutsche Wehrfreiheit 1938*. This image is a propaganda cart, where imaginary buildings were illuminated by ascending lighting technique. The column of victory appears as a visual landmark in the background. Reflectors projected light to the night sky resembling as artificial torches.

The Victory Column in Berlin was inaugurated in 1874, was built to symbolize the victory of Prussia against Denmark and to commemorate the battle against Napoleon III. It is possible that for these reasons the architectural monument was used for publicity purposes of the Nazi regime, in order to exalt and celebrate the German power. The lighting design was developed taking care of the work's image. Columns arranged in a carousel form were not lit, only the interior which forms the pedestal of the column, creating an effect of background and figure. Nazi's flags (or banners) were placed around the shaft of the column to which was projected upward lighting, in order to symbolize tongues of fire. The angel on the top of the capital was also lit in ascending way. As a whole can be perceived that the lighting concept that prevailed was the drama.

¹⁶⁹PhilafriendseShop 1938.

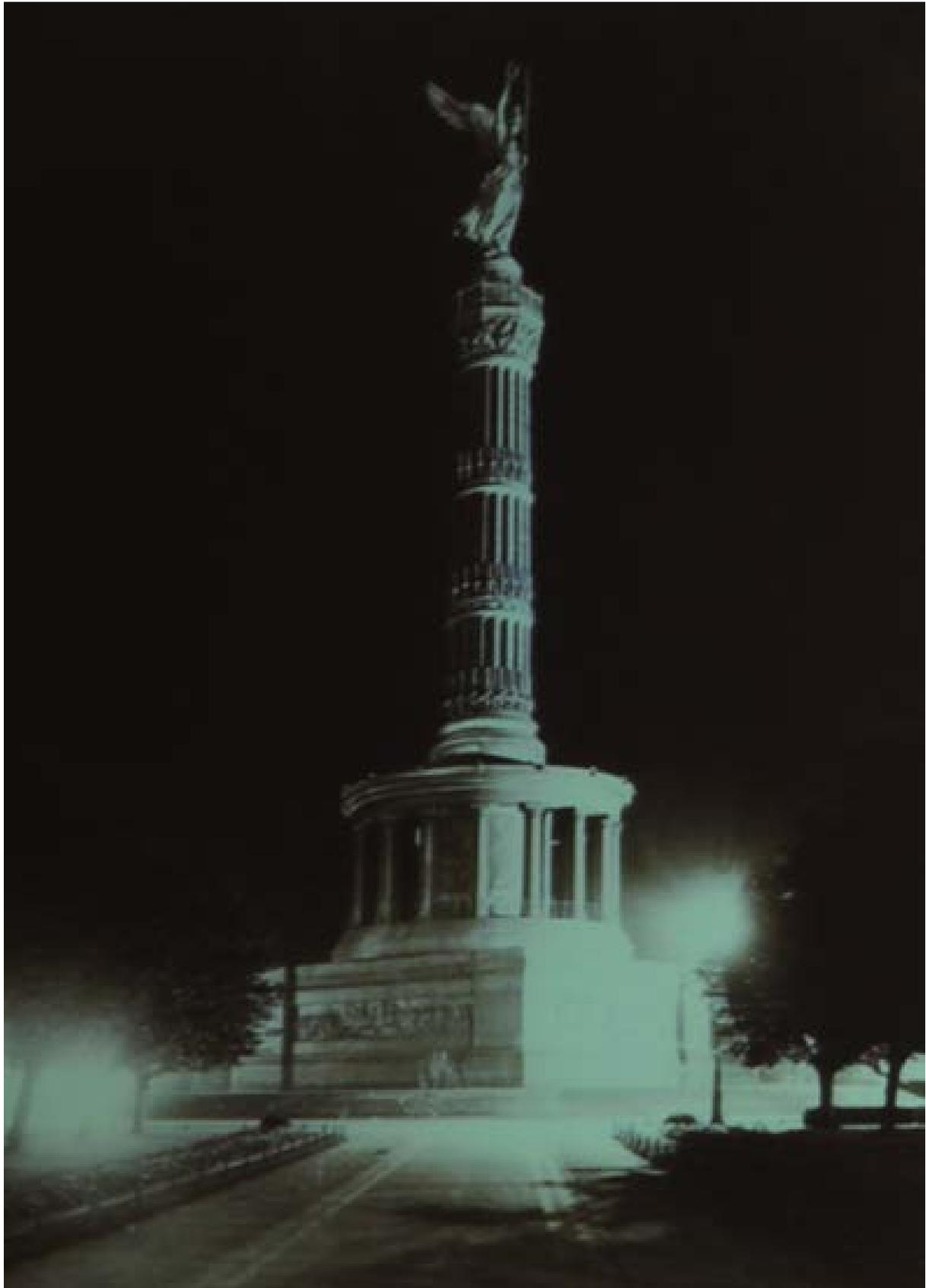


Image 43¹⁷⁰. Victory column in Berlin before the Nazi Regime.

¹⁷⁰Lingenauber 2012.



Image 44¹⁷¹. Victory column in Berlin during the Nazi Regime.

The image shows that the column was illuminated through intrusive light generated by streetlights. In comparison with the image, where can be seen how was the illumination

¹⁷¹ Idem.

during Nazi regime. The sources of light can't be seen and the streetlights were removed in order to increase the contrast between light and darkness.

The examples contained in this research testify how the exterior lighting of architectural works and monuments has been used throughout history by some governments, in order to convey messages with psychological effects to the people. In the case of Nazis, they were looking to recognize Hitler as a god. To do this a strategy was designed, where the mysticism that has the light played an important role, but to reinforce this idea it was necessary to develop different parallel programs. For example children from kindergarten were taught to adore Hitler and to achieve it, the Nazis had instructed them to pray.

“Führer, mein Führer, von Gott mir gegeben, beschütz und erhalte noch lange mein Leben! Hast Deutschland gerettet aus tiefster Not; Dir danke ich heute mein tägliches Brot. Bleib lang noch bei mir, verlaß mich nicht, Führer, mein Führer, mein Glaube, mein Licht! Heil, mein Führer!¹⁷²”.

The lighting, buildings and monuments created the perfect scenario where people could worship Hitler and the ideals of the regime. It is possible that today's outdoor lighting is not used with the intention of comparing any political party or any ruler with God. At present this type of lighting perhaps has more aesthetic and artistic purposes than political, or at least is not obviously used in this way.

2.5 Architectural outdoor lighting in the mid-twentieth century; the use of neon lamps.

In the middle of XX century started the use of *neon*¹⁷³ lamps, which was utilized mostly on the facades of the stores, creating a stage of light with innumerable multicolored forms, which began to change and reshape the streets. Due to its flexibility and bright colors, it was quickly accepted for the design of advertisements. One disadvantage of this lighting system was that it has a low efficiency, reason why its application was not so common in architectural outdoor lighting.

¹⁷²Kohrs 1983, 28.

¹⁷³The neon lamp was discovered by *Heinrich Geissler* in 1856. He introduced neon gas inside of a transparent glass tube and he applied electricity by a coil and it generated a blue light. After *Geissler* there were many people who worked and made test with different gases but it was until 1926, when *General electric* took possession of the patent and it was produced massively after 1938. Las Vegas is today the city with more neon lamps.

An example of the application of neon lamps in architectural outdoor lighting is *Das Blau-Gold-Haus* in Cologne, Germany. The building was built in 1952 by Wilhelm Koep for the company *Eau de Cologne* of Ferdinand Mülhens. The lighting system is based neon tubes and incandescent bulbs. The light sources were placed in a way that they could emit indirect light, thereby creating degradations on the surfaces of the facade. White neon tubes were used in the slot of the cornices, while incandescent bulbs and neon lights were placed on pillars, which are embedded between the windows.

In the inside were placed light sources in ascending way between the windows and the curtains, generating a cascade effect, in which the closest part to the light sources resembles the foam, generated when the waterfall strikes the perpendicular surface. Possibly the light designer conceptualize his creation from the product marketing of the company *Eau de Cologne*.



Image 45¹⁷⁴.Outdoor lighting of *Das Blau-Gold-Haus* in Cologne, Germany, 2012.

¹⁷⁴Robbin 2012.



Image 46¹⁷⁵. Detail of outdoor lighting of *Das Blau-Gold-Haus* in Cologne, Germany, 1992.

The use of neon lights had a great boom, especially in the commercial sector of big cities. It is enough to observe photographs of cities like Las Vegas and Broadway in New York. The excessive use of this lighting system gave as a result overload of information in the main streets and avenues, and step by step this brought significant changes in the urban image of these cities.

¹⁷⁵Neumann 2002, 183.



Image 47¹⁷⁶.Golden Nugget and Pioneer Club along Fremont Street in 1952, Las Vegas.



Image 48¹⁷⁷. Broadway New York, 1955.

¹⁷⁶Edstrom 1952.

¹⁷⁷Schaedel 2010.

Art and architecture critics in different places around the world were aware of the new changes of the city on the lighting field, and how it reshapes their cities. For example during the International Festival of Youth held in Warsaw in the summer of 1955, professional journals discussed about *“modern uses and the compositional-aesthetic sense of light in architecture and popular magazines joined in the enthusiasm for the metropolitan ambitions of the new aesthetic ideology¹⁷⁸”*. This new ideology meant that the urban image of cities should be shaped by light and color. This goal could be achieved by the uses of neon signs along the main streets and avenues¹⁷⁹.

During the decade of the 50s neon lights were an essential tool used in *Googie* architecture. This variant of the modern style was based on the culture of cars, jets, space and atomic age. It exemplified the spirit of what was demanded by a new generation, which was excited under the prospect of a bright and highly technological future. The features of this style were rounded edges, large pylons and already mentioned neon lights. This last was responsible to give light not only to signs, but also to show the edges of the buildings at night, highlighting its architectonic characteristics. These all features symbolized *“invisible forces of speed and energy¹⁸⁰”*.

Neon lights besides being a tool that facilitates the sale of products, it helps to define the contours of some architectural works at night, and it has been also used to communicate under a direct way the activities that take place in the interiors of buildings. Even for its characteristics of versatility has been used by religious groups as an instrument that allows to materialize the basis of their beliefs and simultaneously giving identity and character to their temples.

“When Jesus spoke to the people again, he said: I am the light of the world; anyone who follows me will not be walking in the dark, but will have the light of life¹⁸¹”.

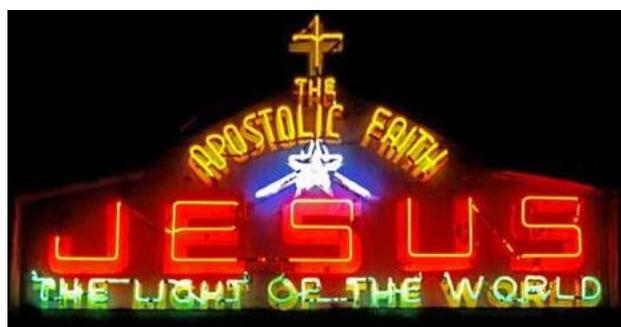


Image 49¹⁸². Neon sign of the Apostolic Faith Church in Vancouver, 1950.

¹⁷⁸Stanislaw 1955, 26-29.

¹⁷⁹Chmielewska 2010, 57.

¹⁸⁰ Hess 2004, 29.

¹⁸¹John 8:12.

¹⁸²Houben 2014.

2.6 Façades used as screens.

Today it is common to see how the outdoor lighting system of some buildings is not only used to show the shapes of the architectural works, but also to convey messages to people, which is often done with a specific goal. As it is already mentioned in the present research, these goals are usually commercial, political, artistic expression or any other cause that deserves to capture the attention of people. As consequence, facades of some buildings are transformed into media. This trend is known as media façade.

The façade is understood as *“the front of a building or any of its sides facing a public way or space”*¹⁸³, which since the beginning of architecture has been the architectural element that makes easier to discern between inside and outside. It has been the face that represented the building and therefore it is responsible of giving the first impression of the work. But what is the meaning of media? Media is *“plural of medium”*¹⁸⁴, medium *“is something by which an effect is transmitted. A means, especially radio, television and newspaper, by which news etc is made known”*¹⁸⁵.

Now, how it is possible that facades turn into media? Starting from that architecture itself is a mean by which architects use to express themselves in order to communicate something to the people. These messages are varied and in some cases are related to the function of the work, social and/or aesthetic movements, ideologies of the time, new trends of conceptualization of architecture, or even sometimes seeks to convey a specific visual message, which on occasions is request by clients, in this last case is when the facades are transformed into media façades.

There are different types of media facades; these can be carved in stone or bricks, made on canvas, painted on walls (labels) or through the use of light. This last one is addressed in this research.

The media façade that use light can be dichotomously divided by its temporality in permanent¹⁸⁶and ephemeral, while by its design characteristics in static and dynamic. These divisions can be correlated to each other. In other words, a media façade can be ephemeral with static or dynamic features; as well as a permanent can be static or dynamic.

Basically there are two main causes that motivate traders to uses outdoor lighting, the first one is used to show products or advertise services offered, while the second is

¹⁸³Ching 1995, 24.

¹⁸⁴Anderson 1997, 298.

¹⁸⁵Idem.

¹⁸⁶Ferrari 2014.

employed to promote the image of the company, which is a practice quite common today. Regarding this last point, one strategy is to highlight the logo of the company through illumination, considering that the logo is an important element that integrates the corporate image of a company. The logo is defined as “a small design used as the symbol of an organization”¹⁸⁷. It can not be pronounced but can be recognized in sight, facilitating in this way the identification of the enterprise. For this, one of the strategies that have been employed is the use of media facades.

The media facades appear as a new option against uncontrolled use of advertising signs, especially in cities like Las Vegas and New York during the decade of the 50's and 60's. The main purpose of its use is to achieve a harmonious integration between light signs and architectural works. As an example of this, we have the case of the building *Thyssen Hochhaus* in Düsseldorf, Germany. It was built under post-war modernist International style between 1955-1960 by architects Helmut Hentrich and Hubert Petschnigg. The edifice was the headquarters of the company *Phoenix-Rheinrohr AG*. The materials used for its construction are concrete, steel, glass and aluminum. It has 94 meters high spread over 25 floors and has 30,000 m² of construction.

The exterior lighting system was designed to be operated in two ways. One contemplated to illuminate 138 windows that integrate the façade, offsetting the verticality of the building with horizontal bands of windows. The second option of lighting is that only a certain number of windows of 13 floors are strategically lit, with the intention of drawing with light the logo of the company. In order to achieve this lighting effect were used 276 blue fluorescent tubes in vertical jambs. This last design is an example of the use of media façade, which was thought from the beginning to be permanent with a static design.

In 1966 the firm Phoenix-Rheinrohr AG ceased to exist, which for obvious reasons caused that the logo which was projected at night was not used again. This building was one of the first employed as screens, in order to convey specific messages to people. In this case was to let the building been identified from the distance, and in this way to promote the company.

¹⁸⁷Ibidem, 283.

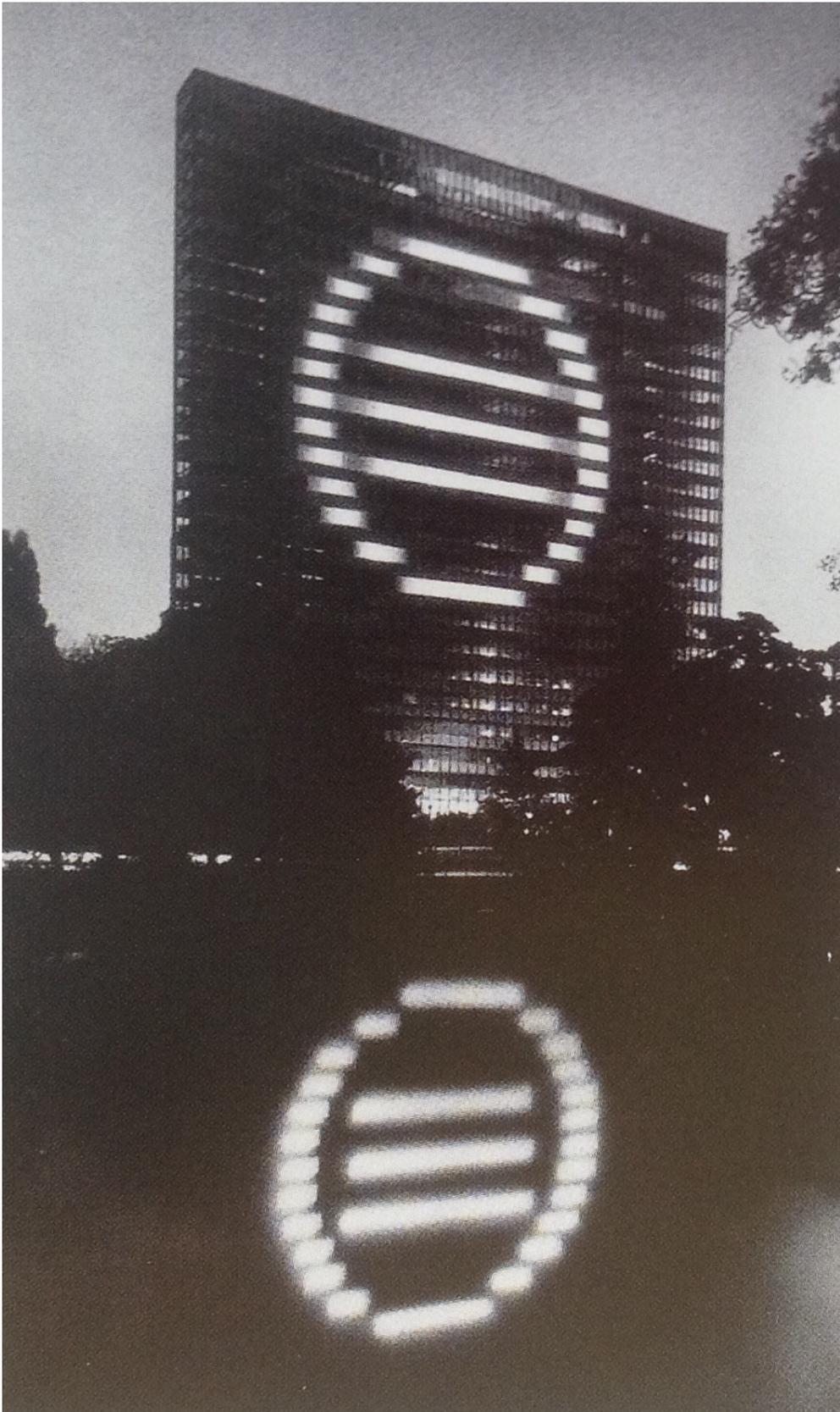


Image 50¹⁸⁸. Lighting system of the building *Thyssen-Hochhaus* in Düsseldorf used between 1960-1966. This building is an example of permanent media façade with a static design.

¹⁸⁸Neumann 2002, 192.

The permanent media façades with a dynamic design are those where lighting is planned to change depending on; the desire of the client, the weather conditions, pedestrian capacity, etc. In order to illustrate this kind of façade, it is mentioned below the case of the Tower of winds in Japan.

In front of the bus station in Yokohama, there was a tower that was used to supply water and also as ventilation of a parking through pipelines. The city government decided not to demolish the structure, which is made of concrete, but rather to improve its appearance, taking as advantage its location. For this, an architectural competition was organized by the city in 1986. The winning proposal was the project of Toyo Ito, who proposed to coat the tower with mirrors of acrylic plates. To achieve this, Ito thought to place around the tower a second oval cylindrical structure with 21 m high, lined with a perforated aluminum coating that reflects the sky during the day.

The lighting system designed by Ito contemplated the use of 30 searchlights, 12 rings of neon and 1300 colored spotlights. Lighting responds electronically to differences in wind speed and noise of the surrounding sound waves and translates them into codes of light and color. For this reason, the system does not follow a predetermined program, offering an ever-changing show of light and color.



Image 51¹⁸⁹. The Tower of Winds in Yokohama, 1986. Permanent media façade with a dynamic design.

¹⁸⁹Ito 1986.

After the digital revolution of 80's, the 90's was the decade of the introduction of the solid light into architecture, known as; "light emitting diodes" (LEDs). In outdoor lighting, the use of this system was very limited in its beginning, due to the short range of colors that it at that time offered. Nevertheless, in these two decades the development of LEDs has advanced not only in quality, but also in the range of colors, power and energy saving, allowing its use in interior and exterior lighting, even as lamps of searchlights.

The media facades have also changed considerably, due to developments that LEDs have in recent decades. These advances have allowed that LEDs are used as main element of giant screens, which can be integrated into building facades. The size and the space that LEDs occupy and the fact that each one operates independently, all these let to places them contiguously in tight spaces, thus achieving a higher resolution on the screens.

It is possible to use giant screens in historic buildings? What is the purpose of using these screens on the facades of the buildings? In order to exemplify the answers to these questions, the case of *Callao* cinema is mentioned bellow. The building is located in Madrid, Spain. It was designed by the architect Luis Gutiérrez Soto in 1926 under neo-baroque style, decorated with elements of art deco. Today this building is integrated on the list of city's heritage.



Image 52¹⁹⁰. Callao cinema, photography taken between 1927-1936. Original facades.

¹⁹⁰Passaporte 1927.

Due to the economic crisis experienced in the last decade in Spain, businessmen of Madrid put pressure on the municipality, in order to undertake changes in planning regulation. The government changed its regulation in 2004, allowing modifications in line of business and even the use of giant screens on the facades of buildings, this latter with the intention of promoting the culture through cultural videos and programs. The owners of Callao cinema were authorized to project ads on screens, but only the 50% of the daily air¹⁹¹, this with the intention of covering the costs and to make profits. Today the reality is different; the screens show more advertising than cultural programs. It means that approximately 75¹⁹² % of the broadcast has commercial content.



Image 53¹⁹³.Callao cinema. Actual appearance at day.

Responding to the questions; it is indeed possible to use giant screens, not just in historical buildings, but also in buildings that integrate the heritage of the cities. However, its use should be well based from an ethical and conservationist approach, respecting the image and the integrity of the building. The purpose of its use (possibly in most cases) is to obtain economic benefits, as the case of Callao cinemas.

¹⁹¹ García 2013.

¹⁹² Ferrari 2014.

¹⁹³ Rodríguez Schaeffer 18.05.2014.

The permanent media facades have developed due to technological advances. In recent years, innovative proposals are being produced under conservation criteria, which besides of conveying messages to people, they seek to protect the integrity of buildings. For example, the Chelsea Art Museum in New York, in 2008 wanted to modernize the facade of the building, which was built in 1850. The design team Mader Stublic Wiermann was in charge of the remodeling project.



Image 54¹⁹⁴. Chelsea Art Museum in the evening.

The design team Mader Stublic Wiermann explains below the project.

“A layer of vertical LED-rods will be installed on the facade of the Chelsea Art Museum, with a gap in between the building and the new structure. The LED structure will surpass the height of the building, to be in line with the taller buildings immediately surrounding the Museum”.

“The installation will feature abstract images moving across the building, at times even appearing to extend the structure of the Museum beyond its actual size... The effect will be to make it seem as though a new structure is being developed over the original facade as the viewer is watching”.

“The new facade does not replace the existing one, rather, it plays with its surface and volume. Consequently, art, normally contained within a museum,

¹⁹⁴Thyes 2007.

*will step beyond the confines of the building to interact with the city and its inhabitants*¹⁹⁵.



Image 55¹⁹⁶. Permanent media façade's proposal for the Chelsea Art Museum. 3d Perspective at night.

The project included not to harm physically the building and besides it allowed to see from inside out and vice versa through the superimposed second façade (like the Ito's Tower of Winds), this due to the separation between each vertical LED-rods, which also does not allow high-resolution images. For this reason, the images transmitted would be abstract. This will seek to convey a message that would be closely related to the type of exhibitions that are exhibited inside of the museum. It was thought that the project would take place in 2010, but was discontinued because the museum closed down in 2011.

The ephemeral media facades are those in which the lighting is designed so that only a short period of time is used. As permanent media facades, seek also to convey messages to people for different purposes. To achieve it, today one of the most common techniques used is through the projections of images, which can be static or dynamic.

For the projection of static images can be used a technique called *gobo*. This technique is based on the use of templates or patterns, which can be made of borosilicate

¹⁹⁵ MSW 2008.

¹⁹⁶ Mayer 2008.

glass or a metal plate. The name is derived from the phrase *Goes Before Optics*, due to its position in the lamp. Through them, images can be projected from a distance of a few centimeters to more than one kilometer.

The advantages of using gobos are; they don't need any connection to a computer, the messages can be placed without on-site changes to the façade and the motives can be changed easily and inexpensively. A disadvantage is that they cannot project videos, because they are not digital device. The images that can be projected are:

- Logos.
- Text.
- Photos.
- Pictures.
- Commercial art images.

The first metal gobos began to be used in the decade of 60's¹⁹⁷. They are metal plates in which a cut of the desired image is done, this with the intention that the light passes through it, projecting the image on any surface. They were initially made by hand, today are made through a photo chemical process. Their uses have some disadvantages, such as the images cannot be complex and some letters are often deformed, and this due to the size and material of the plate. Another problem is that the material may suffer deterioration due to prolonged exposure to the lamp.

The glass gobos began to be used in the decade of the 80's¹⁹⁸. These templates are made with the same material that graduated cylinder of laboratory are fabricated. They are also composed of a photosensitive material, in which the image through a photo chemical process is fixed on the glass. These templates allow to overlap colored glass (dichroic glass), generating with this colors in projections without limitations. Other advantage is that due to the borosilicate glass, it withstands extreme temperatures, allowing its prolonged exposure.

An example of the use of gobos is the case *Rautenstrauch-Joest-Museum* in Cologne, Germany. The building was inaugurated in 2010. The main entrance is located on the north side of the new building, and is flanked by two broad walls, where Information on current exhibitions and programs is projected with light onto the façade, using two graphic projectors GL 1200 EL, which are mounted in front of the main entrance on a street lighting pole and project images at a height of ten meters onto the left and center wings of the building. The light designer was *Derksen Lichttechnik*.

¹⁹⁷Lagobonoia 2014.

¹⁹⁸ Idem.



Image 56¹⁹⁹. Outdoor projection of gobo at the Rautenstrauch-Joest-Museum, Cologne. 2010.

¹⁹⁹Lueck 2010.

The ephemeral media facades with dynamic image projections are done through a technique called *3D Video Mapping Projections* or just *Video Mapping*. As its name denotes, this technique consists in to map²⁰⁰ images or videos on facades of buildings. To achieve it, in the first place is needed to create a 3D model with the characteristic of the architectural work in which we want to project. To do this, it is necessary to use specialized softwares for modeling. The most commons are: *3D Studio Max*, *AutoCAD*, *Lightwave*, among others. With them the designer creates the mask of the facade in 3D. Then the designer generates a video texture and with a software like adobe after effects or similar, makes the video editing in order to achieve the movement of the texture and also of the building.

To adjust the projected images, it can be used the *Catalyst software*, *Arkaos* or *Module 8*, in order to give the impression that projections comes from a single projector. The result is an artistic motion effects.

To calculate it, it is needed to know the square meters of the surface on which we want to project the video texture. Then with the use of the following formula, which helps to determine the amount of lumens required, in order to define the type of projector or projectors to be used.

$$\text{Constant} \quad \text{The required Lm (Projector)}$$

$$(100 \text{ Lx}) (\text{m}^2) = \text{Lm}/\text{m}^2$$

$$\text{Total surface of the element}$$

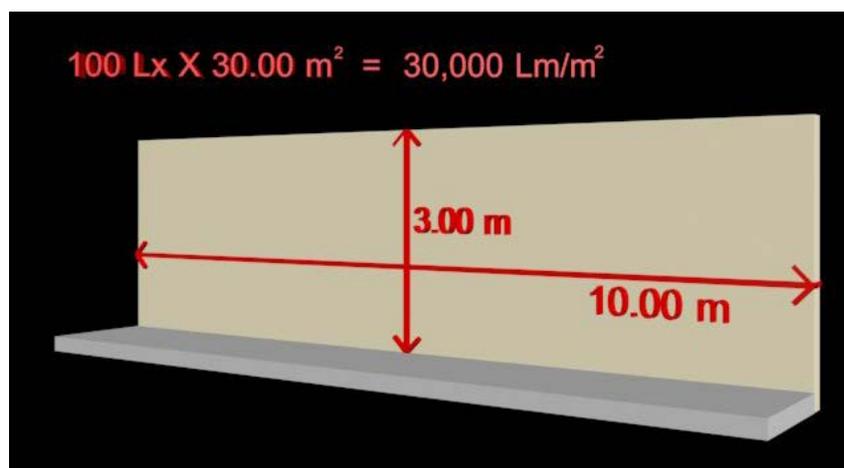


Image 57²⁰¹. Calculation formula for *Video Mapping*.

Since the heritage organization from all over the world concern and prohibit major interventions in heritage sites, particularly since 90's and during the first decade of 2000. The

²⁰⁰ To map means to assign images or video on a surface of any real object.

²⁰¹Elaborated by the author.

media facades started to be for some people the best way to highlight the beauty of the historic buildings, because the projections are just temporary and they doesn't require a high level of architectural intervention. As an example of this lighting tendency, it is presented above the case of *San Agustin* temple in Zacatecas Mexico.

The temple of *San Agustin* in Zacatecas Mexico is recognized as a World Heritage by UNESCO. It was built in the sixteenth century. It suffered also different transformations, for example, in 1862 its baroque façade was completely demolished.

In 2009 took place the virtual restoration of the temple, which was the first virtual intervention in Latin-America. The main objective of this project was precisely to know and to have an idea of the history of the old temple. That means to tell the story of the building, and in the same time to promote tourism in the State of Zacatecas. In order to achieve it, it was necessary to research deeply old texts, photographs and engravings. This research helped to give a precisely idea about the original aspect of the historic building. The information collected was assembled multidisciplinary in the project, combining technology in audio, video and lighting.

The idea of the light designer *Elias Cisneros* was based and supported on three important points²⁰². The first one was to bring a solution to the dilemma of restore the old baroque façade or not. The second point was to exalt the identity of the Zacatecas society, revealing the old edges and landscapes that have been forgotten through history. The last one was the versatility of the digital technology, which allowed to the light designer to present to the people the main celebrations of the country (Independence and the Mexican Revolution) through video projections on the old façade.

It is important to mention that this Video Mapping takes place just on Saturdays and special days like the anniversary of the Independence and the Mexican revolution. The spectacle starts at 21:00 and lasts 5 minutes. It is repeated every 45 minutes.

²⁰²Iluminet 2009.



Image 58²⁰³. Current daily lighting system of the Temple of San Agustín in Zacatecas, Mexico.

²⁰³Polycarpio 2009.



Image 59²⁰⁴. Ephemeral media facades with dynamic image projections of the Temple of San Agustín in Zacatecas, Mexico.

²⁰⁴Iluminet 2009.



Image 60²⁰⁵. Ephemeral media facades with dynamic image projections of the Temple of San Agustín in Zacatecas, Mexico.

²⁰⁵ Idem.

The case study of the Temple of San Agustin provides at least three advantages; the first one is that it brings a clear and precise idea to the people about the original aspect of the main entrance of the building before its destruction. It also promotes a feeling of appropriation of the people and thus ensuring the conservation of the architectural object for the present and future generations. Additionally the projection gives a solution to the controversy of restoring the facade or not, since the present facade is part of the history of the building. That is why it should not be altered in the quest of rescue the previous state to the demolition of 1862. With this kind of solution, the viewers can appreciate two aspects of the building, at day they can see the current austere facade and at night they can observe how the temple looked like before 1862.

The use of media facades, allows to tell stories and to transmit messages in a clearly and accurately way. The facades of buildings are transformed for a short time into giant canvasses, where the artist's creativity can be fully expanded. However, its use is not always advisable, it will depend on the characteristics of the architectural work, as well as the state of conservation that it has. This, at least regarding to the use of Video Mapping, when it is accompanied by sound effects, since vibrations can affect the structure.

Another reality is that, although some historic buildings are holders of an architecture that encourages artists in lighting design to play with their elements, generally the building does not become the main protagonist of the show, since these are transformed just into a surface where images are projected, being these the true protagonists. As some lighting designers says; painting with light. For example a lighting show that took place in France in 2005. The aim was to project images of Monet's paintings on facades of main buildings as the Cathedral of Rouen.



Image 61²⁰⁶. Video Mapping lightshow in the cathedral of Rouen. 2005.

The uses of urban heritage as screen are beginning to be one of the favorite strategies to impulse the economy of the cities. They are also starting to be an important part of the cityscape that through lights, images and sounds tells the story of the city in an understandable language, that lets the people remember and know the past. It uses are also a tool that allows to change the visual perception of the cities trough the generation of virtual materials, which give a different understanding of the urban heritage and its space.

²⁰⁶ Anderson 2005.

Chapter 3: Factors to consider in outdoor lighting design.

There are some certain factors to consider in lighting design of urban heritage, in order to achieve a proper dialogue between the building, context and lighting. When these factors are not taken into account, they could directly affect the perception of the building, thus providing an erroneous reading of the architectural object and the entire urban space where the study object is immersed. These affectations could even impact the physical integrity of the building and its environment.

To understand these factors, it is important to divide them in two groups: intrinsic and extrinsic.

3.1 Intrinsic factors.

The intrinsic group consists of the entire characteristic elements which agglomerate the historic building. This group is composed by two subgroups: primary and secondary. The primary are all the physical elements of the building, such as; materials, color, texture, shape and volume. The secondary group is integrated by intangible elements that support the lighting design to emphasize a special meaning through the light, as an integrator element or as a mean to highlight items. Such elements are: the function of the building and the history, but not just the history of the building, but also social events, which took place in or near the architectural object.

3.1.1 Primary group.

3.1.1.1 Materials and its properties.

The materials in urban heritage are the skeleton and the epidermis of the historic buildings. They are the raw materials in construction, which under certain placement, they allow the buildings to be erected, sustained and protected, thereby challenging the forces of nature and sometimes even men.

In the beginning, the selection of the materials depended directly on the natural deposits of the region. However, sometimes the man's desire to achieve immortality through their work motivated the quest of durable or elegant materials, which in some cases they had to be imported from miles away.

Light designers who were interviewed for this research are aware of the importance of materials, which integrate historic buildings and monuments. A total of 100% of light designers who were interviewed take into consideration materials of monuments and historic buildings for their lighting projects. Depending on what kind of material has the urban heritage, will be designed the lighting proyect.

“Any light designer wants to celebrate the material you see²⁰⁷”.

Something important to be considered regarding to materials is their appearance, which depends directly on the light. The behavior of the relationship between light and materials are based on the own properties of each material. In urban heritage we can study the material properties in relation to their light behavior (*Optical material properties*) from two main attributes; aspect and resistance. Aspect is the appearance of the materials when they are exposed to light and resistance is the photosensitivity that has each material.

A) Aspect.

- 1) Transparency
- 2) Translucency
- 3) Opacity
- 4) Brightness (*Photometric brightness*).

1) Transparency

They are the materials which let the light pass through them without difficulty, because of the characteristic of being easy to see through. We can find it as glass windows in historic and urban heritage buildings.

2) Translucency

Are those that allow light to pass through them, but the image is diffuse. As an example we can find them as ground glass and stained glass in windows.

3) Opacity

Are those that don't let the light pass through them. In this category we can find all the materials used in the construction of urban heritage as stone, brick, adobe, and wood, among others.

4) Brightness (*Photometric brightness*).

The luminous intensity of a surface in a given direction per unit projected area²⁰⁸. It means that *brightness* is when the light is reflected on a material surface. We can distinguish two kinds of brightness; metallic and nonmetallic. The metals have the metallic brightness and also some materials with metallic appearance, the rest of materials have nonmetallic brightness.

There are also other physical factors which are important in lighting design. They are known as optical phenomena of materials. The phenomena are integrated by reflection,

²⁰⁷ Rodriguez, Alan P. (11/14/2012).

²⁰⁸ Westinghouse 1976, 18.

absorption, transmission and refraction. The study of these phenomena is important to take into consideration if the main goal is to get a proper outdoor light.

In order to exemplify in a simpler way the optical phenomenon, we can assume that when light comes from a source and it reaches an element which could allow the light to return to the source, this phenomenon is known as *reflection*. When the light pass through the material and it is converted in a different form of energy it is called *absorption* and when it doesn't change is *transmission*. When the light passes through an element and the light changes the direction is named *refraction* (See image 62).

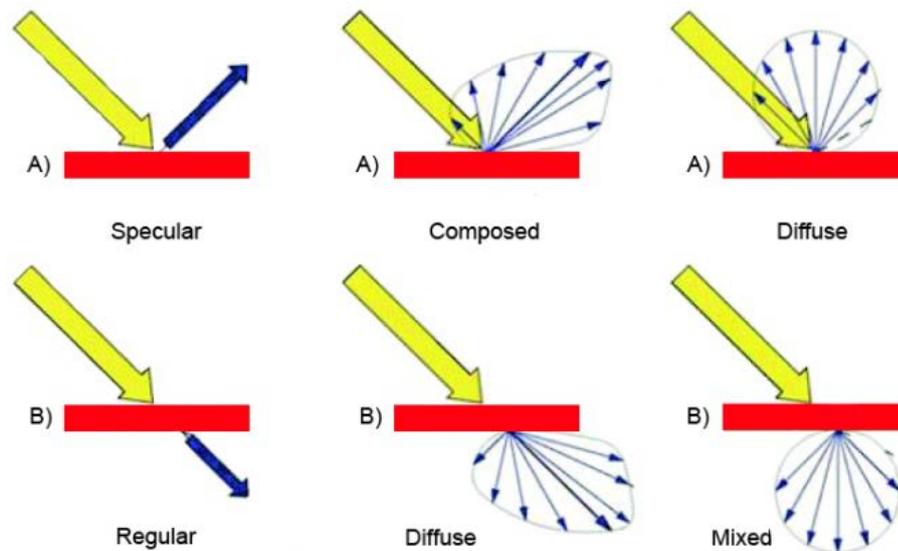


Image 62²⁰⁹. A) Different types of light reflection. B) Light Transmission.

Each material has a percentage of reflection which can help to light the architectural element or can also prejudice the project, depending on their capacity of reflect the light (See table 3).

²⁰⁹ Martín 2006, 20.

Material	Percentage of reflection
Brick (Light)	30 - 40
Brick (Red)	20 - 30
Brick (Dark)	15 - 25
Concrete (Light)	30 - 40
Concrete (Middle)	20 - 30
Concrete (Dark)	15 - 25
Glass (Black)	5
Granite	15 - 25
Lime	80 - 90
Limestone	35 - 65
Marble	50 - 60
Plaster	90 - 92
Wood (Light)	30 - 50
Wood (Dark)	10 - 25

Table 3²¹⁰. Percentage of material reflection.

Material (Glass)	Percentage of transmission
Clear and optical coated	80 - 90
Configured, obscure, etched, ground, sandblasted and frosted	70 - 85
Opalescent	55 - 80
Flashed (cased) opal	30 - 65
Solid opal	15 - 40

Table 4²¹¹. Percentage of light transmission in glass.

B) Resistance.

Each material has some degree of sensitivity to light. This depends on the characteristics of the element and its chemical composition. This sensitivity is named; photosensitivity. This affects the matter in two different ways, generating photochemical and photomechanical reactions.

Photochemical reaction.

It is produced by photophysical excitation, ie, photons of light stimulate the molecules of matter, which appears to fading or bleaching the materials. For example, this reaction can be found within the urban heritage, particularly in the change of color of natural-based paints and also the mineral-based, but with less intensity.

²¹⁰ Elaboration based on data obtained from: (Laszlo 2011), (Martín 2006, 36) and (Westinghaus 1976,185).

²¹¹ IESNA 2000, 38.

“...fading of dyes is attributable to absorb visible energy as well as ultraviolet, while structural damage is due in greater part to absorbed invisible energy (ultraviolet and infrared)²¹²“.

Photomechanical reaction.

It appears when the photon deteriorates the molecular structure of materials, as it happens in the case of cellulose, which integrates from 37% to 56% of the chemical composition of wood²¹³. This means that cellulose is what forms the structural tissue of plants. When it receives light radiation, breaks its molecular chains, manifesting itself in cracks and discoloration in the surface as inside of the wood.

“Photochemical deterioration is relatively severe in celluloid due to the ability of the molecule to absorb strongly in certain wavelength ranges. The far ultraviolet is readily absorbed by celluloid²¹⁴“.

“Different wavelengths of light have been found to deteriorate celluloid by reducing the viscosity and/or chain length of the molecules. The results of strong absorption can be seen as yellowing, embrittlement, and softening²¹⁵“.

Another important material used in urban heritage around the world is the adobe. It is made with earth, sand and different natural fibers like the straw, which has also cellulose. The straw is used to increase the binding force of the mixture and to reduce the appearance of cracks²¹⁶. Sometimes the adobe is exposed to the outdoor without a protection of plastering (See image 63), then not just the natural light but also the artificial can destroy the straw contained inside of the adobe pieces, producing a loss of cohesion.

²¹² Harrison 1956, 6.

²¹³ Barcenás-Pazos et al. 2008, 83.

²¹⁴ Reilly 1991, 155.

²¹⁵ Idem.

²¹⁶ Minke 2006, 40.



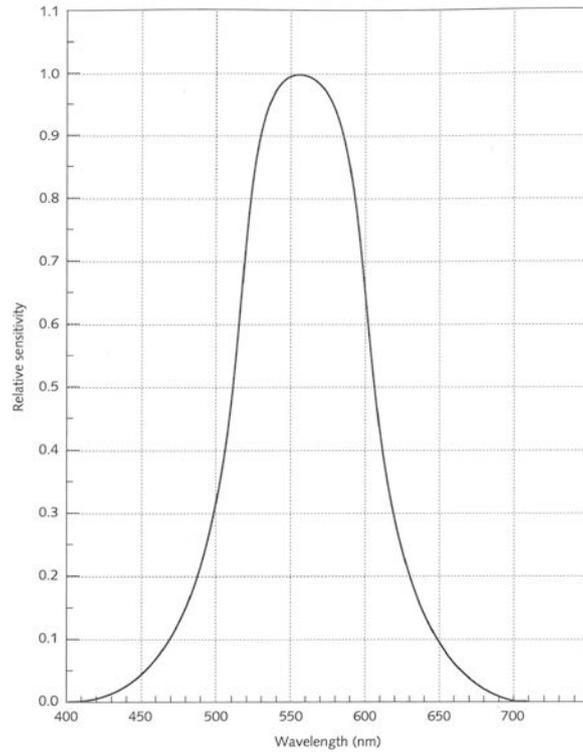
Image 63²¹⁷. “San Sebastian” Temple in Chiapa de Corzo, Mexico. The paraments of the south facade are made of adobe and they have no protection against sun light and from inclement weather.

The level of deterioration of the materials and the fade of colors depends generally on the time of exposition to the light and it is proportional to the energy they can absorb. However, there are studies about the radiation hazard associated with light source of spectral irradiance, particularly for exhibitions in museums, where it is determinate that the worst damage for radiation are under 300 nm. and above 640 nm of the spectral irradiance²¹⁸. In order to understand it better, it's important to explain that the eye can detect radiant energy at wavelengths throughout the visible range, which is from 400 nm to 700 nm. It is known as *luminous efficiency curve*, and also called the *photopic curve* (See graphic 1 and 2).

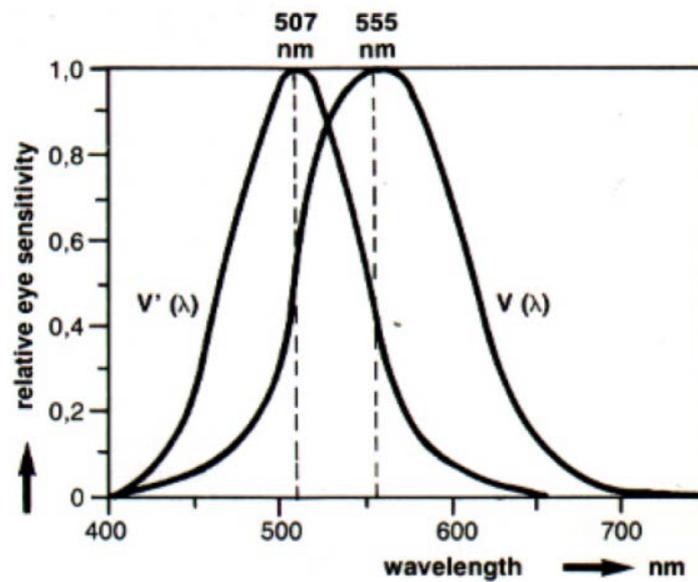
The maximum range at daylight (*Photopic*) is 555 nm, which corresponds to the green-light region, while the nightlight (*Scotopic*) is 507 nm, corresponding to the blue-green light region. The Scotopic decreases in proportionally the same manner as the photopic curve. This results in the scotopic curve reaching a relative value of zero sooner in the visible spectrum than the daylight curve. As a consequence of this fact, our nighttime vision does not see red.

²¹⁷ Rodríguez Schaeffer 2010.

²¹⁸ Harrison 1956, 8.



Graphic 1²¹⁹. Photopic curve. This graphic shows the relative sensibility of retinal cone cells to light, at daylight lighting levels.



Graphic 2²²⁰. Standard spectral eye sensitivity curves for Photopic $V(\lambda)$ and Scotopic $V'(\lambda)$ curve, showing the relative sensibility of retinal cone and rod cells to light, at daylight and nightlight lighting levels.

²¹⁹ Schaeffer 2001, 8.

²²⁰ Phillips Lighting 2009.

In urban heritage we can find different types of lamps. Each lamp has its own characteristics and therefore they interact with the materials in different way. The most commons are:

- Incandescent.
- Fluorescent.
- Discharge.
- LEDs.

The next table shows the most common light sources used in urban heritage and some of their uses and characteristics.

Source		Uses	Appearance	Color reproduction	Ultraviolet emission	Infrared emission
Incandescent	Standard	General light, directed light to general areas and decorative light.	Warm yellowish.	Very good.	Low	High
	Halogen	Outdoor light; facades, yards, trees, directed light to surfaces and objects.	Warm white.	Very good.	Medium	High
Fluorescent	Standard	General light, indirect light; cornices and behind architectural elements.	Warm white.	From poor to medium.	High	Medium
	Compact	General light, indoor porpuse.	Warm yellowish, warm white.	Good.	High	Medium
Discharge	Sodium	Architectonic lighting; facades, inside bell towers. Street lighting, pedestrian and outdoor areas.	High Preasure: Yellow. Low Preasure: Yellow-orange	Very poor.	Low	High
	Mercury	Street lighting.	White - blue.	Very poor.	Medium	Medium
	Metal halide	Outdoor lighting.	Cold white.	Medium	High	Medium
	HQL	Outdoor lighting.	Warm white.	Good.	High	Medium

Table 5²²¹. Light sources in historic and urban heritage buildings.

As we can see, all this sources contains ultraviolet and infrared radiations. These sources have been used without taking into account the harm they may cause in urban heritage. Some of these sources are used because their prices on the market are low and they are easy to find even in small towns, for example the incandescent light. The 90% of the energy it consumes turns into heat and only 10% produces light. Also the incandescent lamp needs

²²¹ Elaborated by the author.

more energy to generate light, despite this, until now we can find this lamp everywhere (See image 64-65).



Image 64²²². Current lighting system in *La Quinta del Obispo*, San Cristóbal de Las Casas, Mexico (08.03.2008). The lighting system is based on incandescent light.



Image 65²²³. Current lighting system in *San Jacinto* Temple in Chiapa de Corzo, Mexico (11.02.2010). The light in this temple has a commemorative propose. It try to transmit the patriotism through the uses of colors of the national flag of Mexico, however, the utilization of incandescent lamps is still inadequate.

The last lighting technology used is LEDs. The use of LEDs is ideal for generating energy savings and nowadays it is improving its luminous efficiency, but what about their

²²² Rodríguez Schaeffer 2008.

²²³ Idem.

wavelength? Shall we use all kinds of LEDs? To answer these questions, we have to take a look into the next table, which contains the different types of LEDs that are on the market and their wavelength.

	Wavelength (nm)	Color Name	LED Material
	940	Infrared	GaAlAs/GaAs
	885	Infrared	GaAlAs/GaAs
	843	Infrared	GaAlAs/GaAs
	641	Ultra Red	GaAlAs/ GaAlAs
	625	High Eff. Red	GaAsP/GaP
	624	Super Red	InGaAlP
	610	Super Orange	InGaAlP
	604	Orange	GaAsP/GaP
	593	Super Yellow	InGaAlP
	589	Super Pure Yellow	InGaAlP
	584	Yellow	GaAsP/GaP
	3000K	Warm White	InGaN
	6000K	Pale White	InGaN
	8000K	Cool White	InGaN
	573	Super Lime Green	InGaAlP
	569	High Eff. Green	GaP/GaP
	564	Super Pure Green	InGaAlP
	560	Pure Green	GaP/GaP
	528	Aqua Green	InGaN
	502	Blue Green	InGaN
	460	Super Blue	InGaN
	447	Ultra Blue	SiC/GaN
	420	Ultraviolet	SiC/GaN
	419	Ultraviolet	SiC/GaN
	378	Ultraviolet	GaN

Table 6²²⁴. LEDs and wavelengths.

According to the studies of *Harrison* and the data obtained from the table 6, the LEDs that can harm the cellulose are; from ultra red to infrared. However another study made by the Department of Physic of the University of Buenos Aires, shows that the red LEDs have a wavelength above $647.4 \pm 0.5 \text{ nm}^{225}$. To avoid the hazard in urban heritage, it is better not to use the red LEDs.

As a summary we can determine that ultraviolet light produces the following harmful effects on historic and urban heritage buildings:

- Fades fabrics and finishes²²⁶.

²²⁴ LEDtronics Standard Products 2006, 19.

²²⁵ Artuso, Satz 2001, 5.

²²⁶ IESNA 2000, 655.

- Cause of polymerization of organic molecules.
- Changing the brightness of the materials.
- The wood becomes gray, yellow and subsequently degraded. The Polychrome wood stains.
- In the varnishes produced hardening, fixing it to the surface indefinitely.
- Destruction of the cellulose.

The infrared light also produces harmful reactions on materials used in urban heritage. As we have seen on table 5, most of common light sources produce infrared radiation. The effects are below:

- The exposure to this light induces motion as dilation and contraction.
- Direct contact causes burns on the surfaces.
- Cumulative deterioration of the polymer molecules.
- Produces Moisture migration between the hygroscopic object and atmosphere that surrounds it.
- In varnishes generates cracking and yellowing.
- In paintings on wood produces dryness, flakes, cracks and spalling.

The lighting technology has today a tendency to save energy, but what about the harm that it can produce to heritage? It is not possible to protect the environment and at the same time the integrity of the monuments? It is clear that the use of improper lighting is related to some factors ranging from economic to the lack of reaction that lighting can provoke. Speaking of proper lighting, it doesn't refer to light more, but rather light, considering environmental factors and physical characteristics of the components to light, as well as the technology is intended to implement.

3.1.1.2 Color.

Throughout history the color has not only revealed the particular taste of the architect or artist, but also the philosophy of the time, which can be read it through the cultural heritage represented by the urban heritage. Proof of this is the play of colors in the glassworks of the Gothic cathedrals that sought to stimulate the sense of sight and amaze the parishioners, as well as symbolize the mysticism and greatness for the divine. While the Renaissance was a philosophical message through the mural painting that decorated the temples, rediscovering man as the center of the world and the main character in the creation.

In the Baroque, the play of light and shadows, accompanied by austere colors served as a standard of power reflection of the absolutism of the Catholic religion. Later in neoclassicism we can perceive through the light colors a message of purity of thought and the intentions of religious reform, where both the abuse of color and exuberant use of the decorations were regarded as ostentatious and to some degree even sinful. The modern movement as a result of the industrial revolution brought with it the use of new materials of

construction, which the function was strictly useful and fit. The materials should speak for themselves, i.e., must appear as they are, in their natural colors, without pretensions.

The color has played an important role in the history of architecture. The range of colors that compose the urban heritage is as wide as nature itself. Sometimes the color of the architectural objects is the result of the use of materials from the region, which give as a consequence a harmonious mimicry with their immediate environment, of course, when they are used in an apparent way. However, which are the determining factors that let us see the colors as we see them? Perhaps the color is an attribute of the materials or a chemical process of the brain? And how could we use the colors in the lighting of urban heritage? Why the use of colored light was not so common in the urban heritage until recent times? But before these questions are answered, it is important to know, what are the opinions of light designer regarding to color? Should be colors take into consideration for lighting design? The 100% of the light designers, who were interviewed by the author, consider that it is important to take into account color in lighting design.

The light designer *Jaspreet Chandhok*²²⁷ distinguishes two types of colors which need to be considered in lighting design. They are the color on the monument and also the color in the neighborhood, but before we continue, it is essential to define the concept of color.

According to the *Britannica Encyclopedia* defines the color as follows; “*Colour*²²⁸: Also spelled color, Aspect of any object that may be described in terms of hue, lightness, and saturation”.

The *Oxford Dictionaries* defines it as: “*The property possessed by an object of producing different sensations on the eye as a result of the way it reflects or emits light*”²²⁹.

In both definitions the color is presented as an attribute of objects. In a few words the color gives meaning to what we see through association and experience. Objects have optic properties such as; to reflect, refract or absorb the colors of light that they receive. For example, when a wall that absorbs almost all the colors of a light source and reflects only one, let say red, then the color of the wall is red. I.e., an object appears colored because it reflects light in a selective way. This occurs also because our brain interprets the signals of the spectral composition of the reflected light coming from the object, it passes through eyes and then the brain recognizes the color. It means that there is a close relationship between light, materials and brain.

²²⁷ Rodriguez, Alan P. (11/21/2012).

²²⁸ Encyclopaedia Britannica Inc. 2014.

²²⁹ Oxford Dictionaries 2012.

The urban heritage are colorful, if we look at the heritage buildings, we will see color, which allows us easily to see the shape and contours of the architectural objects, in the same way it transmits to us different feelings and is able to provoke different emotions and moods.

There is also another important factor to take into consideration and it is the spectral composition of the light source, which plays a decisive role in the recognition of the color, as well as the quality of the illumination. The color of the light source can change the perception, not only the color but even the object.

Through history there have been scientists who have investigated the light and color, their limitation was always the technology that they had in that moment, however it didn't stop one of them. The scientist Thomas Young discovered in the early nineteenth century that there are three pure colors of light, which produce other colors. He called them *primary colors*. As a main characteristic is that they are unique and are not produced by the combination of other colors. When two primary colors mixed, the mix generates the *subtractive colors*, which absorb some of the light spectrum and reflects another (See image 66).

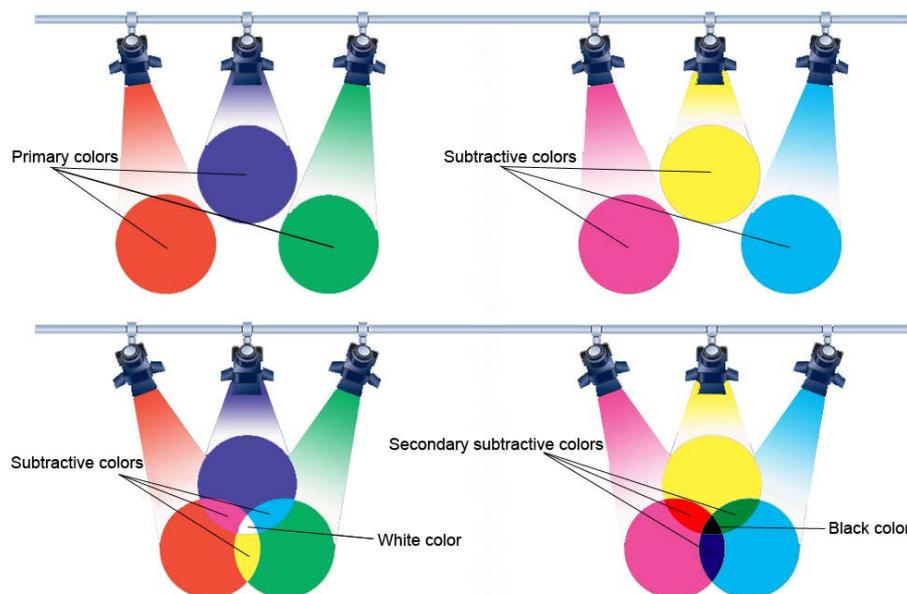


Image 66²³⁰. Light colors.

The primary subtractive colors are magenta, which absorbs green light, yellow, which absorbs the blue light and cyan, which absorbs yellow light. When the secondary colors mix, they produce black color.

²³⁰ Elaborated by the author.

How can we determinate the selection of light's color for a monument or historic building? To the light designer *Vilas Prabhu*, it is important what people (*the user*) expect from the experience of being inside of a historic construction.

"They want the experience, how this objects would have looked in those days, so specially talking about, probably in such case the people would have used a warm tones, I would take any color, but I would play probably with a little bit intensity in that direction, the colour would be in the warmer side, because in ancient days there was only one color of artificial light, or the people used fire, so the color was warm. So I'm not strict to warm colors, Ok, you have a dance club in a very ancient heritage structure, so you can use any kind of color, but yes, as I told you before, the variation would be probably in the intensity²³¹".

Another point which supports what *Prabhu* said, is that the color of monuments and historic buildings "were taken from nature", that's why "the modern color lighting is not for this kind of context²³²". A possible solution for *Chandhok* could be, for example to "use yellow light on the stone, because it does not render all the colors. Kind of, give you feel the history²³³". However there are some historic buildings or monuments which are illuminated with different colors everynight, in order to impregnate them a dramatic effect. Regarding to this, the light designer *Enrique Quintero* thinks:

"La tonalidad de los colores debe estar muy restringida, en los tonos blancos en algunos calidos desde luego, llegando hasta inclusive a 2000° kelvin y no pasar de frio, no llegar a los 5000° kelvin²³⁴".

The light designer *Dr. Acharawan Chutarat* supports the idea of *Prabhu*, stating that "color temperature that is suitable of surface material", but her thoughts go a little more beyond, she says that the light design should have "flexibility for color changing features for special event²³⁵".

As light designer say, the color of the surface is also important. When a color light hits the surface reproduces a different color or hue in a gradient way. For example, when the wall is black and the light is yellow, the color of the surface will be Orange black. Of course, it will depend on the intensity of the source (see table 7).

²³¹ Rodriguez, Alan P. (11/21/2012).

²³² Idem.

²³³ Idem.

²³⁴ Rodriguez, Alan P. (8/5/2013).

²³⁵ Rodriguez, Alan P. (11/29/2012).

The elections of colors to be used in the lighting of urban heritage are related to the sense to be conveyed. For example, if a building where there was a relevant historic event for the city or the nation, it is recommended to use colors that evoke the historic event, as might be the case that the building served as a stage for an important battle.

Effects of colored light on colored objects				
Color object	Red light	Blue light	Green light	Yellow light
White	Pink	Very clear blue	Very clear green	Very clear yellow
Black	Reddish black	Bluish black	Greenish black	Orange black
Red	Bright red	Dark bluish red	Yellowish red	Bright red
Cerulean	Reddish blue	Bright blue	Greenish blue	Dark reddish blue
Dark blue	Dark reddish purple	Bright blue	Dark greenish blue	Clear reddish purple
Green	Olive green	Greenish blue	Bright green	Yellowish green
Yellow	Reddish orange	Clear Reddish brown	Clear greenish yellow	Bright clear orange
Brown	Brownish Red	Bluish brown	Dark olive brown	Orange brown

Table 7²³⁶. Effects of colored light on colored objects. The colors are only representative.

Another aspect to consider is the use of the psychological effects of color²³⁷ on people, that is, if we want to produce the sensation of coldness and create an illusion of space and distance, we can use the colors blue and green, while red, oranges and yellows generate heat. All colors that are close to the red spectrum, give the feeling of stimulation and excitement, while blues, greens and purples are soothing and depression. The white produces equally tranquility in this way can be used to create different architectural environments. Each color transmits a particular feeling and a perfect combination could multiply the expressive power of the image of the building.

As we have mentioned, the percentage of reflections is important to conceder to prevent excessive lighting that may harm not only the heritage building and the environment but also human being. The next table shows the percentage of reflection of the most common colors used in monuments, historic and urban heritage buildings.

²³⁶ Elaboration based on data obtained from Westinghaus 1976, 90.

²³⁷ Note: To know more about psychological effect of colors, consult: HELLER, Eva (2000) *Wie Farben auf Gefühl und Verstand wirken: Farbpsychologie, Farbsymbolik, Lieblingsfarben, Farbgestaltung*. Droemer Verlag, München.

% Of refraction of some colors.	
Color	Reflection factor (%)
Matt white	70 - 80
Light beige	70 - 80
Very light green	70 - 80
Light cream	60 - 75
Yellow	60 - 75
Light green	45 - 65
Pink	45 - 65
Light blue	45 - 55
Light gray	40 - 50
Light red	30 - 50
Light brown	30 - 40
Dark beige	25 - 35
Dark red	10 - 20
Dark brown	10 - 20
Dark gray	10 - 20
Green	5 - 20
Dark blues	5 - 20
Black	3 - 4

Table 8²³⁸. Refraction of colors.

3.1.1.3 Texture.

The texture is a property of the surface that has the objects; it is perceptible by the senses of touch and sight. In the urban heritage has been used as a tool for architectural composition, to contextualize the works into the environment, as also to break the monotony and homogeneity between the surfaces.

Texture as well as materials and color, is a factor which lighting designers take into consideration for lighting design. The 100% of experts who were interviewed appointed that texture plays an important roll in lighting. For example, to *Chandhok* and *Prabhu* finishes are part of standar factor, which should be considered in all lighting designs. Since texture is a component of finishes, then it should be take also into account.

There are several types of textures, depending on their perception; tactile and visual. The tactile texture is three-dimensional and we can perceive it when we touch directly the surface of an object. The visual is one that is recognizable by sense of sight and allows it to feel tactile sensations without touch. In historic and urban heritage buildings has been used as a mean to look like as a construction material by drawing a frame on the walls or any architectural element (see *image 67 and 68*). It is noteworthy that both tactile and visual texture

²³⁸ Elaboration based on data obtained from INDALUX 2002, 35.

are closely related and when we have the opportunity to experience the feeling with both sense (*touch and sight*) but in an individually way, we get an experience full of meaning.



Image 67²³⁹. Complet view of *Casa Grande* in Santo Domingo, Chiapas, 2010. Built in 1920s.



Image 68²⁴⁰. Detail of *Casa Grande* in Santo Domingo, Chiapas, 2010. Artificial textures of walls and roofs that pretend to be bricks and clay tiles. The material used for the walls is a painted zinc-coated steel sheet and for the roofs are prefabricated tiles made of zinc-coated steel.

²³⁹ Hernandez 2010.

²⁴⁰ Idem.

According to the source, the textures are divided in natural and artificial. The natural are those surfaces that have living and nonliving beings immersed in nature, for example; rocks, tree trunks, different animal skins, etc., the artificial are all that have been created by man, for example; concrete, plastics, fiberglass and also those that mimic the nature such as rocks, wood and vegetation.

When the texture is unreachable to be touch, we can perceive it when it interacts with light. It means that by the relief of the surface, it creates light and dark areas, thus giving the impression of depth.

Nowadays there are also video-textures, which are created by a computer and are projected on surfaces of facades. These projections are better known as “*3D Mapping Video Projections or just video mapping*”, which were already mentioned in as a type of ephemeral media facades with dynamic image.

When this type of video texture is used, the surfaces where the video is projected should be smooth as possible, because the reliefs generate shadows. The materials in historic buildings usually have rough textures, so this must be taken into account, as also the areas with elements that may cause glare specular reflections (*ghosts*) that we don't want. That is why it is important to know what kind of texture has the historic building, because otherwise it could causes unwanted effects. For example, if we want to illuminate a building through the projections of lights and its surface are rough, then it will reflect some lights in all directions, giving the impression of brilliant. When the building has reflective elements such as windows or polished finishes, then they will reflect the incident light, giving the feeling of dark objects.

The following images are some examples illustrated by images of different types of reflection that gets depending on the type of surface that could have the building.

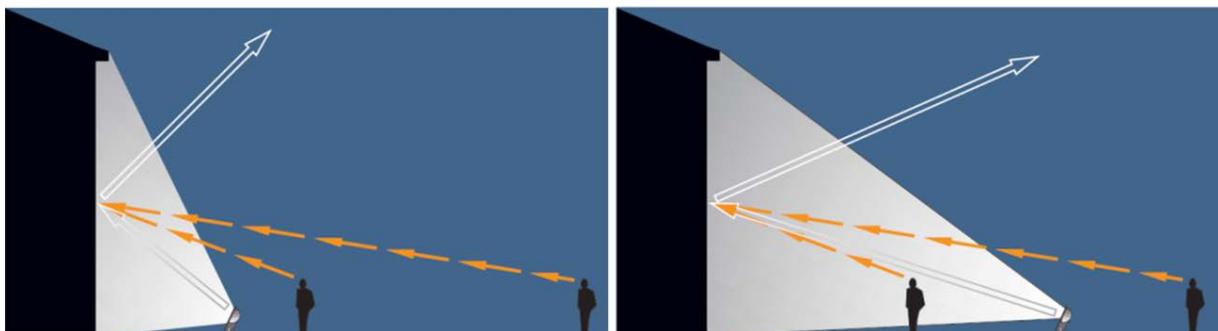


Image 69²⁴¹. Specular reflection. Reflection of the light when the surfaces are: shiny, smooth, etc.

²⁴¹ INDALUX 2002, 173.

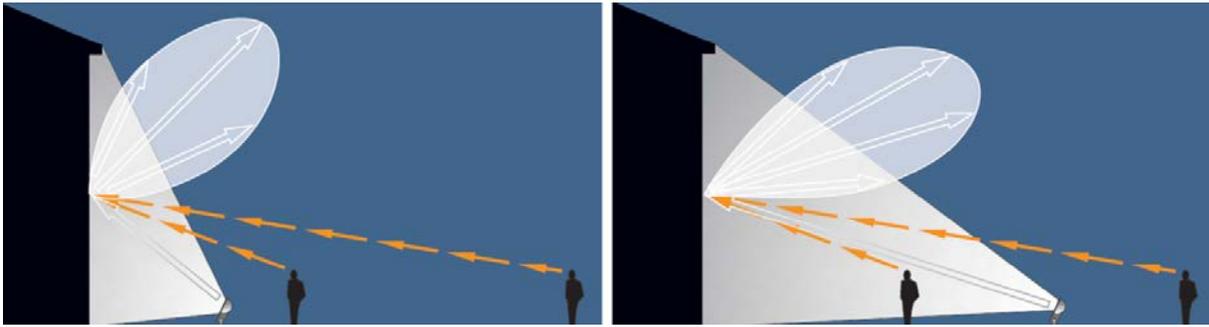


Image 70²⁴². Composed reflection. Reflection of the light when the surfaces are: irregular, rough, etc.

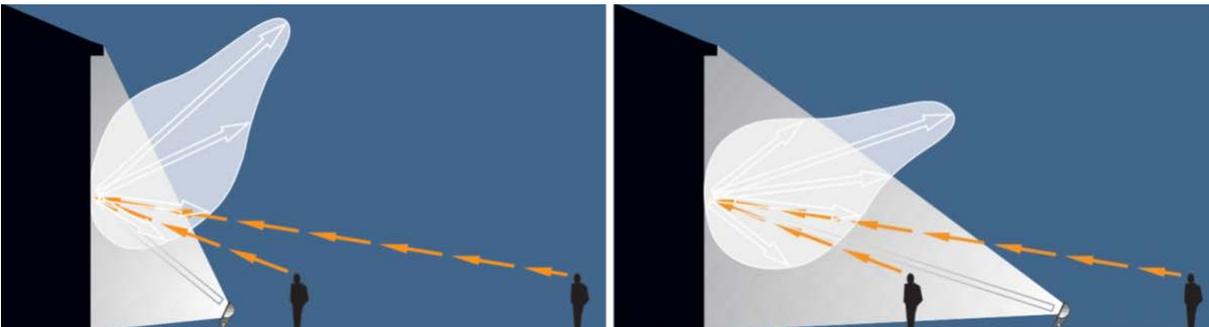


Image 71²⁴³. Mixed reflection. Reflection of the light when the surfaces are: not smooth, varnished, etc.

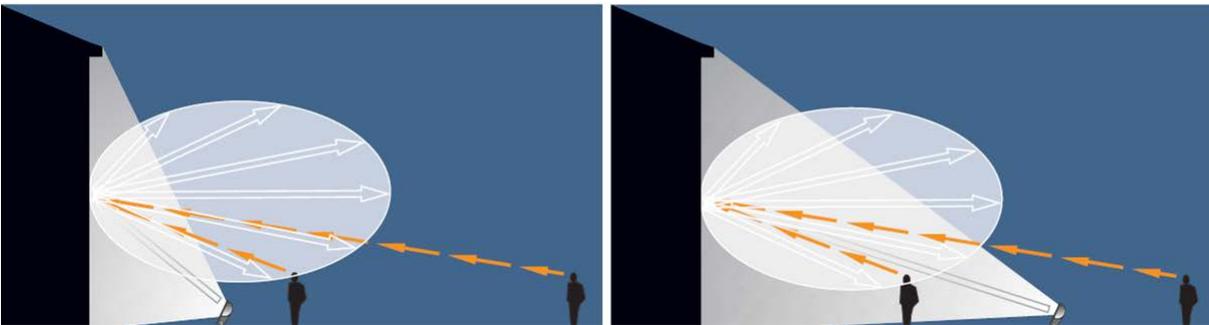


Image 72²⁴⁴. Diffuse reflection. Reflection of the light when the surfaces are: matte, etc.

The different types of surfaces significantly impact the lighting on historic and urban heritage buildings. When facades have different textures in their elements, then it is needed to design the lighting system according to each particular element. In the case that the surfaces of facades are smooth but with a considerable quantity of dust and dirt, then it will be needed to do preliminaries cleaning works, otherwise it impacts in the reflection factor. The reflection factor of *"a clean façade can be more than the double of the same dirty facade"*²⁴⁵.

²⁴² Ibidem, p.174.

²⁴³ Idem.

²⁴⁴ Ibidem, p.175.

²⁴⁵ Idem.

3.1.1.4 Shape and volume.

83.33% of light designer think that shape and volume should be considerate as a factor in lighting projects. This means that most of the experts interviewed are agree that it is essential to take into account the shape and volume in their projects, but why these two factors are important? Maybe the answer lies in the fact to understand the relationship between light, shape and volume. In order to clarify this, we can say that form is the result of the visual combination of mass and volume. However they are not the only elements that allow us to see the form. Through light and shadows the architecture acquires shape. With *“light lends a building its contours and shadows lends it depth²⁴⁶”*. All these elements are intimately linked and they are also essential to understand the shape and to perceive the form.

“Architecture which enters into a symbiosis with light does not merely create form in light, by day and at night, but allow light to become form.” (Richard Meier)

What about the architectural character of historic buildings? Could they be highlighted through illumination? Firstable let’s start to define the term. According to Villagrán, architectural character is:

“Es la conformidad de una obra con su programa particular, que es la adecuación a su destino y que cuando esta adecuación es perfecta, constituye una modalidad formal que caracteriza en su tiempo y lugar geográfico a cierto genero arquitectónico²⁴⁷”.

Along architectural history, many theories have tried to explain what architectural character is and what constitutes it. For this research, the character is integrated by the site where the building or monument is placed, its materials, method of constructions, its function, architectural elements and details, architectonic and architect’s style. All these elements added with the experience that the user has with similar buildings (*in order to identify what is the identity of the building*) are the architectural character of any building. In few words, the character expresses us what is the identity of the building.

²⁴⁶ Binet 2002, 64.

²⁴⁷ Villagran 1988, 346.

Light is a tool, which could be used to accentuate the architectural character of a building, but as we have seen, there are many elements that integrated the character. Therefore illumination can be used as a strategy to highlight some certain architectonic elements, which could help to define the character (see *image 73*). Sometimes this character is too strong and the light can't hide it (see *image 74 and 75*).



Image 73²⁴⁸. Temple "Belén" (14.12.2012), Cajamarca, Perú.

The illuminated elements like niches of the baroque portal stand out from the entire facade. These elements contain sculptures, which are part of the dialectic of religious buildings, as well as the belfry. The illumination helps in this example to accentuate the character of the building at night.

²⁴⁸ Asencio 2012.



Image 74²⁴⁹. Foto at daytime of *St. Mary church*, Dublin, Ireland.

The function of the building was church since its construction until 1997, when the restoration works began to convert it into a Cafe, Bar, Restaurant and Nighclub. It opened its doors in 2005.



Image 75²⁵⁰. Foto at night of *St. Mary church*, Dublin, Ireland.

²⁴⁹ The diningroom 2013.

²⁵⁰ Idem.

In the image 74, the character of the building is readable; it is a church, although there are new elements like the tower and the bridge. While in the nightshot we can see how the illuminations try to convey the message of what is the current function of the building. It is accentuated by lights, but the character of the building remains as a church, due to the strong elements that has the building, which tell us that it is a religious building.

The architects through the time have been aware of the important of a proper illumination to create scenes full of meaning, where the light fuses with the matter to show us its form, and also they knew that the form in architectural expression is given by the correct organization of matter. Regarding to this, Norberg-Schulz said:

"The additive spatial structures of the Renaissance demand a uniform illumination, while Baroque structures based upon dominance and contrast admit a more dramatic illumination²⁵¹".

Norberg-Schulz referred to the importance of light to reveal the form through shadows and shade, and how the architects from distinct point of views and epochs conceived the architecture with different use of light.

With lighting we can model the shape, generating different effects and thereby change the way we perceive the architectural work. A building rich in details and elements is propitious to achieve play of light and shadow, movement and therefore dynamism. Lighting is responsible for defining forms, weakening them or making them more intense according to their incidence on architectural elements within the diversity of shapes in urban heritage. In this regard, *Quintero* says:

"El arquitecto propone una forma geométrica y el diseñador de iluminación dice; la voy a destacar o la voy a cambiar o la voy hacer diferente, porque la iluminación tiene esa facultad, cambiar la forma, cambiar los colores, cambiar las texturas²⁵²".

The different forms that are present in the urban heritage respond to various factors, such as; fashion, materials, economics aspects and even manpower. Sometimes this combination results in an architecture that lacks of elements, which generates flat facades without details, that for practical purposes of lighting, it doesn't produces difficulties of design. However, the results usually lacks of aesthetic attributes, due to the absence of elements that

²⁵¹ Norberg-Schulz 1995, 154.

²⁵² Rodriguez, Alan P. (8/5/2013).

help to create contrasts of light and shade, which could be necessary to avoid the appearance of flattening.

To create the appearance of volume or perspective on a flat facade, it is necessary to place strategically luminaires, in order to produce degraded light projections on the wall, generating with this a dramatic effect (see *image 76 and 77*). If the facade is flat but has a texture like stone, it can also be illuminated by footlights. This will print as well as a dramatic effect. The intention is to highlight the material, creating small plays of lights and shadows. Moreover to break the horizontality of the shape, due to lights draw virtual columns projected on the surface (see *image 78*).

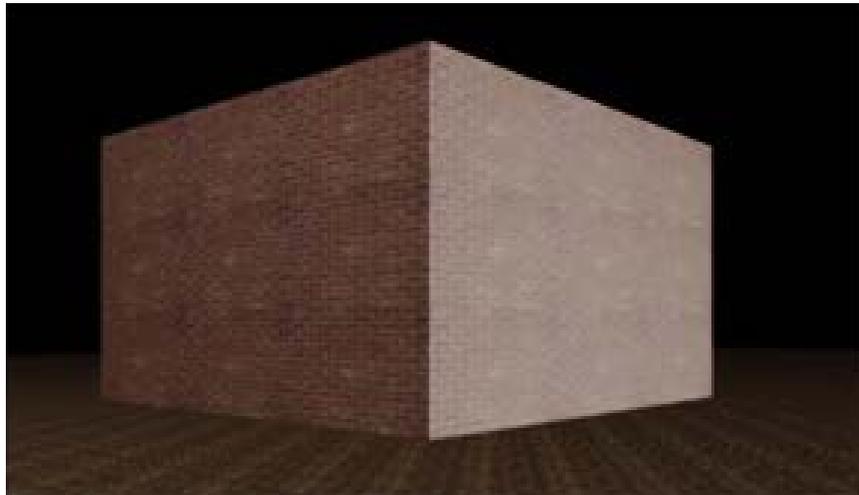


Image 76²⁵³. Uniform illumination on a flat surface.

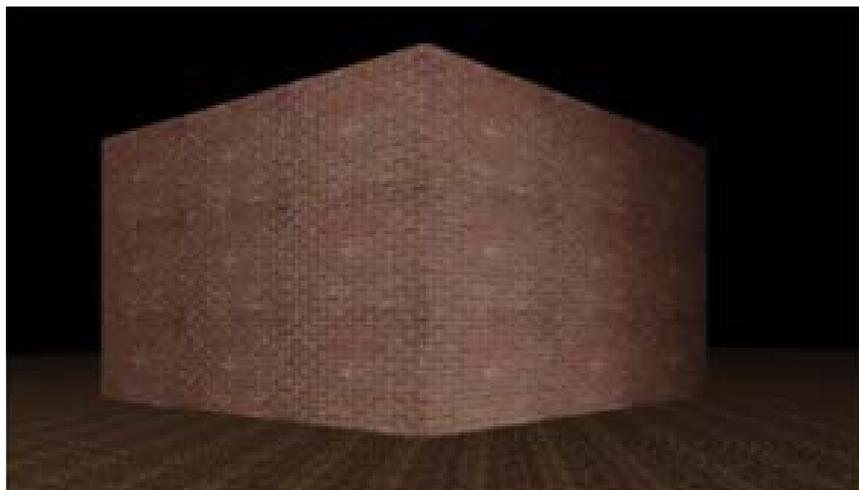


Image 77²⁵⁴. Degraded illumination on a flat surface.

²⁵³ Elaborated by the author.

²⁵⁴ Idem.

The Uniform illumination of the wall highlights the flat surface. It causes that the texture is lost, giving the impression of being flattened. While the degraded one virtually divides the wall, creating light and dark areas, thereby giving the appearance of perspective and dramatism.



Image 78²⁵⁵. Convent of "Tizimin", Mexico. Flat facade with texture. The lighting through projectors placed on the floor of the building, in order to generate an up light, which creates columns of light on the surface of walls.

²⁵⁵ Sachjom 2010.

The view from where the observer is plays a very important role in modeling light, as well as the location of the projectors or luminaires. For example, if the historic building has a cylindrical element, and it was decided to be lighted by projectors in front of the cylinder and in the same direction from where the observer is, then the detail of the texture will be lost and the object will have a flat appearance, but if the cylinder is lit from its sides, it means, perpendicular to the observer, then will be highlighted; the volume, texture and dynamism of the object (see *image 79 and 80*).

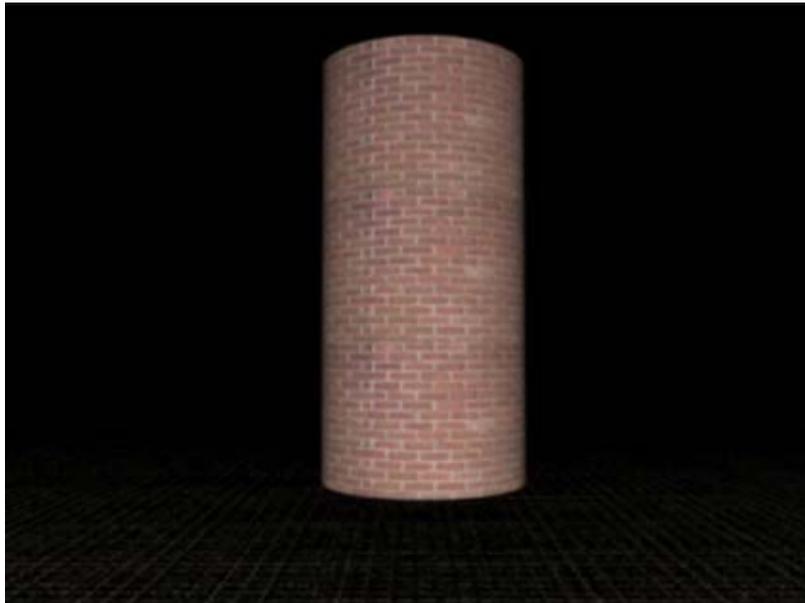


Image 79²⁵⁶. Uniform illumination of a cylindrical object.

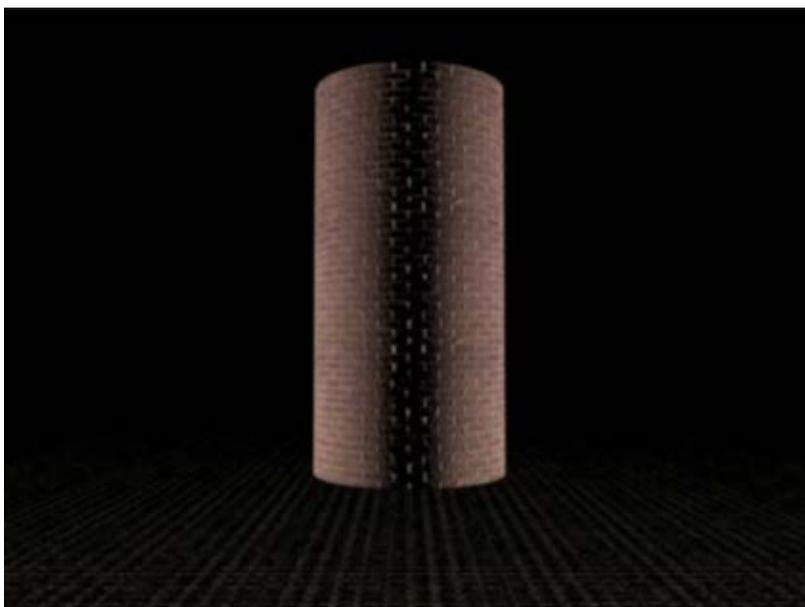


Image 80²⁵⁷. Ascending lighting using two light sources placed on both sides of the cylindrical object.

²⁵⁶ Elaborated by the author.

²⁵⁷ Idem.

Quintero thinks that light designers can break paradigms through illumination. He mentioned an example; we have an architectural element like a cube which by special light, we can print on it the feeling of being an object with rounded edges, such as a cylinder has.

It is important to mention that usually there is more than one observation point from where the historic building can be seen. In this case it will be decided to choose the best view to the monument or building. Another factor to consider is that if the historic building has a slender shape, then the beam of the luminaire could be narrow, in order to avoid the dispersion of light that normally generates light pollution or intrusive lights that illuminate surrounding buildings.

When the architecture of historic or urban heritage buildings has few details or whether the architectural style is sober, then lighting can help to prioritize certain elements of the building, such as portals, gables, moldings, etc. The intention is achieved by projecting colored lights and shadows generation, which create contrasts and in the same time help accentuating the most important elements of the architectural work the most predominant of the architectural work (see *image 81*). However if the mentioned elements are horizontal and shallow, this could represent a problem, because when these elements will be touched by light, then they will project harmful shadows. To avoid this problem is recommended to place the projectors or luminaires away from the building, this will reduce unwanted shadows.

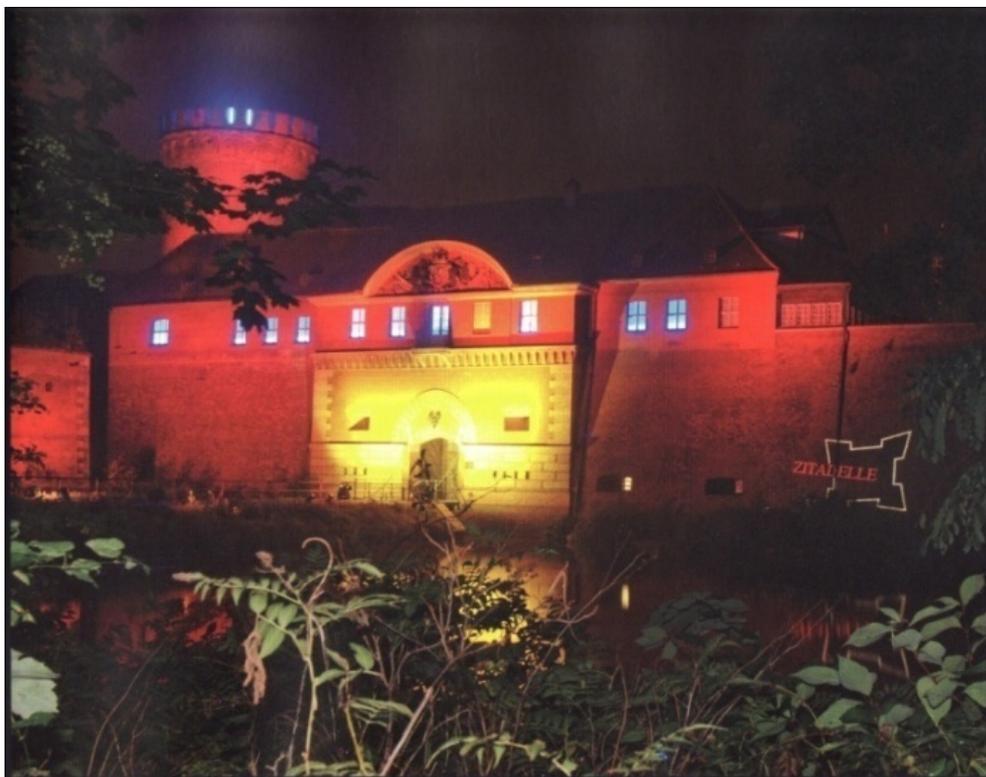


Image 81²⁵⁸. Buildings with sober architecture. Zitadelle, Berlin 2010.

²⁵⁸ Gruppa 2009, 79.

The heritage buildings with shapes and classic elements offer greater possibilities for modeling with light. Since by lighting can be accentuated components that characterize the architectural style or specifically certain details that make the work unique. When this work has a considered number of openings such as windows, it is needed to have special attention, because the light composition can be affected by dark spaces. To avoid this, it is recommended to place luminaries inside of openings with the intention to highlight windows. When windows have in their interior objects that limit the vision, such as curtains or blinds, then luminaries can be installed on the sills, frames or lintels, considering that during the day these objects do not impair the aesthetics of building. Of course the use of all these recommendations will depend on the lighting project.

A good example of lighting of urban heritage building with classical elements and shapes in Germany is the *Reichstag* in Berlin. This building is the seat of the German parliament and in 2009 on the 60th anniversary of the founding of the Federal Republic of Germany was decided to change the overall lighting system, which was presented on May 22 of that year. The lighting project was in charge of lighting artist Michael Batz. The artistic illumination idea of Batz was based on a synthesis of architectural identity, urban quality, democratic symbolism, contemporary design as well as sustainability.

Batz chose as basic color white light in order to highlight with it ornaments and symbolic elements of the façade. The intent was to convey a respectful and sensitive image inside of the context of the building.

“Ich habe versucht, die Räumlichkeit der Fassade herauszuarbeiten, nicht einzelnes hervorzuheben, sondern einen integralen Gesamteindruck zu schaffen. Vorher war das Licht eher zweidimensional gedacht, der neue Entwurf denkt in Linien, Konturen und Umrissformen.“(Michael Batz)



Image 82²⁵⁹. The Reichstag at daytime.

²⁵⁹ Stiftung Lebendige Stadt 2009.



Image 83²⁶⁰. Frontal view of the Reichstag at nighttime.

In image 83 it is possible to see the lighting treatment in openings. The white light with low intensity makes the walls are dimly lit, highlighting the vein and the dome light, creating a balance between the transparent and solid components.



Image 84²⁶¹. The Reichstag at night.

The lighting system of the Reichstag is based on LEDs and metal halide. It was used a total of 400 lamps used brand Philips, families; LEDline 2, Mini DecoFlood, DecoScene and MasterColour CDM-Tm 20/35W.

²⁶⁰ Idem.

²⁶¹ Rodriguez Schaeffer 05.09.2010.

A historic center is integrated by diverse shapes and architectural objects that correspond to different styles that man has conceived throughout history. This presents a challenge in lighting of urban heritage, since lighting treating of shapes and objects is a factor which varies with respect to the configuration and especially to the function of the building or monument. Another important factor to consider is the hierarchy that is assigned to each object in a set. Hierarchy based primarily on social and economic values.

This hierarchy is supported by the axiology of values, which is in some cases from a social perspective, since for society architectural forms acts as an instrument of expression, which through it guides actions toward an ideal. These ideals in architecture are embodied in shapes and architectural objects that respond to a social appropriation within a hierarchized urban context. On the other hand there are special interests, when the urban heritage is seen as an object of lucre and when it does not interact with society but only with a small group of beneficiaries.

The challenge in lighting is not only to identify the hierarchy within the urban heritage, but to provide a solution based on a balance between forms, technology, heritage conservation, energy saving and environmental protection. The answer to this proposed equation is not unique, since it varies with respect to the culture, place and individual and collective interests.

An example of solution to light different architectural shapes and objects within the context of historical center is the city of Bremen in Germany. This city dates from the first century AD and has a historic quarter composed by buildings with different of styles and architectural forms, two of them are cataloged since 2004 by *UNESCO* as a world heritage site. These are the Gothic town hall and Roland statue.

The lighting master plan of Bremen was made by the company "*Ulrike Brandt Licht GmbH*", which included the historic city center. The plan is composed of several projects, which were carried out subsequently from 2006 to 2010. These projects had in common to be contextualized within an atmosphere around the cathedral and the town hall. The main intention was to recreate efficiently realistic lighting, highlighting the texture and shapes of the facades. The luminaries were placed in a discreet way in order to be undetectable during the day, and with the intention of obtaining a good final result, it was chosen to perform several lighting tests, allowing to accurate lighting calculation.



Image 85²⁶². Lighting of the Municipality of Bremen at night.

In image 85 can be observed the treatment of lighting that was given to the roof, with the intention of providing to the viewer a clear idea of the height of the building. It can also be seen how the elements in greater detail are accented by light. In the same way it is highlighted the soffit of the arches in the first story of the façade.

For the lighting system it was used different types of projectors and lamps, which are: Decoflood, MASTERColour CDM-Lamps (150 W and 3000 K). These equipments have different tones of white light, which were used to illuminate the facades of the buildings, as well as certain details like windows of the temple and some mural painting. The lighting of some elements such as; roofs, dormers, and roof structures was performed by using MiniDecoflood lamp. Both solutions have as main characteristic the good color reproduction. For elements with heights between 19 and 20 meters were used as structure for lighting surrounding buildings. The lamps used for this task were OptiFlood. It was also decided to use LEDLine lamps because they require low maintenance.

²⁶² Fotocommunity 2012.



Image 86²⁶³. Temple *Unser Lieben Frauen* at night, Bremen.

The last stage of the lighting master plan of Bremen was the renovation of the temple "Unser Lieben Frauen". Regarding to the illumination, it can be appreciated the lighting treatment gave it to roofs (towers and as the nave). The rosette is highlighted, openings of the belfry and some arches. The mural paintings stand out in the first story through the illumination.

²⁶³ Lighting Philips 2010, 4.



Image 87²⁶⁴. City Hall of Bremen at night.

The illumination of the City Hall of Bremen stands out from the public space, which is shared with other important building, the temple *Unser Lieben Frauen*. The lighting of temple has less intensity in comparison to the City Hall. The hierarchical order of buildings can be appreciate trough the light at night.



Image 88²⁶⁵. *Schlachte Embankment* at night in winter, Bremen.

²⁶⁴ Krüger 2014.

²⁶⁵ Schöning 2007.

Treatment of city lighting is austere with respect to the temple and city hall. Due to the height towers of the temple stands out as a reference point at the distance. The illumination used for the trees are LEDs.

3.1.2 Intrinsic: Secondary group

3.1.2.1 Function.

How is the function of historic buildings or monuments related to lighting? Well, according to 83.33% of light designers interviewed think that it is an important factor to be considered. However this percentage only tells us that it is an important factor, but not how it is related to the illumination. To understand it, it is necessary first to define the concept of function in architecture and its importance in the conservation of urban heritage.

The concept of function has been changing throughout history conforms to the development of space-time needs and above all cultural, therefore components of this concept have been expanding over the years. The architect *Walter Gropius* wrote in 1926 about the new architecture and its function:

“Ein Ding ist bestimmt durch sein Wesen. Um es so zu gestalten, dass es richtig funktioniert – ein Gefäß, ein Stuhl, ein Haus –, muss sein Wesen zuerst erforscht werden; denn es soll seinem Zweck vollendet dienen, das heißt, seine Funktion praktisch erfüllen, haltbar, billig und , schön sein²⁶⁶”.

Gropius in his letter highlighted the importance of the function and its study, not only in the specific utilitarian sense in architecture, but under an integrated approach encompassing economic and psychological aspects. This was applied by *Gropius* not only to architecture but also in a broad sense to all things.

In architecture the function is a determining factor that in some cases is responsible for the permanence of the architectural object. In urban heritage, when the buildings are no longer useful to the society, then it looks for a new satisfier, and thus the building or monument is sentenced to the abandonment and then to extinction. But when the building's structure is flexible with respect to their function (*called by Mies van der Rohe as; **Vielzweckraum**²⁶⁷*), then a new utility could be granted and thereby ensure its permanence. For this it is essential that the new roll of the architectural object responds to new requirements and under an optimal way also fulfill with certain specific functions.

²⁶⁶ Gropius 1926, 117-120.

²⁶⁷The concept created by *Mies van der Rohe* and concerns to that design first should create a practical and satisfactory shape, and then it is assigned to it a function.

Regarding to this, Leland Roth²⁶⁸ mentions and identifies four different functions which are interrelated to each other in the architecture. They are applicable not only to new buildings but also to historic ones. These are; the practical function, of movement, symbolic and psychological.

- Practical function.

This first point refers to the use that is given to a specific space for a specific activity.

- Circulation function.

Here the aim is to provide space to facilitate movement from one space to another.

- Symbolic function.

It is the visible manifestation of its use, which means the correspondence between use and what it suggests to be.

- Psychological function.

It is integrated and depends on the satisfaction of other functions. That is, that for the existence of an optimum psychological function, there must be harmony and consistency between the other functions.

Today historic and urban heritage buildings have different functions. In some cases it still maintains the original function of the building, but in other cases it has been opted to re-functionalize its spaces. This means, to change the original function for which it was designed, changing the building's use, for example, adapting them as hotels, schools and cultural facilities.

It is important to confer a use to historic and urban heritage buildings, but this must be done as long as it is made in a responsible and controlled way. In this regard at the conference on cultural heritage held in Helsinki²⁶⁹ the main topic was the concern to establish innovative and solid basis for urban heritage conservation, considering strategies that have as tools respect measures through seeking a sociocultural and functional balance.

The function is an important factor in planning design of lighting in the urban heritage. Depending on the function that has the building, and then it will be the type of illumination to be used, since around them there are carried out different human activities. It is essential that lighting responds to the function of the building, therefore it is necessary to take into account quantitative and qualitative aspects, as also and psychology of perception in relation to light.

Richard Kelli blends these aspects in the 50s and guides them under a range of functions related to the object and to the observer. To *Kelli "Lighting was planning what we*

²⁶⁸ Roth 2007,11-17.

²⁶⁹ECMRH 1996.

see and how we respond to it, and he felt strongly that the best way to achieve this was to develop the architectural and lighting schemes concurrently²⁷⁰”. Kelli’s studies give as a result three different types of lighting: focal glow or highlight, ambient luminescence or graded washes and the play of brilliants or sharp detail.

- Focal glow.

Kelly proposes a type of illumination that transmits information to the observer. He takes as starting point the fact that the illuminated areas involuntarily attract the attention of people. For example, if in a facade of a building there is any element with relevant information such as an architectural detail that makes special the work, then this could be highlighted by accent lighting, while the other components of the facade can be lit in an attenuated way. This allows application of a certain hierarchy, which is visible through the light. This type of lighting is applicable even to a larger scale. For example, within a historic center converge different objects that usually form part of the urban heritage, but within this urban configuration there is a historic building with a more relevant function with respect to the other works. Then this type of illumination will help to highlight its importance in an urban context.

- Ambient luminescence.

This type of lighting is translated as light to see. It is also known as indirect light. As a main feature is that it doesn’t produce shadows and have the particularity of altering the perception of objects, giving the impression that shapes and volumes are minimized. This can provide greater emphasis on certain elements, in addition to providing orientation to people. *“It suggests the freedom of space and tends to suggest infinity which is usually reassuring, quiets the nerves and is restful²⁷¹”*.

- Play of brilliants.

This last way of illumination allows the viewer to receive information not only through the illuminated objects, but light itself is information. Its function is not only to illuminate the objects, but to makes itself present. This type of lighting tends to take the attention away of the building, becoming the main character. A current example of this lighting system is the *“Media facades”*. In urban heritage can be used not only for publicity events, but also as a means. People can be informed through the use of *Media facades*, what are the activities that take place in the building.

²⁷⁰ IESNA 2007, 2

²⁷¹ Ibidem p.3.

“Play of brilliants excites the optic nerve and in turn stimulates the body and spirit, quickens the appetite, awakens curiosity, sharpens the wit, and is distracting or entertaining as it is used and desired²⁷²”.

These three types of illumination constitutes a palette of possibilities and tools for lighting design, where the designer can make mixtures and combinations with different types of light and in this way getting interesting results. Although any one type of light could dominate. *Kelli* considered the “order of imaginative planning” similar to the creation of a watercolor painting.

Much of the lighting and lighting control equipment available today was initially developed in response to lighting solutions which *Kelly* identified. These solutions are present, not only in isolated urban heritage buildings, but also in historical centers and open spaces such as squares.

The squares of the historic centers play an important role in society, because they are not only places surrounded by heritage buildings, but are spaces where different human activities are performed and therefore have as main characteristic being multifunctional. In spaces where lighting has been particularly developed, from being only functional to become even in some cases a sign of identity of the city.

Lighting of squares should be designed according to the activities performed therein. To discover which function the illumination should perform, daytime and nighttime functions must be analyzed in this urban space. For example:

- Workplace. Where people do this activity (*individually or collectively*).
- Daily recreation Place. It is a space where people meet to talk, eat, play, watch the urban heritage, etc.
- Temporary place of recreation. In this place people can enjoy in a temporary way outdoor plays, concerts, fairs, etc.
- Place of expression. In this space are performed demonstrations by some social groups, with the intention to show support or disagreement to someone or something.

These functions must be analyzed for proper lighting design. If the design is done in a discreet and balanced way, using contrasts and chiaroscuro, this will help to give a reading and clear understanding of the functions performed in the urban space and the dialectic styles in urban heritage, in addition to show the relationship with the context in which they are immersed.

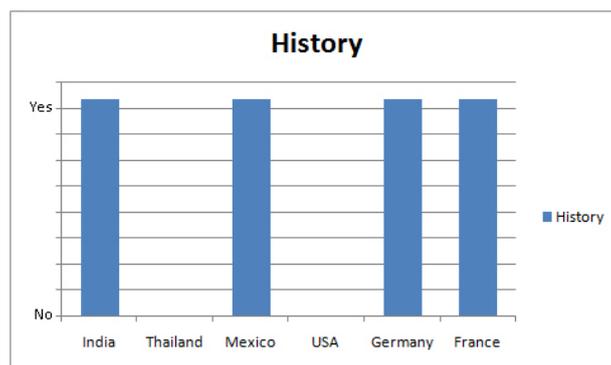
²⁷² Idem.

Marantz thinks that; “Different buildings have different needs, in terms of their responses, there are spiritual buildings, there are government buildings and there are heroic monuments that their aims are to describe the straight of a government, and they are artifacts of history, each one has a different response²⁷³”.

According to Marantz, every historic building has its own special features and lighting should be designed according to these features.

3.1.2.2 History.

In the surrounding of historic and urban heritage buildings have happened in some cases events that have marked relevant aspects for society. These aspects have been concepts and experiences that have accompanied man throughout his history. This is summarized in brief as culture and therefore is worthy to be stored in the memory of the people. However, are all lighting designers who were interviewed aware of the importance of history? Well, 66.66% think that it is important to take history as an important factor in lighting design (see graphic 3).



Graphic 3²⁷⁴. History.

Marantz thinks that lighting design has nothing to do with historical in the world of architecture. To him all issues are the same, which are not different to historical buildings. Against the ideas of Marantz, Quintero says that one of the main objectives of any lighting design for historic buildings or monument is to respect the history.

Quintero identifies two branches of history. One is the history of the context where the building or monument was built, which could have a political or even religious value. The other one is the history of the construction. It means that sometimes there are different stages of construction in the same building, for example, in the case of Mexico there are some temples

²⁷³ Rodriguez, Alan P. (11/14/2012).

²⁷⁴ Elaborated by the author.

which were built on old pyramids. The light designer must respect these two histories of the building.

The historical memory is part of the identity of a social group. This identity makes a society unique and distinguishes it from other, hence the importance of its conservation. The identity materializes itself and becomes visible through the urban heritage, becoming historical synthesis of a particular culture.

Through the illumination of heritage, identity can be highlighted, strengthened, and even constructed, as long as it works as a tool to add value to architectural objects, which simultaneously links the present with the past. In this sense urban heritage is not only a scenario to show, but becomes a symbol of identity of the culture.

The history of a monument, historic building or a place where the architectonic work is located could be used as a main theme in the composition of lighting design. Through the use of lights stories can be told, maybe the history of the building or the place where the architectural object is. The intention is that the observer knows and learns through the lighting.

Today, through the Video Mapping technique, it is possible to narrate historical facts on almost any surface, been the facades the most used architectural element. An example of the use of Video Mapping as storyteller is the case of patron saint festivities of Valladolid, Spain, which were held from September 11th to 12th, 2010. The municipality organized together with the company "*Xtrañas Producciones*" a multimedia show called "*la Reconciliación*". This show consisted to project videos that tell the history of the buildings, which were projected on the facade of three heritage buildings; "*La Colegiata de Santa María*", the walls of la "*Torre de Buena Moza*" and the Cathedral of "*nuestra Señora de la Asunción*". The project included not only videos but also music, sound effects, smoke, pyrotechnics and the performance of a group of actors. For the event was consumed over 90,000 watts of sound and 100,000 watts of light.

Two months before the show, the arrangements started with the measurements of buildings wick were used as screens, and also the distances between projectors, this in order to calculate the projection angles. For these activities were employed 70 people, who were in charge not only for the preliminary work, but also for the days of the event.



Image 89²⁷⁵. Video Mapping projections during the patron saint festivities of Valladolid in 2010. Drawing and images were projected on facades of the Cathedral.

²⁷⁵ Otazo 2010.



Image 90²⁷⁶. Patron saint festivities of Valladolid in 2010. Images accompanied by texts were also projected.

To perform the project of 3d Video Mapping were used four projectors type “*Christie LX 1500*” with 15 lumens. In addition were used 50 robotic heads in order to light adjacent buildings. The projectors were located on separate towers (*four meters high*). Two LX1500 projected a panoramic overview from 30 meters, creating a single image on the front side of the Cathedral. The other two performed independent simple projections at a distance of 50 meters. The software that was used to join the images on the 80 linear meters was *Watchout of Daton*.

The Video Mapping technique has been used only temporarily, and although that it generates significant overhead, it is used in different geographical latitudes and even in some places its use is becoming an annual tradition, as it is the case of the Cathedral of Valladolid in Spain.

Lighting can be used as a communication tool to tell the story of the place. It doesn't have to be necessarily through 3d Video Mapping. This can be also achieved through the use of colored lights or lighting projection on certain architectural elements of the façade. Another strategy would be to tell the history of the construction stages of the building or monument,

²⁷⁶ Idem.

which through a palette of different tones of illumination can be shown the different epochs of elements that constitute the building.

3.2 Extrinsic factor.

This group is composed of those external factors to the object of study. These factors influence directly the design of the light composition, comprising quantitative and qualitative aspects of lighting. The main objective is to protect the integrity of the historic or urban heritage building, while at the same time safeguarding the environment.

This group is divided in three points, the first one are the guidelines and laws, which under legal and even moral give parameters to be follow. The second one is the surrounding context, in order to study the location of the building while respecting and corresponding to its physical environment, and the third one is the light pollution.

It is important to achieve a harmony through the balance between the building, context and lighting, inasmuch as everything is intimately linked, starting from the notion that historic and urban heritage buildings are not isolated items, they are part of an urban and natural context , which all together draw and construct the city landscape.

3.2.1 Guidelines and laws.

During the twentieth century was intensified the international concern about safeguarding cultural heritage, reason why organizations emerge that through the promulgation of rules, laws and agreements are joining international forces to look for the protection of it. However, regarding to lighting of historic and urban heritage buildings, today rules and laws are focused on environmental protection rather than guidelines that show how historic buildings and monuments should be illuminated without harming them. Nevertheless this does not mean that urban heritage structures are not entirely protected. For example, 100% of light designers agree that light project should follow some certain basic rules, guidelines or laws to protect the monument or historic building.

One of the solutions to protect any historic structure is, according to *Chandhok* is not to exposure conducts, do not have wiring within the structures, the use of nails, spikes or conduit. She says that if the light designer nails the structure is not that much damage in comparison if he/she confines the conduits into the finishing.

Other solution which is less aggressive, according to *Quintero* is to place the lighting equipment in the periphery of the monument or historic building. The idea is that luminaries should be separated from all architectural elements. This idea is advisable as long as the supports or structures don't interfere with the architecture. Sometimes it is needed to light the

building from below, since the main view comes also from below, otherwise the observer could see the light sources which will turn into the center of attention instead of the illuminated object.

Restoration theories have been used as guidelines and criteria for any intervention work relating to monuments, historic buildings and art works. These theories have been used and endorsed by organizations worldwide for heritage conservation in international conventions, for example; “*The Athens Charter for the Restoration of Historic Monuments of 1931*”, “*The Restoration Charter of 1972*” “ and the “*Charter for the Conservation of Historic Towns and Urban Areas of 1987*”.

In 1931 was conducted the International Conference held in Athens, where was approved the first international document; *the Athens Charter*. In this paper were confirmed the principles proposed by *Boito*, in addition to expressing concern for urban conservation through respect for the character and appearance of the city, with particular interest in ancient monuments and picturesque works.

Another important aspect is the preservation of the urban landscape, where monuments or historical buildings are the most important protagonists, which give qualities to the environment where they are immersed. This can be translated as the beginnings of the protection of historical contexts.

In 1972 the “*Istituto Centrale per il Restauro*” in Rome published certain criteria for the conservation of works of art. Such principles have been taken by “*Ministri della Pubblica Istruzione*” of Italy. The Principles are preceded by a short report and followed by four appendixes that contain instructions for:

- 1) The preservation and restoration of antiques.
- 2) The way of proceeding in architectural restoration.
- 3) The execution of pictorial and sculptural restorations.
- 4) The protection of historic centers.

The documents annexed should be considered as part of the charter. In this charter *Brandi* ratified its principles for the conservation of works of art.

The *ICOMOS (International Council on Monuments and Sites)* celebrated a general assembly in Washington DC in 1987. As a result of this assembly it was elaborated a new charter concerning to historic urban areas, large and small, including cities, towns and historic centres or quarters, together with their natural and man-made environments.

In this charter is also expresses the preoccupation by the impact of the urban development that follows industrialisation in societies everywhere, which affects directly the

urban heritage. To protect it, this charter defines four principles-objectives, and 12 points of methods-instruments necessary for the conservation of historic towns and urban areas, which will be mentioned below:

Principles-objectives²⁷⁷.

- 1) Historic towns and other historic urban areas should be an integral part of coherent policies of economic and social development and of urban and regional planning at every level.
- 2) Qualities to be preserved include the historic character of the town or urban area and all those material and spiritual elements that express this character, especially:
 - a. Urban patterns as defined by lots and streets.
 - b. Relationships between buildings and green and open spaces.
 - c. The formal appearance, interior and exterior, of buildings as defined by scale, size, style, construction, materials, colour and decoration.
 - d. The relationship between the town or urban area and its surrounding setting, both natural and man-made.
 - e. The various functions that the town or urban area has acquired over time.
- 3) The participation and the involvement of the residents are essential for the success of the conservation programme and should be encouraged.
- 4) Conservation in a historic town or urban area demands prudence, a systematic approach and discipline.

These principles-objectives encourage the light designer to be aware of the importance of the context where the historic building or monument is placed, to research about the history of the place and of course of the monument and the importance of the appropriation by the people.

In the second principle, third point explains what elements define the appearance of the building and monument. Light is also part of the colour and decoration of the external look of the illuminated object.

The methods-instruments of this charter talk more precisely about conservation criteria which should be followed. However some of these points could be taken into account for lighting design, especially point 7.

- 7) Continuing maintenance is crucial to the effective conservation of a historic town or urban area.

²⁷⁷ ICOMOS 1987.

If there is a regular maintenance of lighting equipment, then its useful life will be extended, giving as a result not only economic benefit but also energy saving.

Today, when performing any intervention project for historic and urban heritage structures, it is necessary to sustain it under conservation criteria, based on principles of the theories of restoration, besides to respect guidelines issued by the municipality where the project will be executed.

Unfortunately today there are no laws that protect historic buildings and monuments against the radiation by improper lighting, however, both the laws and rules are dynamic, that means that they are always changing and evolving, so it is necessary to pay attention to changes.

In some places, as in the State of Thüringen in Germany there are laws like; "*das Thüringer Denkmalschutzgesetz (ThürDSchG)*" which mentions that the image of cultural heritage should not be altered. In this case of lighting this law could be applied in the sense that luminaries, projectors, etc., should not alter the image of historic buildings, monuments, etc. These equipments do not avoid the correct reading of urban heritage, as well as the improper use of light projections.

3.2.1.1 Lighting principles for the conservation of urban heritage.

Starting from the fact that lighting is also an action of intervention, a set of principles is proposed in this research. If they are taken into account, could contribute to the conservation of urban heritage.

- Principle of specificity.

There are no identical works; therefore the illumination projects should be also different. Each work has its own characteristics and therefore its own specificities (form, location, materials, texture, etc.), which should be taken into account for a lighting project of urban heritage.

- Principle of respect for the shape.

The luminaires, projectors or accessories should not alter the shape of the monument or historic building. It means that all these external lighting items should be embedded with the building or monument.

- Principle of contextuality.

Today there are some lighting projects, which are taking advantage of compositional elements of design, such as contrast, try to highlight the heritage work with lights, leaving under shadows the surrounding context of the monument or historic building. We should not underestimate the surrounding context or assaulting the environment, but rather take it into account. Lighting projects should be designed under an inclusive perspective. It means that through illumination the urban heritage must be integrated with the immediate context and not to be excluded.

- Principle of respect for the constituent materials of the work.

Lighting should be designed according to the materials that constitute the urban heritage, because in some cases certain materials are photosensitive²⁷⁸ and they could react affecting the integrity of the work. To avoid this, it is necessary to conduct preliminary studies like; the type of lighting to be implemented and the photosensitivity of the materials and coatings.

- Principle of reversibility.

All lighting intervention in urban heritage should have as one of its main features the reversibility. It means that lamps, luminaries, projectors, accessories and installation, if it is required in the future to be removed, should be done without affecting the urban heritage. Besides, they should adapt also to the changing conditions of lighting and technology.

- Principle of maintenance.

“Es indudable que todo proyecto de iluminación que no incluya un adecuado plan de mantenimiento, rápidamente será obsoleto²⁷⁹”.

Outdoor lighting is generally in direct contact with the weather, as well as being prone to vandalism. That is why a maintenance plan should be essential.

The performance of the lights, reflectors, etc., is affected by atmospheric dust and dirt, which are found on reflecting and transmitting surfaces. Additionally there are others factors such as; the oxidation, the effects of heat, violet and red radiations, and even chemical effects that harm not only the monument or historic building, but also the lighting equipment and therefore their performance.

The purpose of providing maintenance is to ensure the good performance of lighting, reducing its depreciation and aging.

The importance of protecting the urban heritage is not just because it is integrated by old buildings and monuments, or because they are or not beautiful, monumental and having other qualifiers. The most relevant is because they are evidence of the past, that through them

²⁷⁸ In this chapter (pages 103-110) is mentioned some causes and materials, which react negatively to certain types of radiation.

²⁷⁹ Deco 2010, 166.

we can have an idea how was the technological and cultural development of our ancestors and to learn what was their spatial, expression and shelter needs. All these give us answers that will help us to have a better vision of the past and in this sense be able to have also a better comprehension of the present.

*“... we need memory, we need something to which to attach our memories”
(John Ruskin)*

3.2.2 The surrounding context.

Before explaining why and how the surrounding context should be taken into account for the design of lighting, the word context will be explain.

According to “*La Real Academia Española*” context comes from latin word “*contextus*”, which means “*unión de cosas que se enlazan y entretajan*”²⁸⁰.

The Brockhaus Enzyklopaedie says that context comes from the word in Latin “*contexere*” which means “*eng verknüpfen*”²⁸¹

The Oxford Dictionaries explains that the word context comes from “*Latin contextus, from con - together + texere to weave*”²⁸².

No matter what are the roots, the meaning refers to a certain organization. That means to a configuration. In practice, the context of an object refers to a structure within something figures. Without that context the object could not be read, much less understood, but are light designers aware of the important of context for light design? Actually 100% of them take into consideration the context for their projects.

Some words and concepts change over time and in some cases fall into disuse. In other circumstances they are retaken and become the main idea of a new trend. This has been precisely the case of the word “*context*”. In the first half of the twentieth century the use of this term was for the first time used as an idea to respect the history and the place, due to buildings and monuments are not isolated elements, but are part of a set. This set is known as the context.

In architecture the term context began to be reused more strongly in the second half of the twentieth century, when a movement wich fought for the respect of all the historical factors that influenced the production of space. This movement was called “*contextualism*”.

²⁸⁰ RAE 2012.

²⁸¹ Brockhaus Enzyklopädie 2012.

²⁸² Oxford Dictionaries 2012.

The context is integrated by; geographic, physical, cultural, historical, social factors and also by built elements which characterize a particular place where the historic building or monument are immersed. When these factors are not taken into consideration then the image of the city is harm. This brings as a consequence the loss of historical value, lack of private investors, tourist disinterest, impacting finally on the local economy.

The surrounding context is the immediately external environment which surrounds the historic building or monument. It is integrated by the natural and built context. The natural context is composed of physical and environmental factors, such as; geography, climate, hydrology, topography, vegetation, soil and sunlight. The artificial environment consists of all those elements that represent the influence of human culture, where we can find; buildings, monuments and infrastructure.

When historic buildings and monuments are surrounded by the darkness of night, they become a tempting scenario for lighting designers. Who make use of their technical knowledge to combine artificial light with darkness, resulting in a contrast which buildings are highlighted in relation to their immediate context. However, in some cases the works become the only actor in the scene. Lighting designers forget completely the surrounding environment. This situation worsens when works are illuminated within a historic center or when the architectural work is placed next to a park, where shares the space (*see image 91*).

It is true that lighting is an important tool, which allows us to observe overnight objects and their features, but if it is not used carefully, illumination may exclude historic buildings or monuments. That means, while illuminated works have the main role in the scene, buildings or monuments from the surrounding environment are discriminated, as *Marantz* asseverates; *"If you light a building you give darkness to the context. All light is related to darkness"*. However, he is aware that although the surrounding buildings are not part of the project, the light designer has the responsibility not to exclude them from the scene.

According to *Marantz* the light designer should not attend to compete with the urban context, but what happen if the surrounding context has high level of illumination? *Quintero* thinks that if the historic building or monument has an over illuminated context, then it is possible to compete with it. Another possibility to him is to try to integrate in it, or as *Chandhok* says, to take advantage of the lights which come from the context, it means to use them in our lighting project.

Lighting should be a tool to be used as linker element of shapes and spaces within a same context. To achieve this is necessary to make a preliminary study of the surrounding context, beginning with the collection of basic data, such as: geographic location plans, architectural surveys, aerial photographs, study of weather, hydrology, soil, vegetation and

infrastructure. Afterwards all the information will be analyzed and advantages and disadvantages of the site and surroundings will be also established.

Thorough this previous study of the surrounding context, it can be determined the best way to implement lighting without damaging the surrounding environment.



Image 91²⁸³. Daytime view of the Government Palace and its immediate surroundings, Colima, Mexico.

²⁸³ Wordpress 2011.



Image 92²⁸⁴. Government Palace, Colima, Mexico. Exclusion of adjacent historic buildings.



Image 93²⁸⁵. Government Palace, Colima, Mexico. Exclusion of the natural environment.

²⁸⁴ Enrique 2012.

²⁸⁵ Skyscrapercity 2011.

Through architectural elements of the Government Palace of Colima city in Mexico, we can determine that its style is neoclassical. The building was built in the late nineteenth century. The adjacent building is the Cathedral of Colima. It has austere neoclassical elements dating from the same period of construction of the Government Palace. This is an example of when lighting project excludes the immediate context. In the case of the Cathedral, this building has the same age, however at night it can be only appreciated some of its elements, which are illuminated by the intrusive light that comes from the projected light of the Government Palace. Furthermore, the park which is opposite to the Palace and like the Cathedral, it only receives the reflection of the light that comes from the Government Palace. The lighting designer did not into consideration the immediate context, just took advantage of it to highlight his lighting design.

3.2.3 Light pollution.

During the decade of the sixties of the twentieth century, astronomers began reporting that some stars were disappearing behind a veil light²⁸⁶. Until that moment the nature of the problem was not defined and much less a name had been given to it. In the next decade is when the first studies of this phenomenon started. Today this luminous veil has been named; "*light pollution*". It is defined as:

"Cualquier afectación al medio natural que esté ocasionada por la iluminación artificial nocturna. Estas afectaciones son el resplandor luminoso de la cúpula celeste, la luz intrusa en hábitats naturales oscuros, el deslumbramiento y el consumo energético²⁸⁷".

At the present time different activities that take place at night in public spaces require artificial lighting. Its widespread use is the main cause that generates light pollution. San Martín²⁸⁸ named some evening activities that require artificial lighting. They are:

- To create conditions of safety.
- To improve traffic safety of roads, streets, etc.
- To give fluidity and comfort to the activity.
- To avoid hazards and accidents in the activity.
- To allow social activity between the individual and increase economic activity.
- To give a new appearance to cities, by the illumination of facades, ornamental, etc.

In the last point is mentioned the need to give a new appearance to cities. Regarding to this, lighting is a tool that has been used to give a new look to cities. This activity is breaking increasingly paradigms of conception of historical buildings and monuments at night, since the

²⁸⁶ CNMA 2000, 1.

²⁸⁷ San Martín 2012, 11.

²⁸⁸ Ididem, p. 15.

tendency of illuminate them is growing as human activities are demanding longer hours, incrementing consequently the use of lighting, thus this becoming a source of contamination.

3.2.3.1 Sources of light pollution.

Sources that generate light pollution are three²⁸⁹:

- 1) By direct emission.
- 2) By reflection of illuminated surfaces.
- 3) By particle dispersion in the air.

1) By direct emission.

It is when the light is directed toward to heaven or toward to some natural habitat. This type of emission is the main cause of pollution, as a result of poor or lack of planning in lighting design. That means that instead of lighting directly the building or monument, the lights is dispersed and as a consequence another environment is affected. To prevent contamination by direct emission, it is necessary to consider the following in the lighting design

The luminaire generates a cone of light, which is only usable when it has an opening angle of 140° . To find this angle it is necessary to draw a vertical line down from the lamp (a) to the ground (b). The half of the angle is 70° . This makes a triangle (points a, b, c), which represents the usable area. The triangle formed from 70° to 90° (points a, c, d) creates a blinding light. The light goes directly to the sky from 90° to 180° (points a, d, e) (see *image 94*).

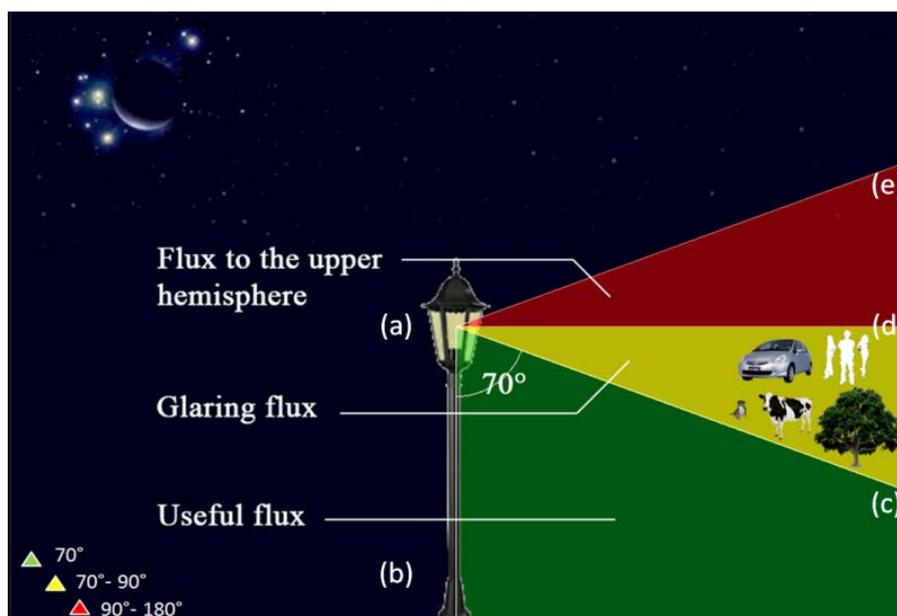


Image 94²⁹⁰. Flux emitted by a street luminaire.

²⁸⁹ Rodríguez 2008, 30-31.

²⁹⁰ Elaborated by the author.

2) By reflection of illuminated surfaces.

The reflection is a physical phenomenon that can be used by lighting designers. However this phenomenon can also harm the environment since it contributes to light pollution. For example, when a historic building has facades composed of smooth materials like glass, marble, etc., and it is illuminated, then part of the light will be reflected directly to the sky, which generates and contributes to the light pollution (see *image 95*).



Image 95²⁹¹. View at night of the Orthodox cathedral of Saint Sava. Svetosavski Square, Belgrade, Serbia.

²⁹¹ Schröder 2012.

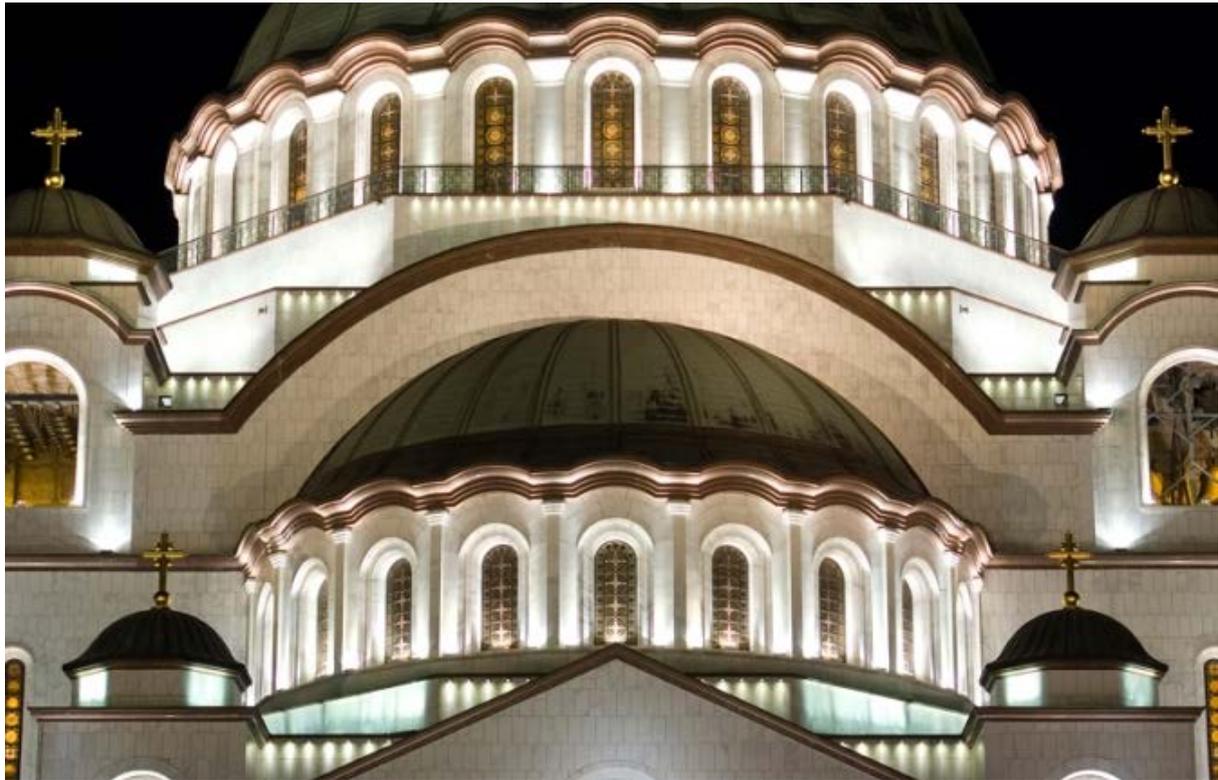


Image 96²⁹². Lighting detail of the Orthodox cathedral of Saint Sava. Svetosavski Square, Belgrade, Serbia.

The predominant material used to build this neo byzantine building is white marble. For lighting were used 67 projectors "*Terra*" with a high tightness level of *IP 67*, and mechanical strength to resist the passage of pedestrians. In total 1200 floodlights were used for the light Project. The Focal, fitted with a visor, illuminates the half-dome while the same model fitted with a light channel emphasises the stain glass windows at the entrance. Lights were placed in both directions ascendant and descendant way.

3) By particle dispersion in the air.

This source of pollution is originated from the reflection phenomenon. Light instead of been reflected on a solid surface, this is reflected in the particles that are suspended in the atmosphere (see *image 97*). Light pollution is therefore the result of the sum of the pollution sources; direct emission, reflection of illuminated surfaces and particle dispersion in the air.

²⁹² Idem.



Image 97²⁹³. Light pollution in Mexico City 2010. The light coming from the city hits by reflection the particles of the air. As a result a lighting halo above the city is produced.

3.2.3.2 Effects of light pollution.

Light pollution produces harmful effects not only in the sky, but also in humans, animals and plants. As it is explained below:

1) Effects on the sky.

When a light source illuminates the night sky, for example, the city lighting creates a halo effect of light in the sky that avoids us to watch the stars. If there is no light pollution, then it is possible to contemplate the stars, due to the contrast of illuminated bodies with darkness of the night.

During the decade of the 60s and even the 70s, the effects of light pollution on the night sky were almost minimal. In later years this problem has increased to visualize the stars that even with special and sophisticated equipment is difficult to study them.

²⁹³ Wicked Magazine 2010.

"...more than one fifth of the world population, two thirds of the U.S. population and one half of the European Union population have already lost naked eye visibility of the Milky Way²⁹⁴".



Image 98²⁹⁵. The night sky of Leamington, Utah. Population of 217 in 2009. The constellations of Sagittarius and Scorpius are visible.



Image 99²⁹⁶. Night sky of Orem, Utah. Metropolitan area with a population of around 400,000.

²⁹⁴ Walker 2009.

²⁹⁵ Stanley 2009.

²⁹⁶ Idem.

Today measures are being implemented in order to prevent that light pollution affects astronomer's studies. One of them is to build observatories away from population centers. However this measure increases costs, therefore light pollution continues hampering astronomical studies, limiting the development of knowledge in this area. However, the problem is not only related to astronomical studies.

“Approximately 40 percent of the United States population, one-sixth of the European Union population and one tenth of the World population cannot even look at the heavens with the eye adapted to night vision, because its brightness is above the night vision threshold²⁹⁷”.

In response to these problems, *UNESCO* has published in Article 1 of *The Universal Declaration of Human Rights for Future Generations*, the following:

“Persons belonging to future generations have the right to an uncontaminated and undamaged Earth, including pure skies; they are entitled to its enjoyment as the ground of human history of culture and social bonds that make each generation and individual a member of one human family²⁹⁸”.

2) Effects on humans.

Light pollution affects not only astronomical activities, but also economic and human health. When astronomical activities are being affected by light pollution, it harms directly the culture, as *UNESCO* mentioned in the introduction of *Proclamation of 2009 as International Year of Astronomy*.

“This interest in astronomy has had profound implications for science, philosophy, religion, culture and our general conception of the universe²⁹⁹”.

According to *UNESCO*, astronomy is not only important to professional and amateur astronomers, although it is an activity practiced by few people. It has significant impact to the society³⁰⁰, for example, light pollution generates significant energy losses, which result in an increase in costs of production, distribution and consumption.

²⁹⁷ Cinzano et al. 2001, 701.

²⁹⁸ UNESCO 1994, 2.

²⁹⁹ UNESCO 2005, 4.

³⁰⁰ Note: To know more about how the light pollution affects the society read: Rodríguez, P. (2008) *Análisis de comportamientos sociales en el uso del alumbrado artificial y sus repercusiones en el medio ambiente nocturno*. Tesis de doctorado. Barcelona, España. Programa de Ingeniería de Proyectos: medio ambiente, seguridad, calidad y comunicación. Escola Tècnica Superior d'Enginyeria Industrial de Barcelona. Universidad Politècnica de Catalunya. (Spanish)

The solution is not to reduce urban lighting. The answer is to illuminate properly. In this sense, that is why some foundations and municipalities aware of this have decided to change the street lighting system in their municipalities, as are cases of Valladolid in Spain and Schwäbisch Hall in Germany.

The municipality of Valladolid made the lighting project *Ruta ríos de luz*, with a total investment of 1.357 million Eu. The previous system had lighting power of 108.384 KW, having been reduced to 60.25 kW, that means that it has achieved energy savings of 44.5%³⁰¹.

Valladolid received in 2011 the award for *best lighted city in the world*. A total of 180 candidates competed of four continents. The award ceremony took place in the city of Goteborg in Sweden, organized by “LUCI” (*Lighting Urban Community International Association*).



Image 100³⁰². Rutas ríos de luz. Valladolid, España. The full facing facades are not illuminated, but only certain elements are highlighted.

³⁰¹ Ayuntamiento de Valladolid 2011.

³⁰² Philips 2011, 1-2.



Image 101³⁰³. *Rutas ríos de luz*. Valladolid, España. 2011. The entire facades are bathed with white light, only openings of the tower has different color. The designer used the contrast to highlight vain elements.

The lighting system used for *Rutas ríos de luz* is mainly based on LED technology. This technology not only provides a reduction of energy consumption, it also reduces maintenance costs for its long duration.

The city of Schwäbisch Hall in Germany also changed the street lighting systems as well as the illumination of some monuments and historic buildings. It started when the *Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* in 2010 financed programs for the environment protection under social, cultural and urban approaches.

The lighting project of the municipality of Schwäbisch Hall changed the old lights of some streets of the city's historic center, which was integrated by *T8* and *HQL80* luminaires with at least 40 years old. The current system has LED technology which helps to save approximately 80%³⁰⁴ of energy (see image 102).

³⁰³ Idem.

³⁰⁴ SHR 2013.



Image 102³⁰⁵. Streetlights of *Marktsraße* in Schwäbisch Hall, Germany, 2013. The luminaires are recessed directly on the walls and their light projection is enough to see at night. The color of the light is amber.

³⁰⁵ Elaborated by the author.



Image 103³⁰⁶. Streetlights of *Salinenstraße* in Schwäbisch Hall, Germany, 2013. The luminaries have amber color, type *Siteco SL 10micro*³⁰⁷.

³⁰⁶ Idem.

³⁰⁷ SHR 2013.



Image 104³⁰⁸. Streetlights of *Froschgraben* in Schwäbisch Hall, Germany, 2013. A proper lighting doesn't mean that it is necessary to bath the entire façade with light. In this case it was only lighted the main concept of the façade, which is the opening.

³⁰⁸ Idem.

The municipality of Berlin has also decided to change the lighting system of some historic buildings and monuments, like for example the *Reichstag*. The lighting project contemplated among its main objectives, the reduction of energy consumption and CO2 emissions. The new system achieved a consumption in 4 hours of 5 euros and 33 Tons of CO2 per year, this is translated as an average energy savings of 60%³⁰⁹.

Another detrimental effect on humans in relation to light pollution is health. *Eva S. Schernhammer* has demonstrated by her study; *Nurses Health Study* that obtrusive light affects the circadian system in humans and may increase the risk of cancer.

"I have done work on the effects of light at night on cancer risk through the melatonin pathway and demonstrated that the effects of light at night may affect not only breast cancer, but also other cancers such as colorectal cancer, generating evidence that supports a new hypothesis on the development of cancer³¹⁰".

The circadian system is responsible for the physiological processes which have fluctuations at a rate of about 24 hours. These include the sleep-wake cycle, changes in body temperature, alertness and some neuroendocrine functions, such as cortisol and melatonin secretion.

When the obtrusive light is captured by the retina then modified our biological clock, causing insomnia, which affects the performance of human activities. Another cause which creates health problems are the white light of LED lighting systems, which have been studied by the *Agence nationale de sécurité sanitaire (ANSES)* of France. This French agency has published in October 2010 a study on the effects caused by white light LEDs lamps, which has the ability to cause irreversible damage to the eyes.

According to *ANSES*'s studies, the light intensity of the light emitted by white LEDs is approximately a thousand times more than the traditional systems. The white light LEDs produce glare and toxic stress to the retina. People who are more prone to these effects are those who have an undergone surgery of cataracts, those with photosensitivity and children. Especially the last one, since lens of the eye is still developing, so it is not able to filter adequately the light³¹¹. It is important to mention that animals are also affected by this lighting system.

³⁰⁹SLS 2009.

³¹⁰ Note: *Eva S. Schernhammer* MD, DrPH. She is Associate Professor of Medicine in Harvard Medical School, and also Associate Epidemiologist, Department of Medicine in Brigham and Women's Hospital.

³¹¹ Note: To know more about this topic, the information is available on: <<http://www.anses.fr/index.htm>>

3) Effects on animals and plants.

The natural lighting effects of ecosystems have been studied for some time by biologists and ecologists. Today, the studies focus on another type of light source, artificial light. According to a study published by *Travis Longcore* and *Catherine Rich*³¹², artificial light as a source of light pollution, has important effects on the biology and ecology of wildlife, since it alters the natural cycles of light. These effects are reflected in changes in animal behavior and even also in plants.

a) Effects on Animals.

Some animals feel attracted by artificial light, while others flee from it. Apparently this doesn't affect significantly, however the consequences of these changes may affect in; increased predation, migratory alterations, animal's collisions against architectural structures or monuments, change in feeding schedules.

According to the book *Ecological consequences of artificial night lighting*³¹³, most rodents and small carnivores are active at night. The 80% of marsupials and 20% of primates are nocturnal.

One of the wild species which have had affectations produced by light pollution is sea turtle. These animals after spawning on the beach are guided by the light of the stars and the reflection of the moon on the sea to find the way back to the ocean. When there is excess of artificial lighting turtles become disoriented, following light sources which usually are on streets and buildings, this finally provokes the death of them in many cases³¹⁴ (*see image 105*).

³¹² Note: To know more about this topic, the information is available on:

<[http://www.esajournals.org/doi/abs/10.1890/1540-9295\(2004\)002%5B0191:ELP%5D2.0.CO;2](http://www.esajournals.org/doi/abs/10.1890/1540-9295(2004)002%5B0191:ELP%5D2.0.CO;2)

³¹³ Note: To know more about this book read; Rich, C. and Longcore, T. (2006) *Ecological Consequences of Artificial Night Lighting*, Island Press.

³¹⁴ El mundo.es 2009.



Image 105³¹⁵. Tortoises at night following the light, 2010.

Another affected species are birds. These animals are also attracted by artificial light. The situation worsens when the buildings have reflective surfaces such as glass and moreover when the weather is rainy or foggy.

“Birds migrating at night are strongly attracted to, or at least trapped by, sources of artificial light, particularly during periods of inclement weather ...”

“they become vulnerable to collisions with the structures themselves. If collision is avoided, birds are still at risk of death or injury. Once inside a beam of light, birds are reluctant to fly out of the lighted area into the dark, and often continue to flap around in the beam of light until they drop to the ground with exhaustion. A secondary threat resulting from their aggregation at lighted structures is their increased vulnerability to predation³¹⁶”.

The insects are also affected by the excessive use of artificial light, since the light attracts them, resulting in many cases in a trap for them (see image 106 and 107). It is important to mention that over 75% of Lepidoptera (*butterflies*) are active at night, this also happens to a large number of Coleoptera (*beetles*), and other insects³¹⁷.

³¹⁵ Richardson 2010.

³¹⁶ Evans 1996, 4.

³¹⁷ CNMA 2000, 23.



Image 106³¹⁸. Luminary of Bad Muskau Park at day, 2012.



Image 107³¹⁹. Luminary of Bad Muskau Park at night, 2012. The insects feel attracted by the white light.

³¹⁸ Elaborated by the author.

³¹⁹ Idem.

The first documented reports mentioned how the electric lighting system attracts the attention of some insect species. For example, *La Société Entomologique de France (SEF)* published in its Bulletin that entomologists had seen in the city of Turin, France beetles flying near artificial light sources, as we can read below.

“Le professeur Lassona a signalé l’invasion à Turin d’innombrables quantités d’Hydrophiles, qui, attirés par la lumière électrique, tournent autour des verres qui protègent les becs lumineux, se brisent contre eux et jonchent bientôt le sol. Il rappelle qu’un fait analogue s’est passé à Alexandrie, mais il s’explique mieux dans cette ville entourée d’eaux stagnantes. A Turin, les lumières électriques du côté de la cité pauvre en eaux n’ont pas attiré les Coléoptères aquatiques, tandis que, dans la partie qui regarde Vanchiglia, les insectes ont pu venir en cohortes pressées. Il est curieux de constater que l’attraction de la lumière électrique s’exerce plus particulièrement sur les Hydrophiles et même sur des Coléoptères d’autres familles³²⁰”.

Today it has been discovered that insects are sensitive to radiation in the blue wavelength spectrum, this corresponds to 400 nm. It is also known that they are attracted by ultraviolet rays which artificial lighting systems radiate. Some insects overnight depend on the reflex of light on water, to determine the place where they feed, spawn and reproduce. Artificial light sources are traps that attract and disorient them, after that some die burned by the heat produced by the lamps and in other cases collide with light sources, allowing them to be an easy prey for some predators, causing an ecological imbalance.

Public lights with mercury lamps are particularly aggressive to most insects, since the viewing range is between 550 nm and 360 nm and the lamps produce a radiation above 600 nm., range which is invisible to insects³²¹.

b) Effects on Plants.

Today lighting refers not only to the lighting of buildings, monuments and public spaces, but also has led to the green areas with the intention of illuminating trees, flowers and shrubs, in order to complement in some cases the architectural lighting project of some monument or building. However, if it is known that plants are living organisms, do they aren't they affected by the constant bath of light? Plants as living organisms are also affected by light pollution. The flora as animals and humans, has established its biological cycles during the day and night.

³²⁰ SEF 1888, 37.

³²¹ Dolsa et al. 1998, 5.

When plants are exposed to prolonged periods of light, it produces alterations in their natural biological processes.

Some deciduous plants are affected by artificial light, which inhibits photoreceptor production called phytochrome. This results in a delay in the falling leaves. This change is necessary because it allows seasonal acclimatization³²². In other plants changes are visible, due to the lack of flowering.

“... la alta intensidad de fuentes de luz, tal como las lámparas de vapor de sodio a alta presión (VSAP), tienen grandes impactos en retardar el color de las hojas y de la actividad sustancial de los árboles³²³”.

All light designers who were interviewed are aware of the importance to avoid light pollution with their projects. In this sense, they give some recommendations:

Chandhok says that it is important to use smaller components of uplight, limiting the illumination of dense trees, angles of throw, controlling trespass, using flat beams or elliptical beams to avoid skyward spill. *Prabhu* adds to this and advises that today's lighting technology will help us to avoid light pollution.

To *Marantz* it is almost hopeless to avoid light pollution, at least in the big cities like New York, because there is a gigantic concentration of people, but he thinks that sometimes the upper lights are crucial.

To *Chutarat* advises the use of beam angle, proper reflector, equipment that is suitable to objects with minimal percent of light spill. Light designers should use a good light distribution that does not cause discomfort glare or disability glare. She also thinks that a proper light composition can provide city beautification rather than to light everywhere without strategies, this helps reducing light pollution.

Quintero suggests that classifying the monuments and historic buildings according to their age will help to determine what percentage of the entire façade should be illuminated. It could be only 5, 4 or even 3% of the entire surface.

It is true that public space is the stage where people interact socially and is the place where different social activities are made. It is also a place for biodiversity, as we saw above. Effects caused by the intrusion of man are not only in their own habitat, but also in the environment. That is why it is necessary to become aware and to avoid as much as possible continuing attacking ecosystems.

³²² Hansen 2003, 7.

³²³ Rodríguez 2008, 42.

Part III. Case of Study.

Chapter 4. Case of Study.

4.1 Chiapas: Geographic location.

Chiapas is located southeast of Mexico, bordered on the north by the state of Tabasco, on the west by Veracruz and Oaxaca, on the south by the Pacific Ocean and on the east by the Republic of Guatemala. Chiapas coordinates are: North $17^{\circ}59'$, south $14^{\circ}32'$ north latitude, east $90^{\circ}22'$ and west $94^{\circ}14'$ of west longitude³²⁴.

4.2 Chiapa de Corzo.

4.2.1 Geographic location.

Chiapa de Corzo is located in the center of the Chiapas state and bordered on the north by the cities Osumacinta and Soyaló, on the west by Tuxtla Gutiérrez, Suchiapa and Villaflores, on the east by Zinacantán, Ixtapa and Acala and on the south by Villa Corzo. It is placed just 15 km southeast from the capital city Tuxtla Gutierrez. It's coordinates are: $16^{\circ}42'N$ and $93^{\circ}00'W$ ³²⁵.

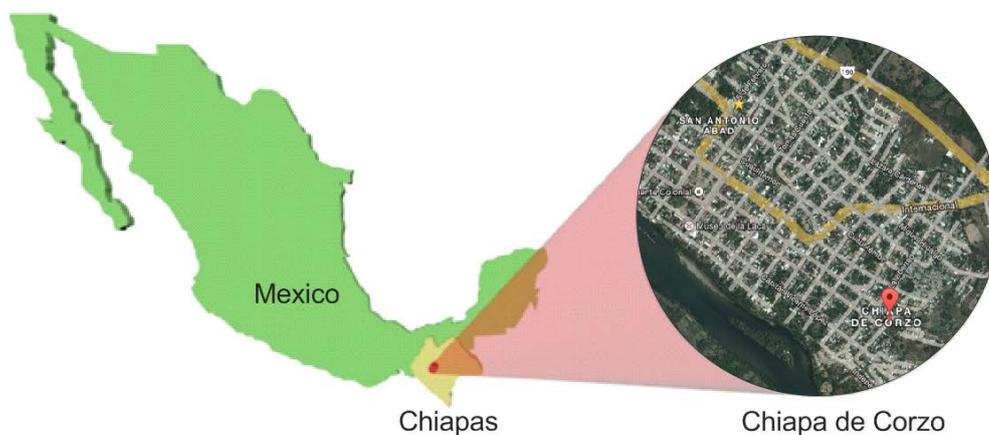


Image 108³²⁶. Geographic location of Chiapas and Chiapa de Corzo.

4.2.2 History.

The history of Chiapa de Corzo dates back between 1500 and 1000 BC. Approximately 700 BC it was a ceremonial center. The settlement reached its greatest splendor between 400 and 450 AC³²⁷.

³²⁴ GC 2012.

³²⁵ INFDM 2012.

³²⁶ Elaborated by the author.

³²⁷ Orozco 2007, 52.

In 1524 arrived at the first time the Spanish to Chiapa de Corzo. In those days the indigenous town was one of the biggest Pre-Hispanic settlements in the center of Chiapas that also had important natural resources. One of the Spanish soldiers named Bernal Díaz del Castillo, who was in the first expedition, wrote his impressions of the town:

“Las casas y las calles muy en concierto y de más de cuatro mil vecinos [...] y en lo más poblado, donde estaban sus grandes cúes y adoratorios [...] las casas tan juntas que no osábamos asentar real³²⁸”.

The main goals of the expedition were to establish peace in the region and found villas. It was not possible due to some armed insurgencies. Not precisely in Chiapa de Corzo, but these social movements happened in the same region. Finally the Spanish had to leave the town without found it.

A second expedition took place in 1528, but this time the Cap. Diego de Mazariegos could found the city. The name of the city was: *Villa Real de Chiapa*³²⁹, also known as *Chiapa de los Indios*, as opposed to the other city "Chiapa de los Españoles", today known as *San Cristóbal de las Casas*. Chiapa de Corzo was the first villa founded in Chiapas.

Before 1550, Chiapa de Corzo was one of the main evangelization centers³³⁰. That is why the Spanish decided to build religious buildings, such as an important convent complex that could help the Church in the spiritual conquest and in its evangelizing tasks.

4.2.3 Architecture and Urbanism.

One of the urban characteristics of the Pre-Hispanic Chiapa de Corzo that even today is visible, are the division of “*Barrios*” (*neighborhoods*), named; *San Miguel, San Jacinto, Santa Elena, San Pedro, San Antonio Abad, San Sebastián, El Calvario, Santo Tomás y San Gregorio*. Of course, the Catholic Church changed the original Indian names, instead of them the Church used Catholic names or words (*see image 109*). The settlement was developed from the central square, following a centripetal form with an orthogonal structure.

The architectural development of the city was constant during the period of Spanish colonization³³¹. The architects responsible for constructions in Chiapa de Corzo were the friars of the Order of Preachers, they are known today as Dominicans. That’s why the most buildings constructed during the Spanish colonial era are religious. The constructions most

³²⁸ Vos 1992, 70.

³²⁹ Villa Real de Chiapas is known today as Chiapa de Corzo.

³³⁰ INAH 1999, 124.

³³¹ Note: The Spanish colonization was from 1522 to 1821 (Orozco 2007, 93-96).

representative of the city are: *El Templo y Ex-convento de Santo Domingo (The Temple and Ex-convent of Santo Domingo)* and the *La Pila (the fountain)*.

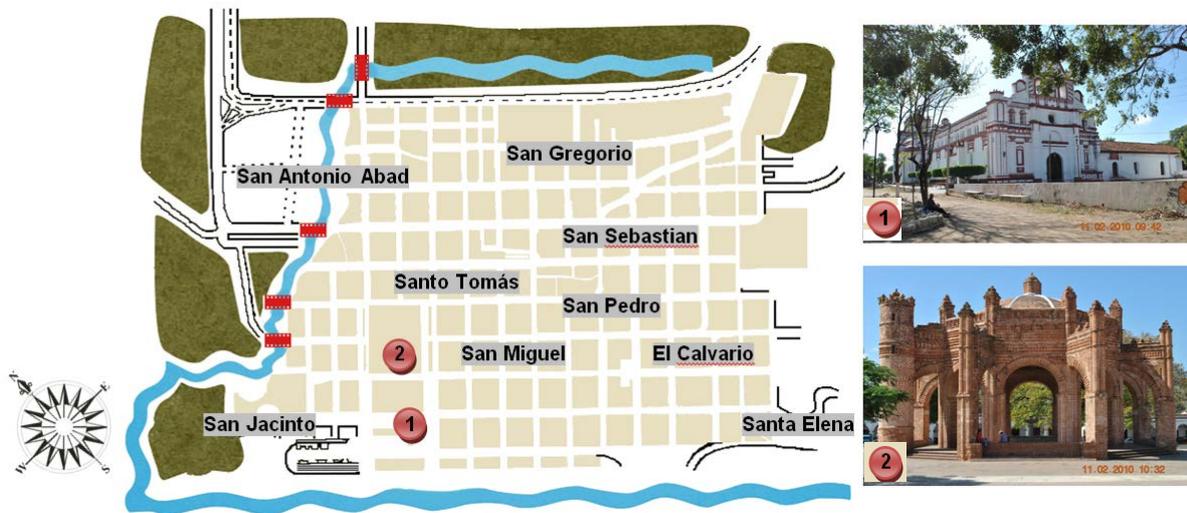


Image 109³³². Neighborhoods of Chiapa de Corzo and the location of the Convent complex of “*Santo Domingo*” and the “*Mudéjar*” Fountain, built during the Spanish Colonial era.

4.2.3.1 The convent complex of Santo Domingo.

Some authors mention that the construction of the convent complex was in the year of 1545, however, the Royal Cedula that would allow the Spanish to establish and built convent complex was promulgated in 17 September 1548 by *Carlos V*³³³.

The *Friar Antonio de Remesal*³³⁴ wrote that the builder of the convent complex was *Friar Pedro de Barrientos*, who came from the convent of Our Lady of the Rock of France. *Friar Pedro* arrived in Chiapa de los Indios in 1554 and died in the convent of *Santo Domingo* in 1588³³⁵.

Another important factor is that in the bell tower of the temple, even today we can find *la Campana Grande (the Big Bell)* also known as *Maria Teresa*, in which it's writing the year (1576), this year corresponds to the bell's foundry. In accordance with these facts, we can assume that the construction of the complex took place between 1554 and 1576 (see image 110).

³³² Elaborated by the author.

³³³ Toscano 1942, 33.

³³⁴ Note: Antonio de Remesal (1570-1619). He was an ecclesiastic, historian and chronicler Spanish in Chiapas and Guatemala. To learn more about Antonio de Remesal read; Fernandez del Castillo, Francisco (1920) *Fray Antonio de Remesal : discurso de recepción*. Academia Mexicana de la Historia, Correspondiente de la Real Madrid. Mexico. Impr. "Victoria".

³³⁵ Remesal 1932, 358.



Year: 1576

Image 110³³⁶. The main bell and bell tower in ruins, 1930.

The main bell with its 2 meters high, 5000 Kilos and a diameter of 2 m., it is the protagonist of popular myth in the city of Chiapa de Corzo. The myth emerges from three inscriptions that are written on the main bell. The only clear thing that we can affirm is that besides the three inscriptions, we can also see the bells foundry year (1576) and a relief of a cross.

The people of Chiapa de Corzo are sure of what it is written on the bell. They affirm the year of foundry and they believe that the content of the inscriptions is:

1. Me llamo María Teresa.
2. Peso cien quintales.
3. Y el que no lo crea que me pese.

The state of conservation that presents the bell doesn't allows us to have a clear reading of its inscriptions. Perhaps the content has been made known to the population and through oral tradition passed from generation to generation. This could cause an alteration of the real content.

In 1916 the Swiss Professor *Wilhelm Gugelman*³³⁷ was able to decipher the inscriptions. Which are not in Castilian. They are written in Latin, with Gothic letters and inscribed in an elongated hexagon (*between three and four inches high*). The inscriptions are engraved on the bottom, middle and top of the bell. *Gugelman* deciphered the content as it follows:

1. ave maria gratia plena dominus tecum Benedicta tu in mulieribus et benedictus fructus.
2. ora pronobis sancte pater dominise ut digni erisiamus (*or, phisiamur?*) promisionibus cristi.

³³⁶ Patronato Casa-Museo y Centro de Investigación "Ángel Albino Corzo", A. C.

³³⁷ Becerra 1987, 245-250.

3. *verbum caro factum es el habitabi yu nobis et vidimus gloriam ejus.*

With the above we can state that the myth has been revealed, and we can say that there are only two things in common between the two *sources (The people of Chiapa de Corzo and Gugelman)* are the word Maria and the year of bells foundry.

We know also that the bell's weigh is approximately 5000 Kilograms. It has 2 meters high, and its diameter has 2 m.

Along the history of the convent complex of Santo Domingo, there have been a lot of interventions, not just conservation tasks but also expansions that are translated as construction stages. Through the years there were also eyewitnesses, who wrote their impressions of the complex as historical testimonies that we can read below.

Friar Barrientos was the architect to whom *Remesal* attributes the construction of the complex. *Barrientos* said; *"It was one of the better churches that the order had in New Spain"*. He also described that *"the building as being large and strong, three-aisled, of brick, with a well-proportioned capilla mayor. The cloister was also well-built and looked out on the river³³⁸"*.

According to *Juan de Pineda*, the temple of *Santo Domingo* was the most sumptuous in all the province and also the largest, and even better than that of Spaniards in Chiapa de los Españoles³³⁹ (today know as *San Cristobal de Las Casas*).

Another eyewitness, *Friar Ponce*, who visited *Chiapa de Indios* in 1586, said that *"the church and convent are well-built³⁴⁰"*.

As we can see, the eyewitnesses were amazed by the size of the temple and how it was well-built. Possibly the size and construction system responded to the fact that Chiapa de Indios was an important evangelization center and the Catholic Church must show its power to the Indians.

Chiapa de Indios was chosen as an evangelization center, because at the time that the Spanish arrived to this Indian town, they found a population of 4,000 inhabitants approximately³⁴¹. It was an important number that was also a big challenge for the church, because they had to convert all of them to Christianity. Therefore the importance of the church to build a majestic temple.

³³⁸ Remesal1932, 536.

³³⁹ Pineda 1594, 346.

³⁴⁰ Ponce 1872, 481-482.

³⁴¹ Díaz del Castillo1933, 117.

The main objective of the majestic temple was to be a public space where activities would take place for the evangelization process. In the beginning of XVII century, the complex administrated towns like; Tuxtla, Suchiapa, Sochutla, Acala, Chiapilla and Ostutla. For the administration task there were 8 friars and 3 laymen³⁴², however, the temple was not built to evangelize the Indians, but it was built by Indian for the Spanish. Since the Temple was finish, the Indians were not allowed to access to the religious enclosure.

The Spanish entrusted to the indigenous the construction of another temple on top of a hill named; temple of San Sebastian. However, the materials quality and the architectural design were very below against the temple of Santo Domingo. Therefore the Indians never identified with the temple of San Sebastian, even today (see image 111).



Image 111³⁴³. *San Sebastián* Temple.

The people of *Chiapa de los Indios* never felt identified with this temple of *San Sebastian*, that's why the people abandoned it for many centuries. In the beginning of 2010, the State Government started with the rescue of the building, but unfortunately the conservation works stopped with the re-construction of the walls. Even today the temple hasn't roof and the new walls are in bad state. The walls don't have smooth and any kind of protection.

³⁴² Grajales 1980, 205.

³⁴³ Elaborated by the author.



Image 112. *Santo Domingo* Temple. The people of Chiapa de Corzo take care of this building. The conservation state is notable in comparison with the Temple of *San Sebastian*.

Since that moment when the Indigenous people realized that the temple of *Santo Domingo* was not built for them, they expressed their inconformity, but it was not until 1776 that the people of *Chiapa de Indios* sent a letter to Mexico City, asking and explaining that the temple was built by the indigenous ancestors. They also rejected completely the uses of San Sebastian temple, because it did not cover the needs of the community. In the same year the Temple of *Santo Domingo* returned to the town of *Chiapa de Indios*³⁴⁴.

One of the first interventions that suffered the complex was in October 1662. In this year the Grijalva River overflowed its banks and flooded front of and the north of the church destroying the entrance to the convent³⁴⁵. Almost 100 years later, in 1770 started the repairs of the complex. In those days the church was in a very bad state, near to the point of being ruins, so the Spaniards asked to the Indians to work on the complex, with the compromise of been paid³⁴⁶.

On June 25, 1856, the finance minister *Miguel Lerdo de Tejada* enacted the “*La ley de desamortización de los bienes de las corporaciones civiles y religiosas*” (the Law of confiscation of properties of civil and religious corporations). The main idea was to take out

³⁴⁴ AGE 1956, 21-58.

³⁴⁵ Ximenes 1929, 286-87.

³⁴⁶ Marroquin 1950, 16.

the power of the most powerful landlord of Mexico, the Catholic Church³⁴⁷. The Government of Mexico took the control of all temples and convents around the country and sells them to particulars. In the case of the convent of *Santo Domingo* was sold to *Cesáreo Agustín Castillo* on May 20th 1887. On 1902 the owner of the convent was *Victor Manuel Castillo*, the son of *Cesáreo*³⁴⁸. In the same year of 1902 took place an earthquake that affected the complex³⁴⁹.

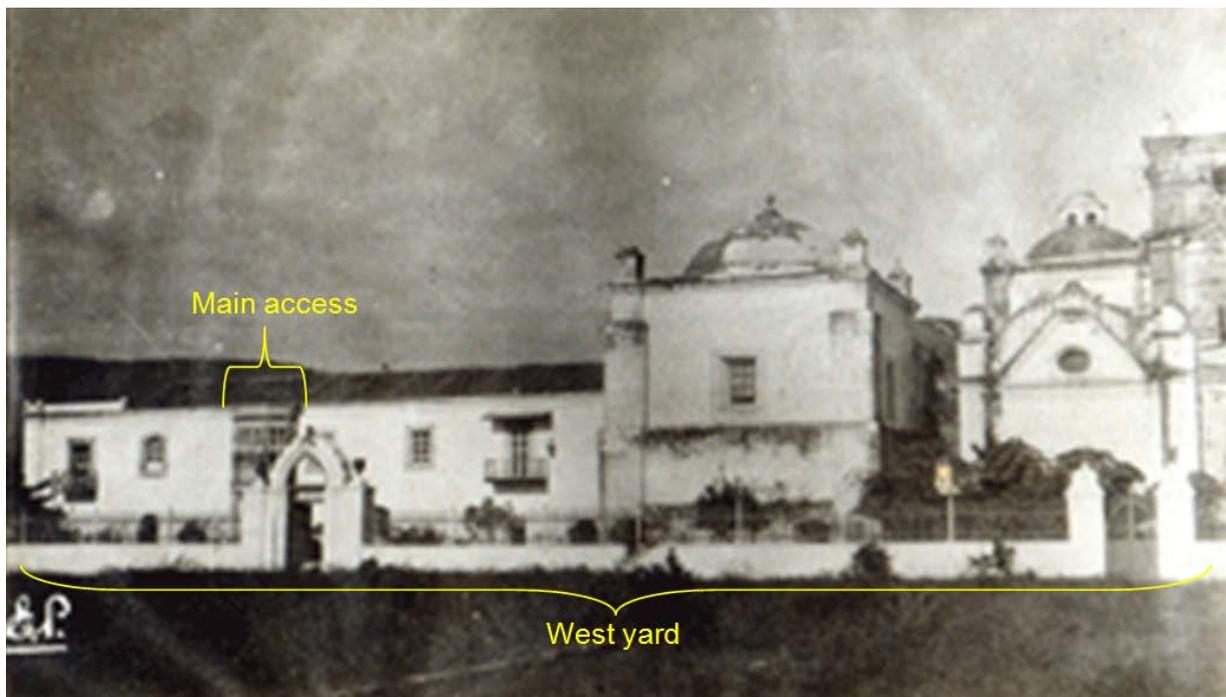


Image 113³⁵⁰. West view of the convent complex of *Santo Domingo*, Chiapa de Corzo, 1901.

In image 113 we can see the main access that conducted into the convent, which today doesn't exist, this due to the fact that over the last hundred years, the entire west façade of the convent has changed. Another modification is that there was only one story on the west front of the convent. On this photo doesn't appear also the parsonage on the west yard.

³⁴⁷ Fraser 1972, 630.

³⁴⁸ AGN 1902.

³⁴⁹ Marroquin 1950, 16.

³⁵⁰ PCMCIAAC.



Image 114³⁵¹. North view of the convent complex of *Santo Domingo*, Chiapa de Corzo, 1902.

In image 114 we can see that the parsonage was already built, therefore we can assume that the construction took place between 1901 and 1902. It is possible that it was designed as a private house instead of having religious purposes, since the building belonged to private people in those years.

³⁵¹ Idem.



Image 115³⁵². View of the west façade of the convent complex of *Santo Domingo*, Chiapa de Corzo, 2010.

If we compare image 115 with image 114, we realize that the main access has disappeared. Nowadays the visitors get into the building through a small door placed on the right side of the west front, which is now the main access. There were also two balconies in 1901, elements that are currently missing on the façade. We can also observe that today there are more windows than before, and the west façade has now two stories.

During the administration of President *Porfirio Díaz*³⁵³, the Catholic Church made peace with the Government of Mexico and they were allowed to retake the evangelizing missions, however the buildings still belong to the Government, until today. Between 1925 and 1926 took place in Mexico "*la Guerra Cristera*³⁵⁴", during this social movement, the Temple and convent were dismantled and looted. The conservations state for the complex was very poor, and as a consequence, the building was abandoned. On May 20th 1938, the

³⁵² Elaborated by the author.

³⁵³ Note: Porfirio Díaz was President of Mexico from 1876 to 1911.

³⁵⁴ Note: Guerra Cristera (Christ War) The President Plutarco Elias Calles (1924-1928) promulgated a law; "Ley Calles" where the Catholic Church must have just 1 priest per 6,000 inhabitants. The people and of course the Catholic Church were not agree, so they started a political movement. The government retaliated against buildings and clergy. To know more read; Delgado de Cantú, Gloria M (2003): *Historia de México*. 4a ed. Naucalpan, Edo. de México: Pearson Educacion. Pp. 120-176.

complex was declared as Monument³⁵⁵ and from that moment, it was under the protection of the Federal Government, however there weren't conservation works to rescue the building.

Despite the poor state of conservation the building, from 1955 to 1975 was destined to have the function of primary school of nuns. In decades of 60's started the conservation works, because it was a risk for children and for the people who worked there. In 1975 took place an earthquake and the structure of the complex was again affected, that's why the building were close from 1975 to 1979. After 1979 the first stage of restoration was undertaken and the building was ready to harbor the Cultural Center "*Ataulfo Nandayapa*" and the Municipal Library. However, due to lack of resources the cultural center was closed and the building was abandoned for the next four years.

From 1986 to 1992 took place the penultimate stage of restoration of the building, and in 1993 it was ready to open again its doors as Cultural Center "*Ex - Convento de Santo Domingo*"³⁵⁶. The last stage of restoration and conservation is still pending.

4.2.3.1.1 The architecture.

The architecture of the convent complex has changed along its history as many others examples in whole world. In the particular case of Santo Domingo, it was affected by the overflowed of Grijalva River (1662), social movements (1887, 1925-26), earthquakes (1902 and 1975) and the most important cause; the abandoned. These events tend to change substantially historic structures, that's why in some cases we cannot talk about a pure architecture or a unique style.

Today the convent complex is integrated by the convent and the temple (see image 116). The architectural plan of the temple is a Latin-cross with a central nave and two side aisles. This characteristic could make us think about a basilica type of early Christian model. In the State of Chiapas there are just 2 examples of this architectural design, the Cathedral of San Cristobal de Las Casas and the temple of *Santo Domingo* in Chiapa de Corzo.

There are three entrances in the temple of *Santo Domingo*, two on the north and one on the west side. The nave is divided from the aisles by a series of cruciform columns with two stories high. In the southeast aisle we can find 2 side chapels and in the northeast just one chapel. The morphology of the apse is rectangular and it's the place that holds the main altar. The rectangular apse is a characteristic of Mudejar³⁵⁷ temples. The sacristy is roofed

³⁵⁵ INAH 1999, 202.

³⁵⁶ CECAC 2013.

³⁵⁷ Mudejar architecture: "A style of Spanish architecture produced from the 13th to 16th centuries by Mudéjars and Christians working withing the Muslim tradition, characterized by a fusion of Romansque and Gothic with Islamic elements" (Ching 1995, 132).

with a barrel vault. It's located in the southeast area and its access is through the chapel. The north transept of the crossing is longer than the south one, but both are oblong. The crossing and transepts are roofed with domes.

The convent is attached to the south of the temple, in accordance with the symbolism found in the majority of Catholic convent complex in Mexico. The convent has rectangular form and has three buildings located on the east, south and west. There are two entrances, one on the east building (*the main entrance*) and the other on the west building (*just for special occasion like some events*). The convent has two garths³⁵⁸ enclosed by semi-open spaces named cloisters. The interior horizontal mobility is conducted through cloisters.

The general spatial distribution of the convent was; the first floor is composed by cloisters, porter, refectory, kitchen, pantry, garden and general services, while upstairs are located the library and the rooms of friars. Due to different uses that have been destined, Confined spaces of the convent have been modified along its history. In the center of the garth we can find a fountain, which provided water to the friars.

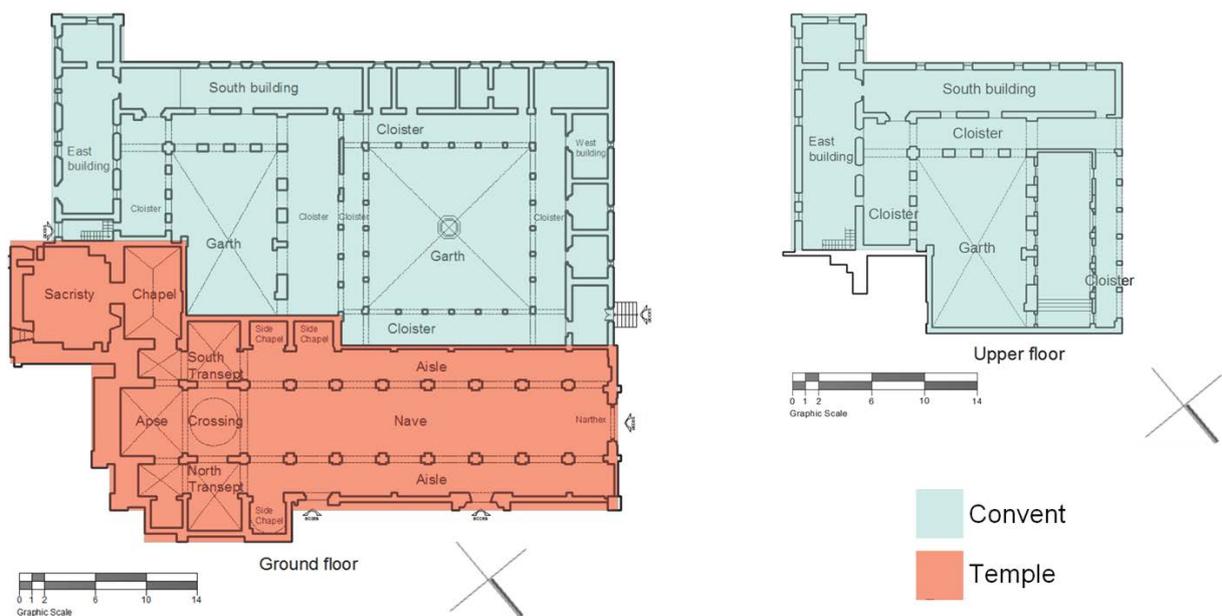


Image 116³⁵⁹. Zone plan of the convent complex of *Santo Domingo* in Chiapa de Corzo.

³⁵⁸ The use of garths produce microclimate suitable for warm weathers like Chiapa de Corzo.

³⁵⁹ Elaborated by the author.

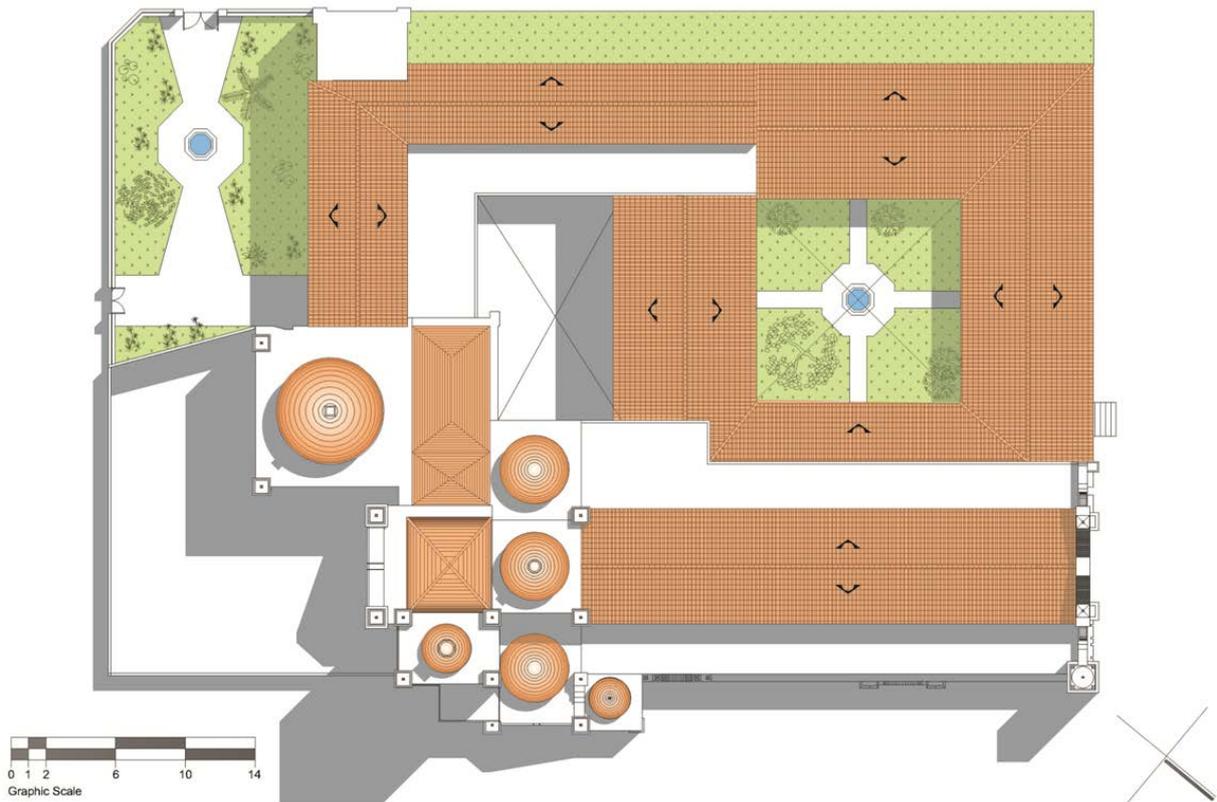


Image 117³⁶⁰. Roofs plan of the convent complex of *Santo Domingo* in Chiapa de Corzo.

The convent complex has two main façades. The architecture and its elements as volumes and architectonic details highlight the temple, while the style of the convent is more sober.

From the west side of the convent complex we can appreciate the main façade of the temple and the convent. The main façade of the temple is an example of retable-façade, designed with a didactic composition under a religious rhetoric. Unfortunately today we can't read the original discourse, due to missing elements like sculptures.

There is not a unique architectonic style of the main façade, due to different interventions through the years, that's why we can find different styles ranging from late gothic to baroque, passing through renaissances and mudéjar structural elements. The façade is asymmetric and it is horizontally divided by two stories, each story is bounded by a cornice. Vertically is the façade marked off by three bays, each bay is bounded by pilasters.

The main entrance is visible in the central bay. Over the door in the lower story there is a blind half-circle lunette. The upper story has a circular window in the gothic manner. Above the upper story we find the belfry with three arches, the arch of the center is blind.

³⁶⁰ Elaborated by the author.

Under the belfry there is a column line and a series of triglyphs, which support the cornice where the belfry emerges.

The belfry is crowned by the bulrush and two merlons, both merlons are in each side of the bulrush. There is also an appointed arch in the center blanked by two half-circle pilasters. All these elements are the visual culmination of the central bay.

The side bays are also asymmetric. There is a tower on the north side of the façade and there isn't a similar element on the south bay. We can notice also that on the second story there are three windows, two on the north bay and one on the south bay. Each window is bounded by half-circle pilasters.

On the lower story of both bays, we found two blind niches highlighted by jambs and crowned by small gable, one on each side. Two half-circle pilasters with composite capitals blanked the blind niche. These capitals are the result of the combination of Corinthian form with Ionic volutes. Each bay story is divided by friezes, triglyphs and metopes. An arch with jambs crowns the upper story.

The tower on the north bay is divided by two stories and crowned by a cylindrical element. The lower story has two rectangular blind niches along it. The upper story has two half-circle pilasters and in its intercolumniation we found a blind niche with the form of an arch. As the bays, the stories of the tower are divided by a frieze and triglyphs (see image 118).

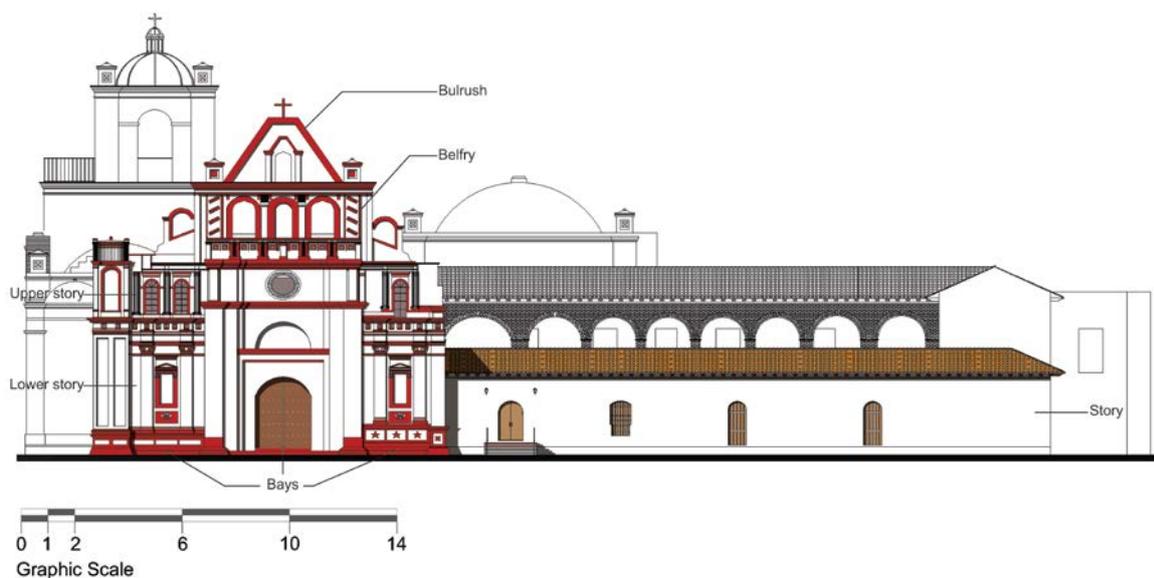


Image 118³⁶¹. West elevation of the convent complex of *Santo Domingo* in Chiapa de Corzo.

In this plan we can visualize the main façade of the temple and the west side of the convent. We can also observe how they are composed.

³⁶¹ Elaborated by the author.

The north façade of the convent complex is integrated by the temple and the parsonage. The temple is divided vertically by nine bays and horizontally by two stories. On the lower story there are two doors that lead the people into the north aisle. The first door is located on the third bay and the second one on the seventh. Both doors are hierarchical through portals and their architectonic style is different.

The first portal on the third bay has two massive buttresses that flank the door and through plans catch gradually the attention driving the view to the door. Above the door there is a semicircular header with two merlons. On the top of the buttresses there are also two merlons. This portal has mudéjar elements.

The second portal was designed in baroque style. It has three bays, one story and a finial. On each side of the door there are twin columns, their capitals are composite Ionic and Tuscan. In the intercolumn of both sides there are two vaulted niches with small gables and they are divided by a frieze. There are; entablature, frieze, cornice with a dentil, these elements run across the portal. On the center bay we find the door and it is highlighted by jambs. The keystone of the arch is remarked and has a console form.

The finial has in the center a relief where we can identify a crown with a small Latin-cross on the top. In the center there is the drawing of a blind rosette. On the bottom there is another Latin-cross that ends the composition. Two narrow and flat fluted pilasters flank the relief and two widths are aligned with the twin column of the lower story, their capitals are Tuscan. Two S-curves draw the contour of the finial in both sides. On the top there are two small merlons and a gable ends the finial.

On the lower story there are five flared windows with jambs and ledges. The proportion of the windows is 1:3 as the gothic manner. On the top of both stories there are cornices composed by sawtoothed dentil and square bricks. On the upper story there are 12 small windows divided from the keystone to the still by a mullion. Each window is separated by a vertical massive element.

The bell tower has two stories and a belfry. Each story is divided by friezes that break the verticality and give the impression that the element seems to be shorter. On the second story there is an embrasure and on the belfry there are two arches. On the top there are two merlons with a diamond peak. It is also visible a vault with a lantern and on its top a Latin-cross. The bell tower is illuminated and ventilated through three portholes, one on the lower story and two on the second. The adjacent elements to the bell tower, like the interior chapels and the parsonage give gradually scale in both sides.

The parsonage is also visible and it is integrated by four bays and one story. It has a frieze along its façade and where the parapet emerges. There is also a baseboard that runs through the north wall that protects the facing from the humidity and dirtiness. There are two square windows and two doors, one to lead the people into the building and the other is used as the entrance for the garage. Both are crowned by a Sill (see image 119).

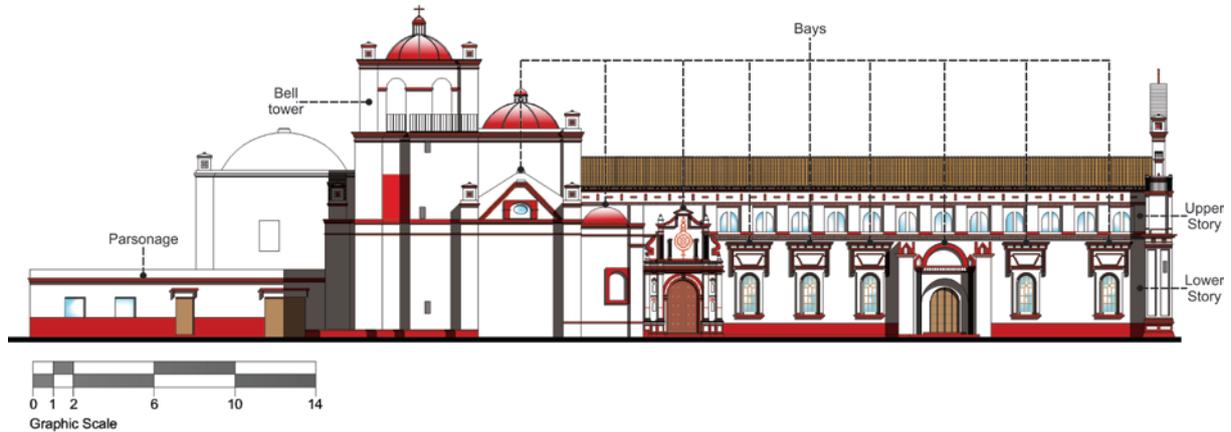


Image 119³⁶². North elevation of the convent complex of *Santo Domingo* in Chiapa de Corzo.

In this plan we can distinguish the façade of the temple with their bays, stories, the bell tower and the main entrance of the parsonage.

4.2.3.2 The Fountain of Chiapa de Corzo.

The fountain known as; *la Pila* is the most representative architectural object, not only of Chiapa de Corzo, but also of the State of Chiapas. People of Chiapa de Corzo are particularly proud of their fountain and that's why they feel identified with it. As a consequence of this feeling, today the appropriation is visible in the good state of conservation that the fountain has.

The fountain is located in the main square of Chiapa de Corzo, where the indigenous people used to meet them to talk and trade (see image 109). It was also the place where the Spanish headed speeches to the people.

The fountain was the first one in Chiapas³⁶³, however the exact date of construction is today unknown, but according to *Remesal* we know that it was finished on 1562, when a Spanish poured water³⁶⁴. *Remesal* also wrote that the designer of the fountain was *Friar Rodrigo de León*, who unfortunately didn't see his finished work³⁶⁵.

³⁶² Elaborated by the author.

³⁶³ INAH 1999, 192.

³⁶⁴ Remesal 1932, 422.

³⁶⁵ Idem.

The artistic importance, function, fabric, location and aesthetic of the fountain have been expressed throughout the history of Chiapa de Corzo by some Historians and eyewitnesses mainly from XVI, XVII and XX centuries. Below we can see some examples.

XVI century.

Antonio de Ciudad Real in 1586: "... en la plaza una fuente hecha de ladrillos con mucho primor y galanía, es de bóveda y tiene quince arcos y un caracol, por el cual suben a lo alto, y una pila muy grande en que por muchos caños cae el agua³⁶⁶".

Juan de Pineda in 1594: "... en esta plaza está una fuente muy bien hecha toda de ladrillo, que pueden estar dentro della más de cien personas sin que se mojen aunque llueve³⁶⁷".

XVII century.

Antonio Remesal: "... la fuente que está en medio de la plaza, que es uno de los buenos y bien trazados que hay en todas las Indias,...³⁶⁸".

Vazquez de espinosa in 1612: "Excelente y muy Hermosa³⁶⁹".

XX century.

Salvador Toscano in 1942: "La fuente colonial de Chiapa es uno de los monumentos que se han considerado con justicia como más importantes no sólo del arte en México, sino en América³⁷⁰".

Sidney Markman: "The brick fountain in the main plaza of Chiapa de Corzo has no direct parallel in Central America or Mexico, nor anywhere else in Hispano-American architecture. Its unique design is not directly related to any prototype in the New World or in Spain³⁷¹".

When the Spanish chroniclers and historians saw the fountain, they felt amazed, although they had already seen important architectonic and engineering works all over

³⁶⁶ Ciudad Real 1976, 42.

³⁶⁷ Pineda 1924, 346.

³⁶⁸ Remesal 1932, 422.

³⁶⁹ McAndrew 1965, 566.

³⁷⁰ Toscano 1942, 36.

³⁷¹ Markman 1984, 148.

Europe. In the case of indigenous people, when they saw the water running out, they thought that it was a miracle of God³⁷².

The town of Chiapa de Corzo is located next to a large and important river, which supplied water to the Indians before the Spanish settled down in their lands. But, why the Spanish invested and wasted their efforts to build the fountain? According to *Markman*, the fountain had two purposes; it was a part of urbanization program and for socio-religious purpose³⁷³. Another aim could be that the river in those years was dangerous. We know that even today there are crocodiles and snakes. Maybe the intention was also to prevent a future accident.

4.2.3.2.1 The architecture.

The fountain has Romanesque (massive and arches), Gothic (flying buttresses, nerves and pinnacles), Renaissance (half-sphere dome divided by sections and inscribed polygons) and Muslims (octagon and brick) elements. That's why the attributed style is *Mudéjar*. The entire structure is made of brick with lime mortar, which is one of the characteristic elements of mudéjar architecture.

To trace the fountain plan, friar de León inscribed three octagons in a circle. The small octagon is the base of the water dispenser. In the second are inscribed eight columns. In the third are inscribed eight flying buttresses. The designer disposed radially all the elements and he built a turret with a spiral stairs that overlaps the adjacent buttress (see *image 120*).

According to *Markman* the process of the trace that followed the designer is described below:

“A square is laid out and divided into quarters by longitudinal and transverse axes. A second square of the same size is superimposed but is then turned 45°. In this manner the eight axes of the two squares establish the corners of the octagon. The axes of the first square become the diagonals of the second and the axes of the second become the diagonals of the first”³⁷⁴.

³⁷² Remesal op cit.

³⁷³ Markman 1984, 149.

³⁷⁴ Markman op cit., 150.

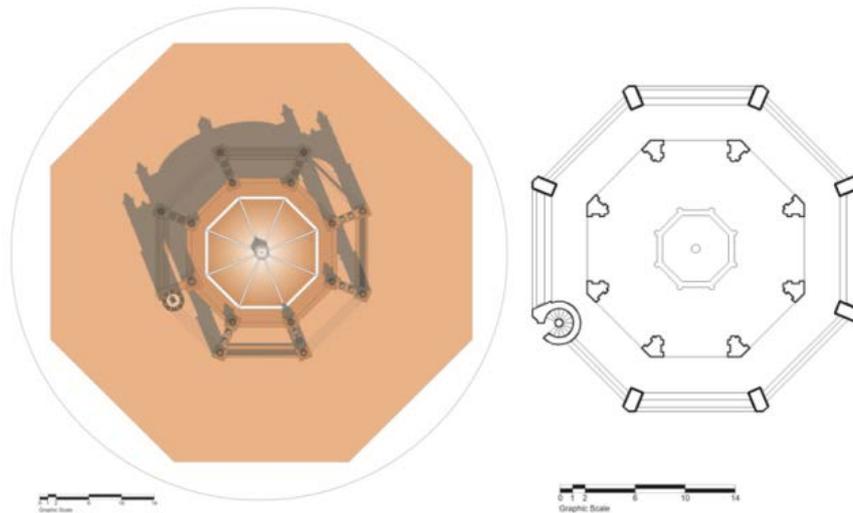


Image 120³⁷⁵. On the right. The architectonic plan of the fountain. On the left. The top view of the fountain.

The people of Chiapa de Corzo have the inherited belief that the form of the fountain was conceived under the concept of the Spanish crown, however there are no written elements that proofs this theory (see image 121).



Image 121.

1 - Fountain of Chiapa de Corzo (Finished on 1562). 2 - Crown of the Queen Isabel I de Castilla (1451-1504). 3 - Drawing of King Fernando II de Aragón with the royal crown (1452-1516). 4 - Drawing of Queen Isabel I de Castilla with her crown.

³⁷⁵ Elaborated by the author.

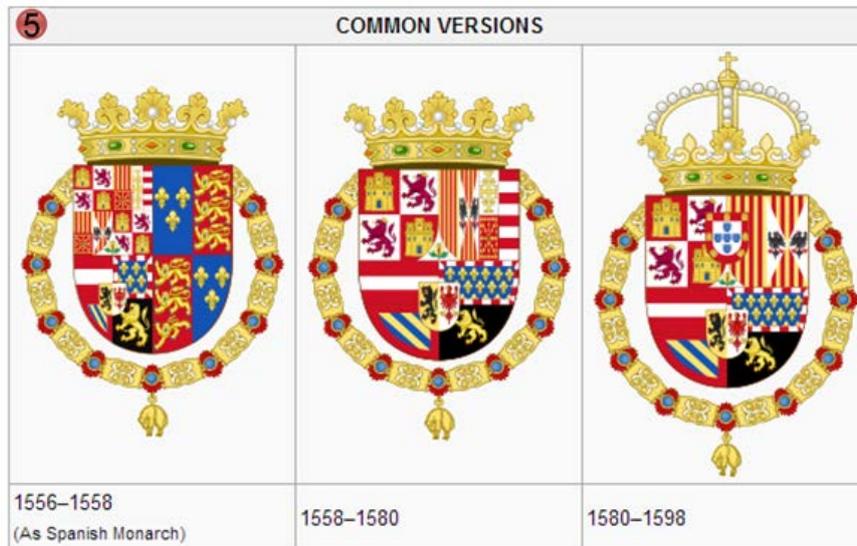


Image 122³⁷⁶. Spanish Heraldry from middle to ends of XVI century.

In images 121 and 122 we can appreciate the similarity between the fountain and different Spanish crowns used in XVI century. An important fact is that the foundation name of the town “*Chiapa de Indios*” changed in 1552, when the town depended directly from the Spanish Crown. After this event, the town was named *Real Corona de Chiapa de Indios* (*Royal Crown of Chiapa of Indians*). The fountain could be monument that commemorated the new status that had reached the town.

The structural concept of the fountain consists of a dome supported by eight semi-circular arches, which receive the pushes from the dome and they distributed the forces to the eight buttresses. The dome is reinforced by eight thin nerves that run from the interior compression ring to the exterior compression ring. According to *McAndrew* the dome of the fountain is one of the six longest Dominican domes in the south³⁷⁷.

The parapet of the arches, buttresses and pinnacles are decorated with diamond-shaped bricks, they are also used for the archivolts of the arches. Special bricks were made for Pinnacles and merlons (*Image 123*).

³⁷⁶ Wikipedia 2013.

³⁷⁷ McAndrew 1965, 564.

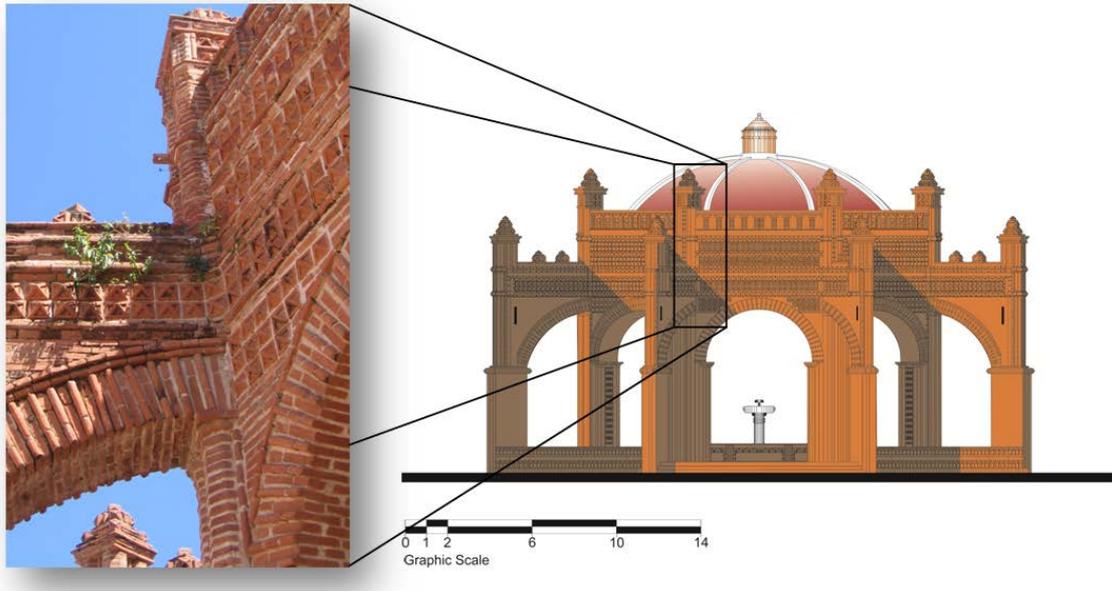


Image 123³⁷⁸. Details of the fountain.

In this image we can appreciate how the rows of the bricks are placed and the three dimensional diamond-shaped.

4.3 Diagnosis.

In chapter four of this research, it was mentioned that there are intrinsic and extrinsic factors, which should be considered in lighting design. For a proper diagnosis of the object or objects of study, it is essential to take these factors into account, since the lighting project will directly depend on the diagnostic results.

To diagnose it is proposed a study of intrinsic and extrinsic factors of the object of study. The proposed method is divided into two phases. The first corresponds to previous studies and the second is the evaluation.

The phase of previous studies consists in gathering all the information, as activities *in Situ* and desk works. *In Situ* activities are architectural and electrical surveys, photographs and if it is necessary studies of coves (in order to know the materials composition). The activities of desk works are internet and bibliographic researches, to sketch, draw, etc.

The evaluation is the last phase, and it consists in processing all the information gathered from previous studies. In this phase plans will be drawn to synthesize information, and conclusions also will be made. The main goal is to know the object as best as possible in all aspects.

³⁷⁸ Elaborated by the author.

4.3.1 Diagnosis of the convent complex of Santo Domingo.

4.3.1.1 Materials and its properties.

Through studies that were conducted *in situ*, it was found that the main material that was used for the construction of the temple is brick. It was mainly used for walls, vaults and details like pinnacles, merlons, friezes, jambs, etc.

- Walls.

As it was mentioned before, brick is the structural material used for walls of the entire convent complex. However brick was not applied in apparent way. Walls have a smooth lime plaster. Therefore, the appearance (optical material property) of facings is opaque.

The material to be taken into account to determine the percentage of reflection is therefore lime plaster instead of brick. Its percentage is between 80-90 %³⁷⁹.

Concerning to the light sensitivity, it is determined that the lime plaster is not photosensitive and therefore there are not photochemical reactions.

- Doors.

In total there are nine gates in the convent complex, four on the north side, two on the west, one in the south and the last two on the east. In the north facade there are two *entableradas*³⁸⁰ doors that lead to the temple, their material is cedar wood. The two remaining doors are located in the parsonage, one for the access of people and the other leads to the garage. Both doors are made of iron sheets.

The west front doors are made from cedar and are also *entableradas*. The door of the left side is the main door of the temple. It leads directly to the nave. The second door leads to the convent. It has the function of secondary door.

On the south side there is a wrought iron fence, which has a gate of the same material. The gate leads to the east courtyard of the convent. The last two doors are located on the east of the complex. One leads to the east courtyard and it is made of wrought iron and the second one is made of cedar wood and it is *entablerada*. This door has the function of main entrance of the convent.

³⁷⁹ See table 3, P.103.

³⁸⁰ Entableradas doors are all doors that have a frame made from table to fixing the boards.

The percentage of reflection of wood doors is between 10-25%³⁸¹. Wood has cellulose, therefore it is photosensitive and hence the light produces photochemical reactions. It is advised not to light the wood.

- Windows.

The material used for windows of the north side of the temple and on the parsonage is iron fenestration with common glass. On the west facade, all windows have common glass with cedar wood panels and as protection cedar turned bars.

The windows on the south facade have common glass with cedar wood panels. All have turned balusters or bars protection of cedar wood, except the window which is on the volume that protrudes from the facade.

In the first story of the convent's East facade has four windows, two with cedar wood panels and cedar turned bars. The other two have cedar wood fenestration with common glass. On the second story, all windows have common glass with cedar wood panels and as protection cedar turned bars.

As it was mentioned, wood has cellulose and that's why it is recommended do not use direct lighting on windows.

The appearance of the optical properties of glass is transparent, that is to say, light passes through the glass without difficulty. The percentage transmittance is between 80 and 90³⁸²%. Special care must be taken to prevent that light sources are reflected on the glass. It may cause glare and unwanted effects.

- Roofs.

The material used on roofs is clay tiles, vaults and some flat slabs of clay brick. Only the roof of the parsonage is concrete. Flat slabs and vaults are protected by waterproofing, therefore the structural material is not visible.

The reflection's percentage of clay tiles is between 15% and 30%, taking into account that some areas are clearer than others. The percentage of reflection of vaults and flat slabs will be mentioned in the heading of color.

³⁸¹ See table 3, P.103.

³⁸² See table 4, P.103.

4.3.1.2 Color.

- Walls.

The color of all exterior walls of the convent complex is matte white. Some architectural details such as jambs, friezes, baseboard, etc., are dark red.

The percentage of reflection for the matt white is between 70% - 80%. For dark red is between 10% - 20%.

- Roofs.

The colors that can be seen on the roofs of the convent complex are three; the natural color of the clay tiles, dark red used on vaults and on some flat slabs of the temple and matt white for the rest of flat slabs of the whole convent complex.

The reflection's percentage of clay tiles were already mentioned in the section of materials and its properties. Colors used on roofs have the same percentage of reflection as the colors of the walls (matt white and dark red).

- Texture.

The characteristics of the composition of construction's materials of walls and vaults of the convent complex and their finishes cause that the incident light reflects diffusely, that means that the light hits the element or object and the texture deflects the light in all directions.

Roofs with red titles have another kind of reflection, due to its characteristics such as been small pieces that conforms a whole, in addition to their rough surfaces, therefore their reflection is composed (*see image 125*).

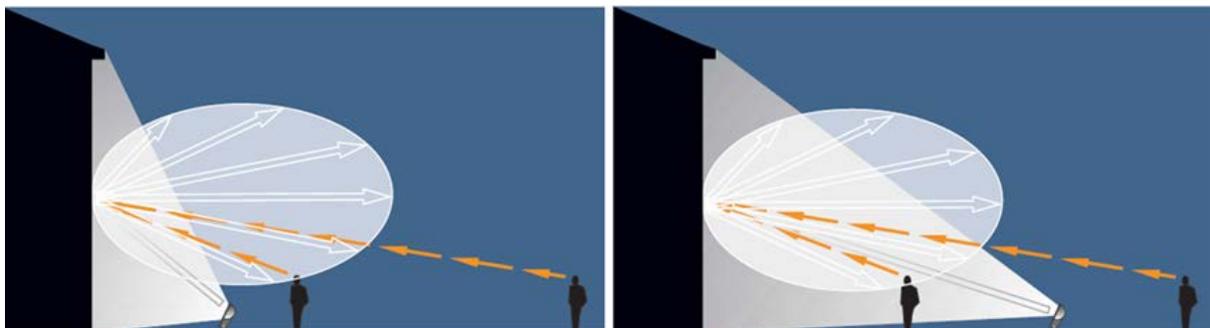


Image 124. Diffuse reflection.

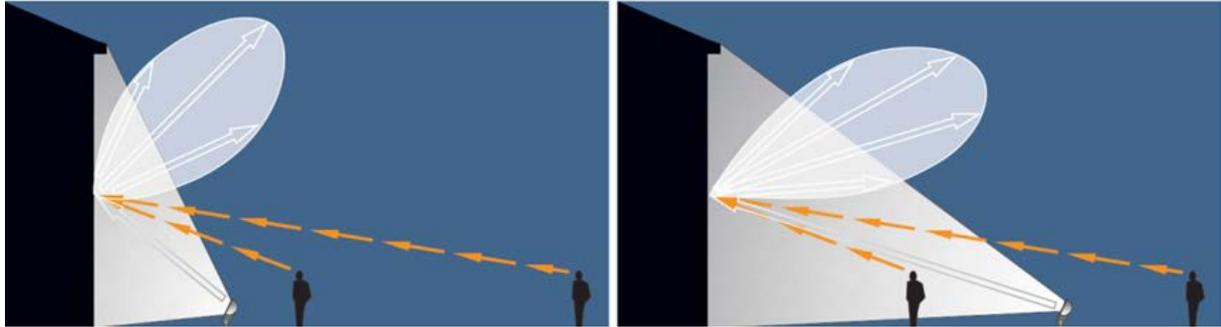


Image 125³⁸³. Composed reflection. Kind of reflections found in convent complex.

Images 124 and 125 show what kind of reflections that are found in the convent complex. Diffuse reflection of the light when the surfaces are matte. When surfaces are rough, they are named composed reflection.

4.3.1.4 Shape and volume.

The north and west facade of the temple have emerging architectural elements on different planes, which generate shadows, rhythm, movement and therefore dynamism, in contrast to the austere facades of the convent.

The north facade on the lower story there are windows with Gothic proportions of 1:3 and two massive buttresses that emphasize bays and in addition break the horizontality of the façade. The upper story has twelve windows divided from the keystone to the still by a mullion. Under the effect of figure-ground the mullion stands out highlighting also its verticality.

The heights have been designed under a gradually way in ascendant direction to the belfry. Half-sphere domes dynamically soften the high. The bell tower is divided by friezes that break its verticality and give scale (*see image 126*).



Image 126³⁸⁴. North view of Santo Domingo Temple.

³⁸³ INDALUX 2002, 175.

³⁸⁴ Elaborated by the author.

The west facade of the architectural complex consists of two buildings; the temple and the convent. The architecture of both edifications contrast with each other, while the façade's temple is rich in ornaments, the convent lacks of architectural details, therefore we can say that the architecture of the convent is completely sober. This different also reflect the distinct stages of construction between buildings.

The west facade of the temple is the most important, that's why its design is more elaborate in comparison to the other facades. However, if we observe carefully, we can notice that the façade is asymmetric. While the central bay is symmetric, the others side bays have differences, which are:

- The north bay has an attached massive and there is an arch-window and a pilaster more than in the south bay.
- There are some star reliefs on the bottom of the south bay that are missing in the north one.
- The length of the pilasters of the first story is also different. The pilasters of the north bay are longer than the south ones.

On the west facade of the temple we can see the play of volumes that come out of the main façade's plane. This produces shadows, causing impression of movement. Vertical volumes are combined with horizontal elements, such as friezes and moldings that generate frames, creating stability and strength on the facade.

The selection of bichrome between the white and the red-brown creates an important contrast that visually helps to section and to define the facade. While vains, niches and vaulted niches interact with rigid elements of the facade, generating a balance between strength and lightness (*see image 127*).

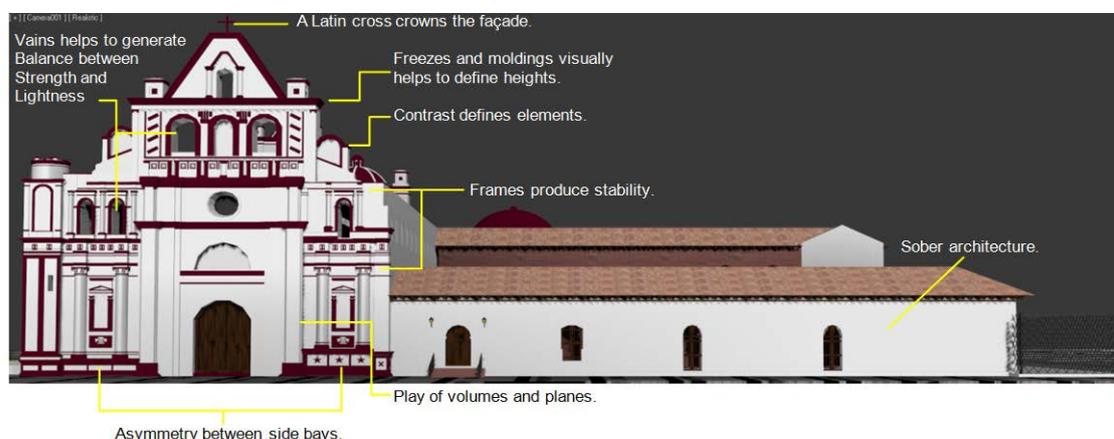


Image 127³⁸⁵. West view of the convent complex.

³⁸⁵ Elaborated by the author.

The south façade is the most sober of the all convent complex. The only decorative elements are the window's jams on the lower story. There is also an element with two stories, which actually is on the first plane of the façade.

The façade has a rhythm of heights, beginning on both sides with one story and in the just in the middle we found two stories. There is an entrance for cars, which is also on the first plane of the façade. It is hierarchized and flanked by two columns (*see image 128*).

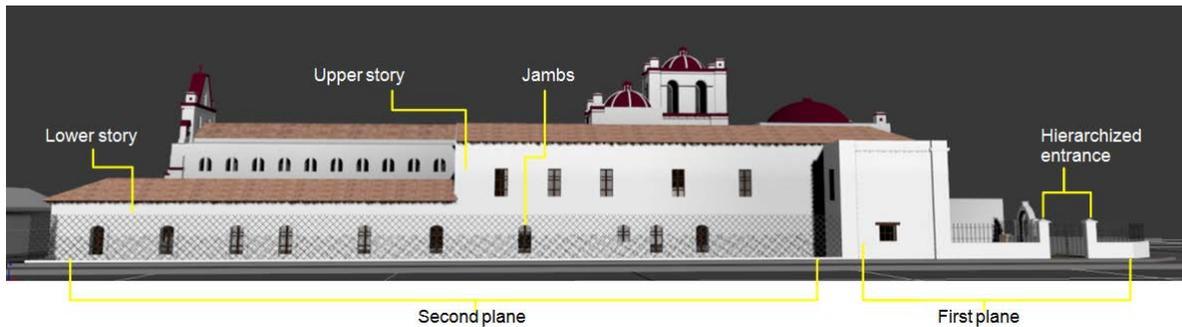


Image 128³⁸⁶. South view of the convent complex.

On the east side we can identify two buildings; the temple and convent. Approximately 50% of 100% of the total facade corresponds to the convent and 50% to the temple. The facing of the convent is completely flat and has two stories. 3/4 parts of the facade are roofed with tiles and the rest with flat slab, this creates the feeling that the front is longer than it really is. On the east side is the main entrance to the convent, which is hierarchized from the south access through a pointed arch.

The facade of the temple is composed of different volumes at different levels. This generates motion. Basic shapes like circle, square and triangle were used to design the facade and they are easy to identify. There is also gradual play of heights, in which the belfry protrudes. The friezes are used to give scale to different stories of the temple (*see image 129*).

³⁸⁶ Elaborated by the author.

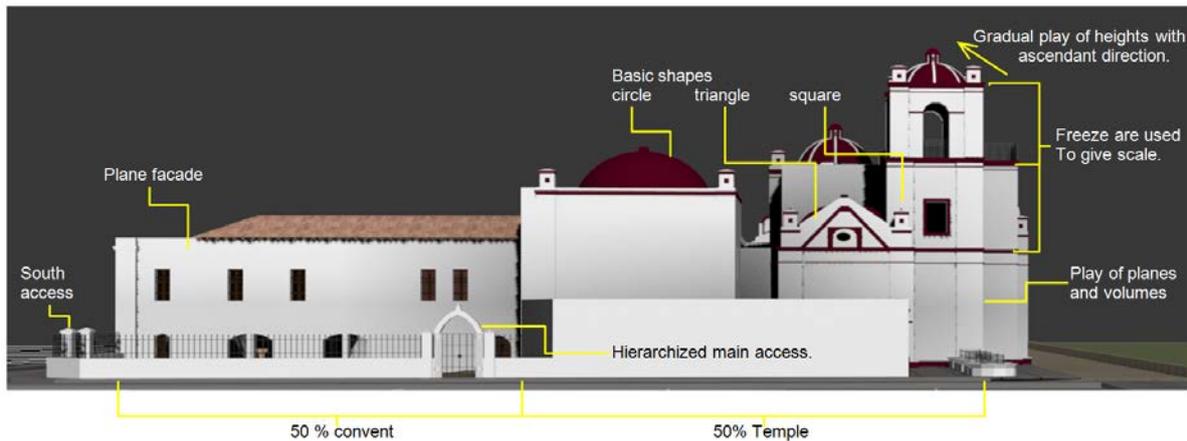


Image 129³⁸⁷. East view of the convent complex.

4.3.1.5 Function.

According to the four functions that *Leland M. Roth (op.cit)* identifies in architecture, we have the following diagnosis for the convent complex:

- Practical function.
Today the convent complex is divided basically by two different functions. The function of the temple is still a cult place where religious ceremonies are held by the Catholic Church, while the convent, as it was mentioned, since 1993 is used as a cultural center where exhibitions of works of art and crafts are exhibited. Also are conducted cultural events like; conferences, presentations, concerts, etc. Exhibitions are made usually at daytime, while cultural activities cover both shifts.
- Circulation function.
The circulation spaces for the temple and the convent are inside and outside of the convent complex, for interior spaces are through corridors and courtyards, for exterior spaces are through pedestrian thoroughfares (*pedestrian streets, sidewalks, courtyards and squares*) and streets are destined for vehicles. This means that the circulation function is adequate and it does not pose a problem for the design of lighting, because users can move from one space to another regardless of the schedule.
- Symbolic function.
The current use of the temple corresponds to the function for which it was designed. The building reflects to have the character of a Catholic temple. It means that there is a symbolic function.

³⁸⁷ Elaborated by the author.

The convent's character reflects the function for which it was designed, however today the use has changed. This has generated that nowadays there is no correspondence between the current use (*cultural center*) and what it suggests be (*convent*). According to the criteria used for the conservation of the convent complex, the main intention is to keep the image of what initially was. In brief, regardless of conservation criteria are being followed, there is no symbolic function in the convent.

- Psychological function.

If we divide the convent complex according to practical functions, we have that there is in the temple optimal psychological function. It means that there is a complete harmony and congruence between the others referred functions.

Regarding to the convent, we observe discrepancy in the symbolic function, and therefore there is no optimal psychological function.

A proper lighting can help to reinforce the symbolic function to achieve harmony between functions.

4.3.1.6 Surrounding context.

For the study of the surrounding context of the convent complex is important to divide it into two parts. The first one corresponds to the natural environment and the second one to the artificial.

4.3.1.6.1 Natural environment.

The natural environment consists of physical and environmental factors, such as: geographical location³⁸⁸, climate, rains, winds, topography, vegetation, soil and sunlight. Together these factors grouped certain special features that influence directly each object of study and therefore the lighting design.

These environmental factors will be mention from general to particular, as it is shown below.

a) General.

- Climate.

The climate of Chiapa de Corzo is warm subhumid. The maximum temperatures (in the shade) are in April and May between 36° and 38°

³⁸⁸ Note: In section 4.2.1 of this research, it was already mentioned the geographical location of the State of Chiapas and Chiapa de Corzo.

Celsius. The month with the lowest temperature is December with 18°C. The average temperature during the year is between 24° and 26 °C³⁸⁹.

- Rain.

When the sun passes through the zenith begin the rains in Chiapa de Corzo. This event takes place between 8 and 10 of May. In the months of May to October the average of rainfall ranges between 900 mm and 1200 mm. From November to April the average rainfall ranges from 25 mm to 200 mm³⁹⁰

- Winds.

The prevailing winds travel from south to north and their intensity goes from 4km/h. to 12 km/h³⁹¹.

These general factors will help to determinate which kind of lighting equipment we are going to use. This equipment must resist the environmental conditions of Chiapa de Corzo.

b) Particular.

- Geographical location.

The center³⁹² of the convent complex is located at latitude: 16° 42' 23.27" N and longitude: 93° 1' 4.42" W³⁹³.

- Topography.

The convent complex is into the 70% of the plains that constitute the city of Chiapa de Corzo. It means that the people are not able to see the religious buildings from everywhere in the city.

- Vegetation.

It will be mention only main trees that are near (*from less than one meter to 10 mts.*) to the facades that are going to be illuminated. This with the intention to protect the vegetation from irradiated light and in special those trees which are more sensitive to the light at night. Also it is important to know the characteristics of the adjacent vegetation, like high, etc. (*see image 130*).

³⁸⁹ SGPP 2013.

³⁹⁰ Idem.

³⁹¹ Idem.

³⁹² To determinate the center it was necessary to trace two lines on the plant view, starting the first line from east-south vertex to the west-north. The second line was traced from west-south to east-north. The idea was to join the opposites vertex of the complex.

³⁹³ The geographical location was determinate with a GPS.

- Ficus-tree (*Ficus benjamina* L.).

This tree grows up to 6 m high. Its bark is smooth, from gray to whitish. Its bark is very flexible. The tree develops easily aerial roots and it has drooping branches.

Its leaves are dark green, lustrous, pendant. Its form goes from ovate to elliptic, 4-8 cm long, 3-4 cm wide³⁹⁴.
- Flamboyant (*Delonix regia*).

The Flamboyant tree or also known as *Flame* tree is highly branched up to 12m high. The leaves are compound, 30 to 50cm long and are divided into 10-25 pairs of leaflets. The red flowers are very showy fire. The fruits are pods up to 60cm long.

The tree is a native of East Africa, grows in temperate climate between 10 and 2000 masl. Usually it is cultivated, although it may be associated with agricultural, land irrigation and temporary³⁹⁵.
- Guanacaste (*Enterolobium cyclocarpum*).

This tree is also known as *huanacastle*, *elephant ear tree*, among other names. It is a huge tree, deciduous, from 20 to 30 m (45 m) high, with a diameter at breast height up to 3 m. The crown is hemispherical with abundant foliage. It is more wide than high.

It has bipinnate leaves with 4-15 pairs of opposite pinnae, they measured between 15-40 cm long, numerous leaflets (*15-30 pairs per pinnae*) bright green that **fold overnight**.

Its trunk is straight and sometimes with small buttresses at the base. It has ascending branches.

The bark is from smooth to grainy and sometimes slightly fissured. The color is goes from light gray to brownish gray³⁹⁶.
- Almond-tree (*Terminalia catappa* L).

It is a fruit deciduous tree of a temperate zone. Its trunk is not always straight. The color of the crust varies; when it is young is green and smooth, middle age becomes flaky and gray. It reaches a height between 5-16 meters.

This tree is native of tropical Asia. It grows in warm and semi-dry climates from sea level to 1100 m. Almond-tree is associated with tropical deciduous forest³⁹⁷.

³⁹⁴ UNAM 2013a.

³⁹⁵ UNAM 2013b.

³⁹⁶ CONABIO 2013, 161-164.

- Bamboo (*Phyllostachys nigra* var. *Henon*).
 The Bamboo-plant belongs to the botanical family of *Gramíneas*. It is a Hairless plant and just on the edge of the pods has hair. The stems are highly branched, grows up to 3 or 4m. The leaves are long, narrow, dark green or pale. This plant is perennial³⁹⁸.

- Solitary fishtail palm (*Caryota urens*).
 It is a palm that reaches up to 18 meters high. Trunk thickness reaches a diameter of 30 cm. For ideal growth should be **in partial shade**. As main characteristic is that at 14-15 years produces inflorescence and fruit for 6-7 years and then dies³⁹⁹.

- Coconut palm (*Cocos nucifera*).
 The coconut palm is a tall, without branches that reach up to 30 meters high, with thick and straight trunk. The leaves are at the top of the palm and their measure is from 3 to 4 meters long, their form plumes. The coconut palm is native to the tropics and live in warm climates and semi-warm, from sea level to 700 m high⁴⁰⁰.

- Ceiba (*C. Pentandra*).
 For the Mayan culture the Ceiba is a holly tree. It was considered as the manifestation of the world tree in the version of the cosmic tree. The Maya people believe that this tree is the side supports at the four corners of the world⁴⁰¹.
 It is a 40 m high tree. Its bark goes from gray to greenish. The color of the bark is from gray to greenish. The leaves are grouped in number of 7 and they are at the ends of the branches. The flowers are yellow and velvety. The fruits are capsules and the seeds are numerous, surrounded by many white, silky hairs. It is probably native from tropical America. It grows in warm and semi-warm climates between 200 and 810 masl. The tree is associated and derived from tropical deciduous forests, perennifolius, sub-perennifolius⁴⁰².

³⁹⁷ UNAM 2013c.

³⁹⁸ Cortés 2000, 12-15.

³⁹⁹ Bouzon 2013.

⁴⁰⁰ UNAM 2013d.

⁴⁰¹ To know more about Ceiba tree read: Kocyba Henryk K. (2001) Consideraciones críticas en torno al significado religioso de la ceiba entre los mayas, in *Animales y plantas en la cosmovisión latinoamericana*. Sociedad Mexicana para el Estudio de las Religiones, CONACULTA – INAH. México. Pp. 65-88.

⁴⁰² UNAM 2013e.

- Mango Manila (*Mangifera indica* L.).

This tree reaches a high over to 20m. It has a thick trunk with dense and extended foliage. It is native from East India, North India, it's found in warm and semi-warm climates, from 0 to 2600 masl., in deciduous tropical, semi-deciduous and evergreen forest⁴⁰³.

- Soil

The soil where the convent complex was built is known as *Vertisol*⁴⁰⁴. It is characterized by a dark surface layer, soft and rich in organic matter. This type of soil is hard and we can find it with different colors, like black, gray and red. It has low susceptibility to erosion and it's fertile for agriculture. Due to its high content of clay (*more than 45%*) it is problematic for urban development, because it not only cracks in dry season, but also generates movement by dilatation that damages the constructions. It could be a problem as well, if we decide to use footlights or some special type of rigid supports, because this kind of soil could harm the equipment.

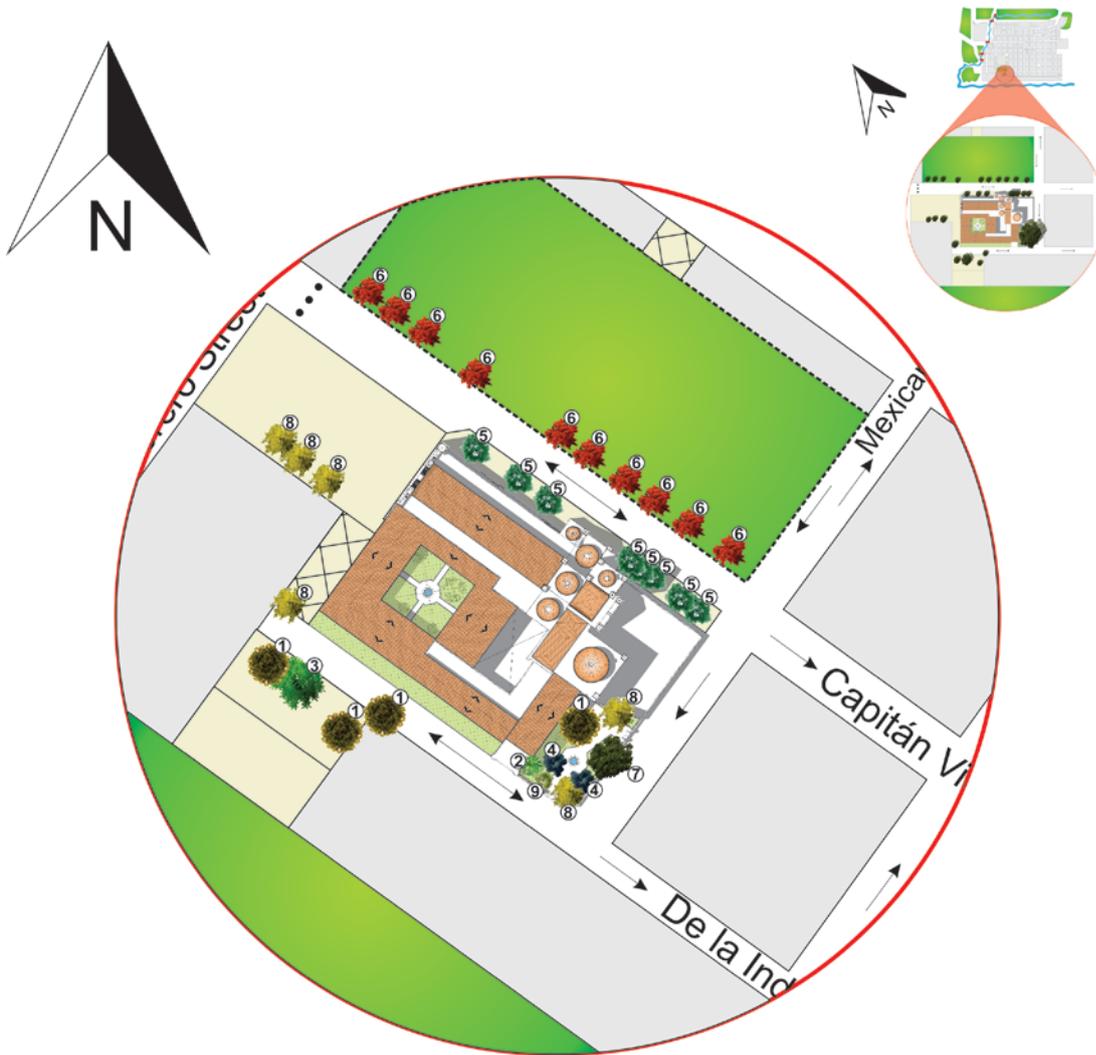
- Sunlight.

As it was mentioned before the temple is east-west oriented, on the north side we can find the atrium of the complex. This distribution favors the north access's temple. It is true that the main entrance is located on the west front, but as it receives the sun most of the day, this causes that people prefer to use the side access, because they exposed to get shades during the day, therefore are fresher.

As a result, we can confirm that the north façade is the most watched and preferred by people, in contrast to the main facade, therefore for lighting design we should pay more attention to north facing (*see image 130*)

⁴⁰³ UNAM 2013f.

⁴⁰⁴ DDUE 1990.



Symbology			
	Block		River
	Green area		Square and Public space
	Malecón (Pier)		Temple's atrium
	North		Two-way Street
	One-way Street		Walkway

Tree's symbology	
	① Almond-tree
	② Bamboo
	③ Ceiba
	④ Coconut-palm
	⑤ Ficus-tree
	⑥ Flamboyant
	⑦ Guanacaste
	⑧ Mango Manila
	⑨ Solitary fishtail palm

Image 130⁴⁰⁵. Vegetation. Location of main trees.

⁴⁰⁵ Elaborated by the author.

4.3.1.6.2 Artificial environment.

The artificial environment consists of all those constructed elements that represent the influence of human culture. These elements are conglomerates into the immediate surrounding context of the case study (*see image 131*).

The convent is located within the historic city center, as a result of this, the land use is mixed. That means that housing and commerce are contiguous found and even in some cases both uses are occupying the same area. We can find also four different types of urban facilities⁴⁰⁶ in the surrounding context, such as:

- Facility for culture.
 - The “*Centro Cultural Ex-convento de Santo Domingo*” (*It is a part of the convent complex which previously had the function of Convent*). Today it is a Museum (*case study*).
 - “*Templo de Santo Domingo*” (*Temple of Saint Domingo*). It has until now the same function of Catholic temple (*case study*).
 - The “*Casa del Patronato de la Feria Grande* (*Patronage’s house of the of the big fair*), which has the function of town’s fair museum.
- Facility for education.
 - “*Colegio la Patria*” (*School la Patria*). Private school for basic education (*primary and 3 years of highschool*).
- Facility for marketing and supply.
 - “*Mercado Público Municipal de Chiapa de Corzo*” (*Public Market*).
- Facility for recreation.
 - Public squares.

Another advantage of been located in the historic city center is that the convent complex has a complete infrastructure, such as; streets, walkways and sidewalks. It has also all services like; water, telephone and electricity. However, in the aspect of public lighting, we found that it is insufficient, poor and inadequate. This is because few lamps work, of course they need maintenance and also updating. Due to the current luminaries are gas discharge lamps that use sodium vapor.

⁴⁰⁶ Group of buildings and spaces, predominantly for public use, in which are carried out complementary activities of housing and work, or in which social welfare services and support are provided to the people for economic activities.

4.3.1.6.3 Emplacement.

The convent is located on a plain between the river *Grijalva* and the central square (*Main Square*) of Chiapa de Corzo. The river is located in the south, while the square is found on the north (see image 131).

The religious and civil complexes are visually linked through a small walkway, where emerges a round arch that frames the temple. This access also has the function to indicate the boundaries between public and religious spaces.

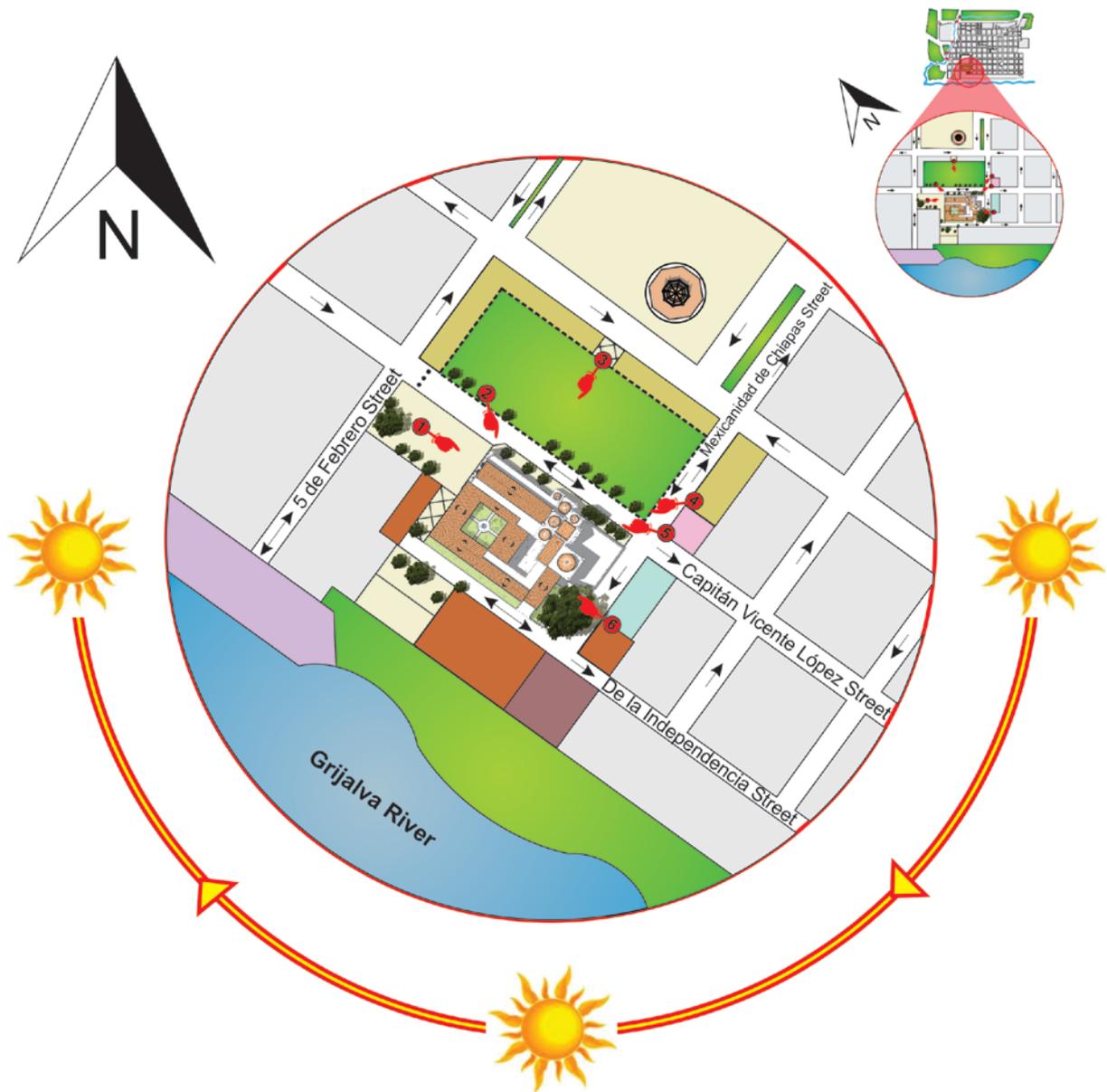
As it was previously mentioned, the temple has east-west orientation, on the north of it is located the atrium, which is divided from the temple by the *Capitán Vicente López Street*. The convent is flanked on the east by the *de la Independencia Street*, on the west by a walkway and a square, on the south by the *mexicanidad de Chiapas Street*.

Today the convent complex has different possibilities to be surrounded by pedestrians, it could be through; walkways, streets and squares around its perimeter. However, the most used way to see and to access to the temple is located on the north, from the street *Capitán Vicente López*.

The adjacent streets more crowded are undoubtedly the *Mexicanidad de Chiapas Street* and the *Captain Vicente Lopez Street*, especially during the day, due to the proximity to the Municipal Market and for being the main routes that lead to the convent complex. At night, people gather together to visit the temple and to enjoy traditional food in stalls, which are placed on the surrounded area.

The *de la Independencia Street* is quiet road, despite it leads to a small square with a viewing point, which has a wonderful view of the river. Possible causes for low crowd could be related to the lack of vigilance by the Municipal authorities, because it used to be a not authorized meeting point to consume alcoholic drinks in public places. This is now an illegal activity, punishable by the Municipality of Chiapa de Corzo.

The less crowded route is the walkway, which connects the west square, located on the Westside of the temple with the *de la Independencia Street*. Possibly causes are those which were already mentioned above.



Symbology			
	Block		Mercado Público Municipal (Public Market)
	Colegio La Patria (Private school)		North
	Commerce		One-way Street
	Green area		River
	Haus of "Patronato de la Feria Grande"		Square and Public space
	Housing		Sunlighting
	Main trees		Temple's atrium
	Main views		Two-way Street
	Malecón (Pier)		Walkway

Image 131⁴⁰⁷. Emplacement of the convent complex and its surrounding context.

⁴⁰⁷ Elaborated by the author.



Image 132⁴⁰⁸. View 1. Main façade of the Temple of Santo Domingo. (see image 131). The photo was taken from the west square to the temple's main façade.



Image 133⁴⁰⁹. View 2. Temple of Santo Domingo. (see image 131). The observer on view 2 is located on the south-west part of the atrium. On this photo it's possible to see the north and west façades, which are the most crowded.

⁴⁰⁸ Elaborated by the author.

⁴⁰⁹ Idem.



Image 134⁴¹⁰. Views 3 (see image 131). From view 3 it's visible the round arch and behind it is located the atrium, which is visually delimited by the north façade of the temple.



Image 135⁴¹¹. Views 4 (see image 131). The photo was taken from "Mexicanidad de Chiapas" street to the temple. On this view are visible stalls, the vegetation of the surrounded area and stresses the temple's bell tower.

⁴¹⁰ Idem.

⁴¹¹ Idem.



Image 136⁴¹². Views 5 (see image 131). This photo was taken from “Capitan Vicente López” street to the temple. From this view we can see the monumentality of the bell tower, temple’s north façade, Ficus-trees and some stalls between the street and the temple. This rout is the most crowded by pedestrians.



Image 137⁴¹³. Views 5 (see image 131). From this view we can see the main entrance to the convent, the east yard and its vegetation. The Guanacaste tree stresses, due to its foliage and size.

⁴¹² Idem.

⁴¹³ Idem.

4.3.1.7 Exterior lighting system.

The lighting system of the convent complex is divided in two parts. The first one corresponds to the convent and the second one to the temple. The convent has interior lighting and the exterior lighting just illuminate some parts of the south, east and west façades. In front yard there is one streetlamp which lights the west façade in an intrusive way. The center of charges and distribution is located in the administrative offices of the convent⁴¹⁴. The cabling system and the lamps have been placed in a visible and external way, under the criteria of protection of the architectural heritage. The type of lamps used is compact fluorescent, type twist of 20 watts.

The lighting of the temple is controlled from the parsonage, where is located the center of charge and distribution of electricity. The main lighting of the temple is interior. On exterior the facades are illuminated indirectly by intrusive lighting from street lamps. The Temple doesn't have a lighting design. The street lights have high pressure sodium vapor lamps.



Image 138⁴¹⁵. West façade at night. In this photo is visible how the interior light highlight from the scene. The main façade of the temple doesn't have illumination. The streetlights are the only source of light that are working.

⁴¹⁴ Note: The authorities of ex-convent and church did not allow to access to revise the centers of charge and distribution of the convent complex, therefore the photographs here presented show only the type of lighting and placement of these.

⁴¹⁵ Elaborated by the author.

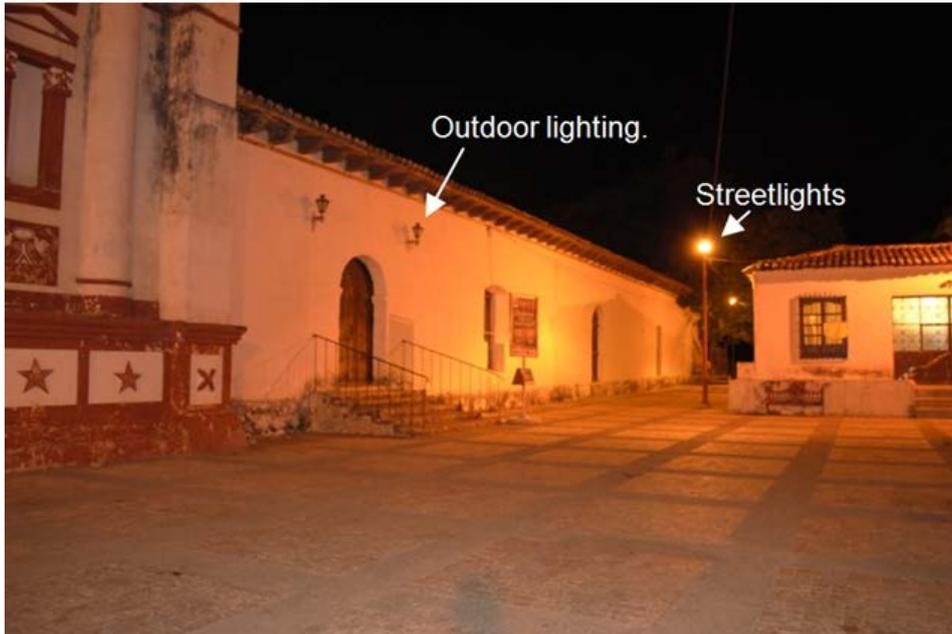


Image 139⁴¹⁶. West façade at night. The western facade of the convent doesn't have a special illumination, although that the mentioned façade has two lamps in cantilever which don't work, due to the lack of maintenance.



Image 140⁴¹⁷. West and north façades at night. In this photo we can appreciate that the building is illuminate in an intrusive way. The lights come from streetlights. The lights from inside of the temple appear from openings, but when there are no activities at night on interior then the only possibility to watch the facades is with the help of streetlights.

⁴¹⁶ Idem.

⁴¹⁷ Idem.



Image 141⁴¹⁸. Lamp detail of south façade.

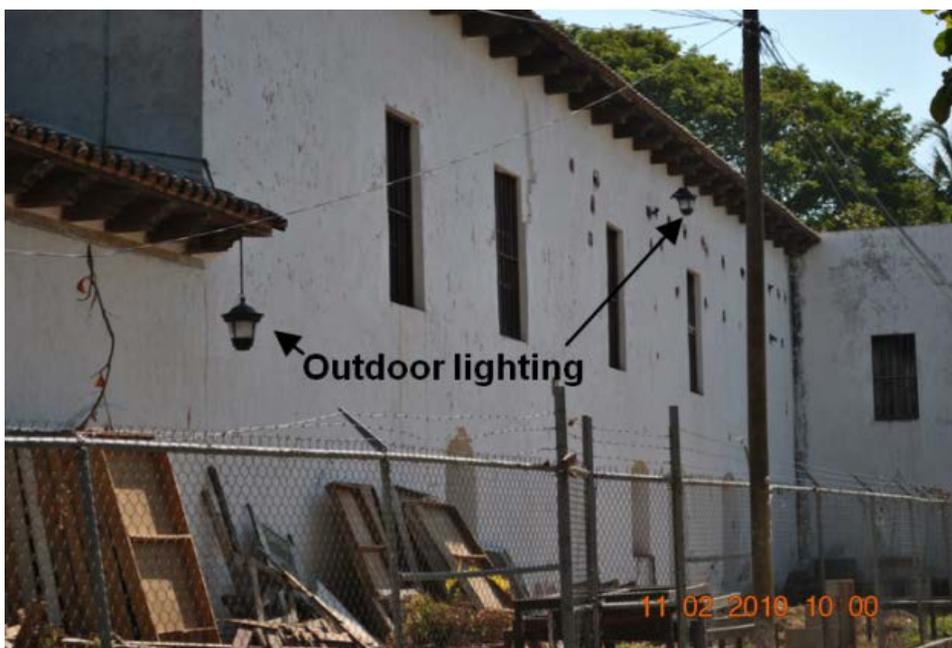


Image 142⁴¹⁹. Lamps detail of south façade.

Three lanterns are hanging from beam heads, but also the lack of maintenance is responsible cause of their malfunction, anyway the lamps are insufficient to light the south façade. The lamps used are compact fluorescent type twist of 20 watts. The system of cables are external, therefore are visible. The intention was to protect the building.

⁴¹⁸ Idem.

⁴¹⁹ Idem.

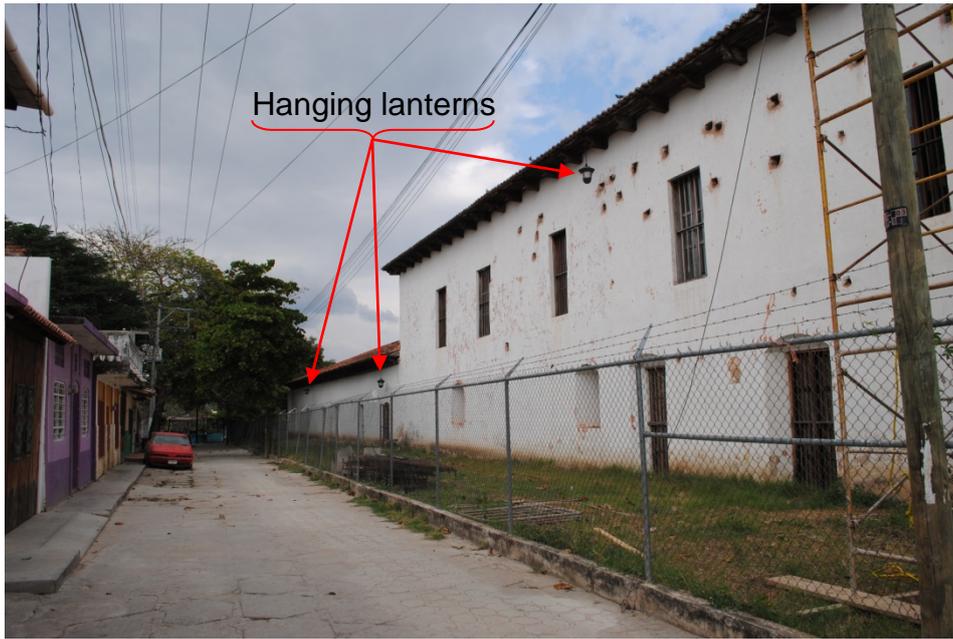


Image 143⁴²⁰. Current lighting system on the south façade of the convent. The photo was taken from the street *De la Independencia*. In this street there are no streetlights, which could illuminate the south façade of the convent.



Image 144⁴²¹. East façade of the convent. There is only one source of light that illuminate the eastern façade, which we can see in this photo. The streetlight has a fluorescent lamp of 100 watts with classic diffuser. However it is insufficient to light this façade and the front yard.

⁴²⁰ Idem.

⁴²¹ Idem.

4.3.2 Diagnosis of the Fountain of Chiapa de Corzo.

4.3.2.1 Materials and its properties.

To determine the predominant material used on the fountain, it is not necessary deep studies, due to the apparent way that bricks were used in all elements that compose it.

- Structure.

As we can see in the images, the whole structure of the fountain is made of bricks, but bricks are not just structural elements which support the thrust of the vault, but also have the function of been its epidermis. It was as well as used in decorative details like; merlons, vault's lantern and pinnacles.

The type of brick used was red brick; therefore its percentage of reflection is between 20–30 %⁴²². Concerning to the light sensitivity, brick is made of clay, it is a material which is not photosensitive and therefore there are not photochemical reactions.

- Doors.

There is just one door on the fountain. It is placed on the turret and inside we can find the stairs that conduce to the vault. Its material is pinewood.

The percentage of reflection of wood depends on the color. In this case we conceder pinewood as light wood. Its percentage is between 30-50 %⁴²³. Wood is photosensitive and it is advised not to light it.

- Roofs.

There are two roofs. The biggest one is a vault which works as the main cover element of the fountain. The second vault but with smaller sizes was placed on the turret. The main material used for both structures was red brick and it was also utilized in an apparent way for their intrados.

A lime flattened protects both vault's extrados from adverse weather conditions, over this layer and to reinforce this protection red waterproofing was used.

4.3.2.2 Color.

As it was mentioned before, all the fountains structure and decorative details as vaults, tambour, columns, buttresses, turret, lantern, merlons, etc., are made of brick, and

⁴²² See table 3, P.103.

⁴²³ See table 3, P.103.

this material was used in an apparent way, except on the vault's extrados. Therefore, the predominant color is the natural red tone of bricks. Vault's color extrados are dark red. Its percentage of reflection is between 10-20 %⁴²⁴.

4.3.2.3 Texture.

One of the main characteristics of brick's texture is its rough. This allows light designers to recreate full scenes charged with drama through uplighting. When light is projected to hits a brick's surface, light is reflected; partially regular and partially diffuse. This reflection is known as composite (*see image 125*).

Vaults red color and texture interact with light, projecting it diffusely in all directions, that is to say, that the reflection is diffuse.

4.3.2.4 Shape and volume.

The fountain's form emerges from an octagon, for this reason it has eight facades, which are similar to each other. Each facade is flanked by buttresses, which have been distributed radially, inviting and leading the viewer's gaze to the central point, where the water supply and container are. Besides that they have the function of providing water, they work also as a visual ending point of the architectural composition. Eight arches frame it.

There are complete unity and concordance between the materials and what they suggest to be, since they are used in an apparent way.

The different heights are highlighted by pinnacles, which give the sensation of more height and provide visual stability. These elements also have a structural function, because they transmit their weight in vertical way to buttresses, counteracting lateral forces that come from the vault and tambour. Buttresses highlight the transition area between exterior and interior.

The turret with its cylindrical shape allows the view to slide dynamically, because its shape does not have vertices at the height of the visual observer that obstaculize the view (*see image 146*).

⁴²⁴ See table 8, P.115.

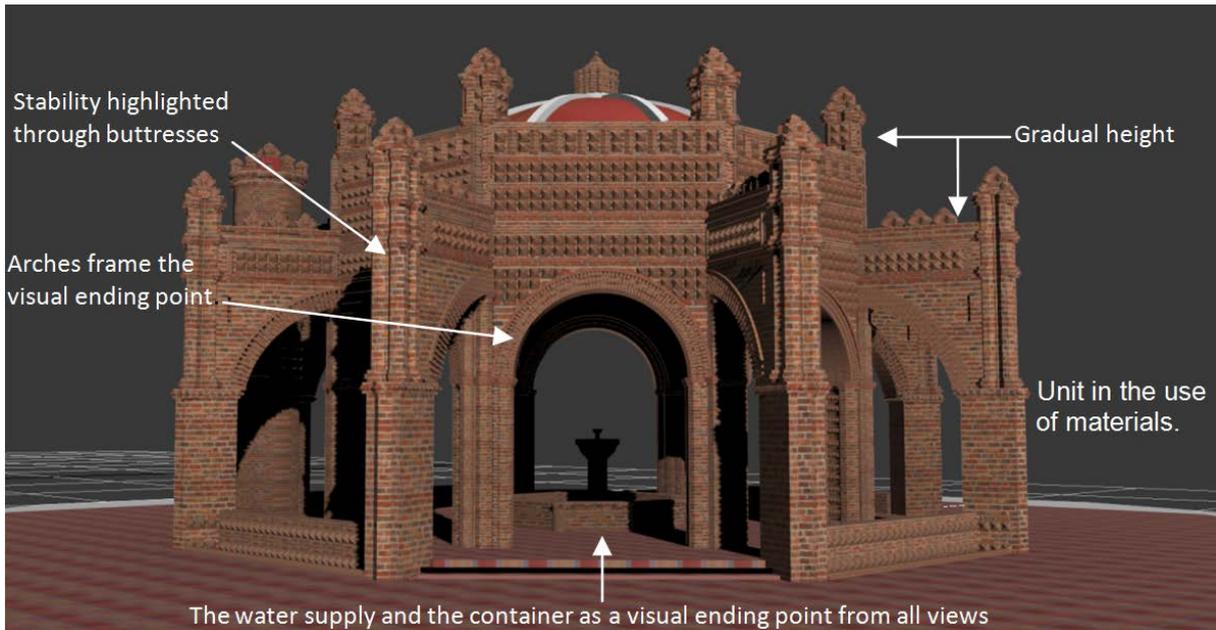


Image 145⁴²⁵. North acces.

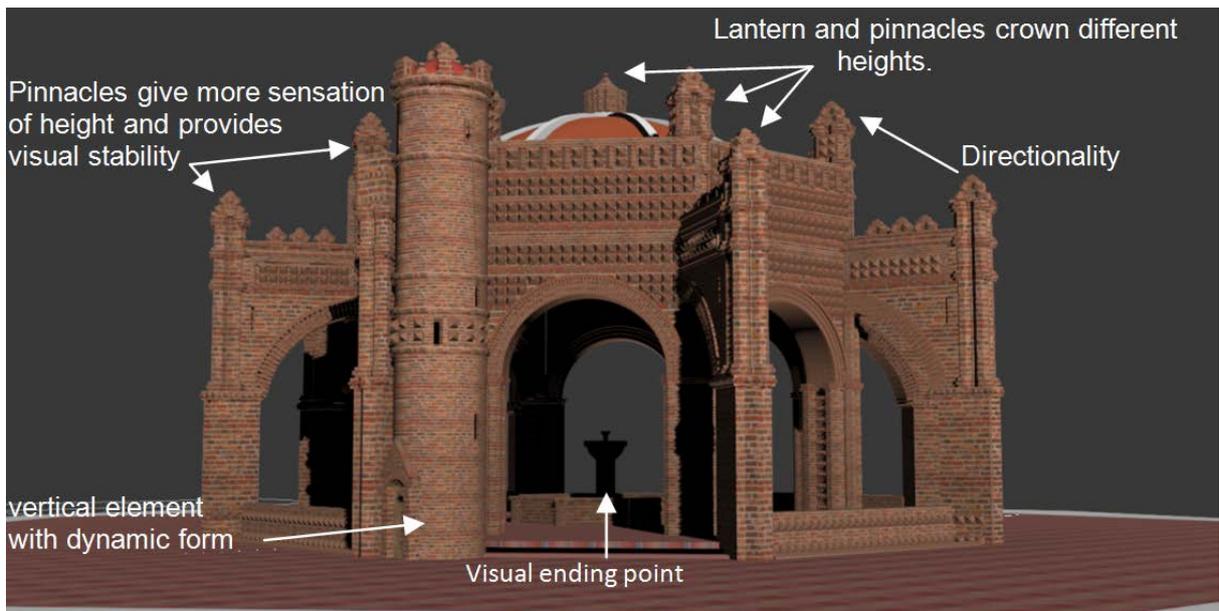


Image 146⁴²⁶. East acces.

4.3.2.5 Function.

- Practical function.

The fountain's function was originally designed and built to provide clean water to people in a safety way for daily use. Today this concept has changed. The fountain is a decorative urban element as many others around the world. The people of Chiapa de Corzo have given more practical functions, for example: meeting point where the

⁴²⁵ Elaborated by the author.

⁴²⁶ Idem.

visitors can protect themselves from the sun and rain, scenery for local events (*concerts, plays, etc.*), and possibly the most important is been the architectural work that represents the state of Chiapas. That's why it has also become an important tourist destination.

- Circulation function.

The fountain contains a semi-open space, in its center is located the water supply and the water container. The architectural object offers different spatial possibilities for pedestrian distribution and circulation.

- Symbolic function.

In this case the fountain function remains the same. However, the fountain concept is what has changed. This concept has been changing and evolving. It is conclude that the architectural object has the character and the function of urban fountain.

- Psychological function.

There is complete congruence, balance and harmony among others functions, therefore we can observe that there is an optimal psychological function.

4.3.2.6 Surrounding context.

The convent complex and the fountain are located in the historic city center, therefore there are some similarities between their surrounding contexts, for these reason, it will be only mention those particular data that are different from the points that have been already mentioned in the study of the convent complex's surrounding context.

4.3.2.6.1 Natural environment.

a) Particular.

- Geographical location.

The fountain was built on the main square of Chiapa de Corzo. The center⁴²⁷ of the fountain is located at latitude: 16° 42' 28.38" N and longitude: 93° 1' 0.85" W⁴²⁸.

- Topography.

The fountain is also into the 70% of the plains of Chiapa de Corzo. It can be seen from the distance just on hills and from the main square's boundaries.

⁴²⁷ To determinate the center, it was taken as reference the center of the water supply.

⁴²⁸ The geographical location was determinate with a GPS.

- Vegetation.

It will be mention only trees that are in green areas around the fountain (see *image 148*).

- Ceiba (*C. Pentandra*) (see *image 147*).

There are two ceibas near to the fountain, the biggest and oldest one encloses a particular story and therefore this tree has a special meaning for the community of Chiapa de Corzo. To know this story, it was decided to interview *Anayanci Díaz López*⁴²⁹.

*“Existen diversos anécdotas, mitos y leyendas en torno a ésta ceiba en particular, los cuales forman parte importante de la historia del pueblo chiapacorseño. Una de los anécdotas más relevantes, es sin duda, la historia del primer rebelde indígena chiapaneca, quien se levantó en armas en contra del absolutismo español y que fuera capturado, amarrado a la ceiba y posteriormente quemado vivo como castigo ejemplar para la comunidad. Es por ello que éste árbol además de considerarse sagrado y protector del pueblo, es también un monumento vivo a la memoria de quien sin dudarlo, dio su vida defendiendo sus ideales*⁴³⁰”.

- Flamboyant (*Delonix regia*).

There are three flamboyant trees near the fountain. Its characteristics were already mentioned.

- Oak (*Ehretia tinifolia* L.).

This tree reaches a high over to 25m high. It has elongated leaves about 14cm long. Its fruit starts with yellow color, then red and finally purple.

Oak grows in warm weather between 5 and 120 masl. It is ornamental, and could be planted in orchards or gardens. It is associated with deciduous and semi-deciduous tropical forests⁴³¹.

- Soil

The soil where the fountain was built, it is *Vertisol*⁴³². It's the same soil founded in the convex complex.

⁴²⁹ Anayanci Díaz López. She is one of historians of the city of Chiapa de Corzo. Her researches about the city cover fields such as architecture, urbanism, history and heritage. She studied architect and has a master in architecture and urbanism.

⁴³⁰ Rodríguez, Alan P. (11/22/2012).

⁴³¹ UNAM 2013g.

⁴³² DDUE 1990.

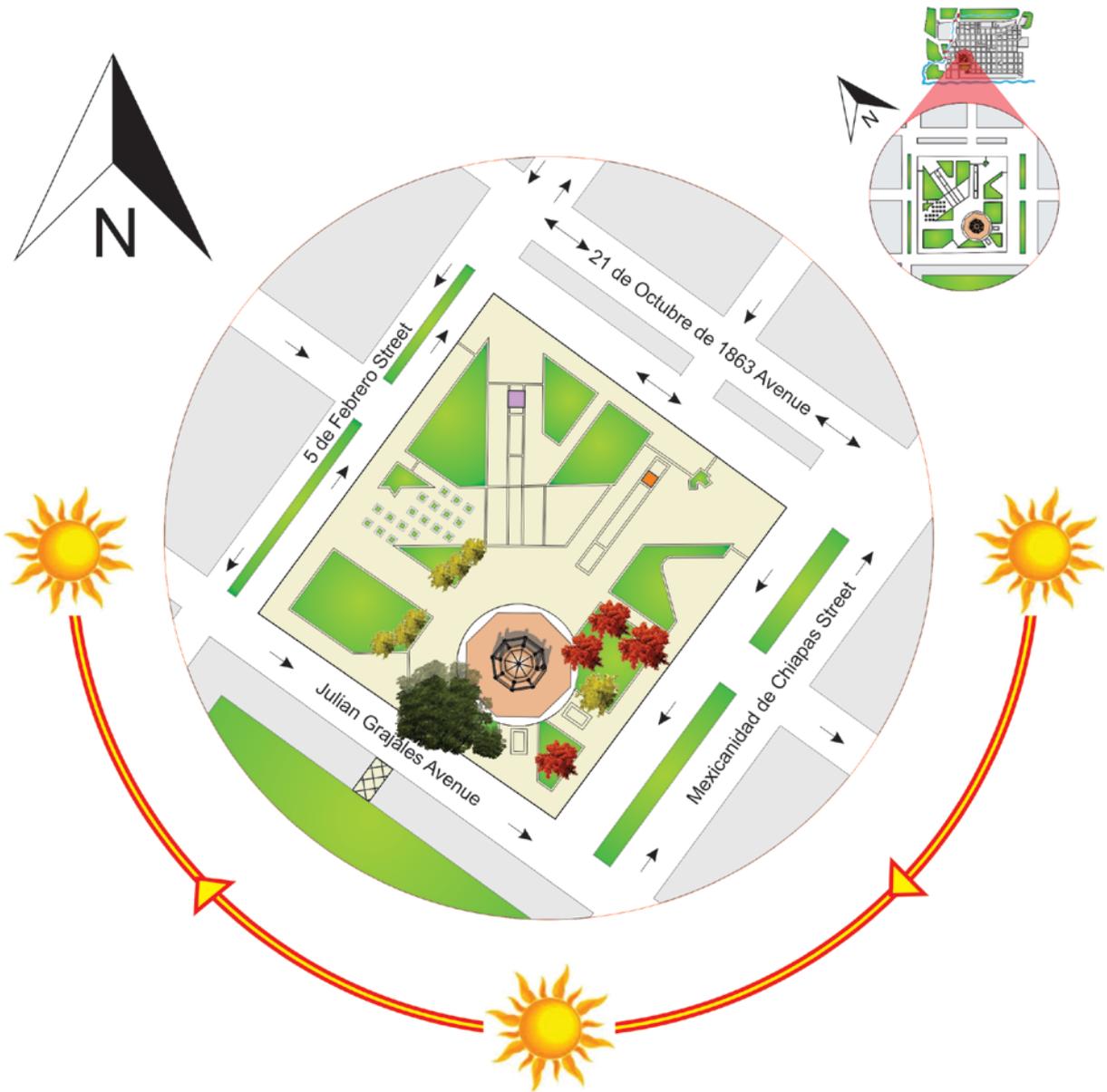
- Sunlight.

The fountain is located on an open air space, that's why it doesn't receive shades from others constructions. Also the ceiba's branches don't interfere with the sunlight, which hits its sides on the west, south and east (*see image 148*).



Image 147⁴³³. Ceiba tree. Holly tree located near to the fountain.

⁴³³ Elaborated by the author.



Symbology			
	Angel Albino Corzo (Statue)		Square and Public space
	Block		Sunlighting
	Green area		Two-way Street
	North		Walkway
	One-way Street		Watch Tower

Tree's symbology	
	Ceiba
	Flamboyant
	Oak

Image 148⁴³⁴. Vegetation. Location of main trees near to the fountain.

⁴³⁴ Idem.

4.3.2.6.2 Artificial environment.

The fountain is located in the heart of the historic city center. Around it there are diverse constructions, some are monuments to illustrious personalities of the city, and others are buildings that enclose essential activities for the city's operation. Among them there are; commerce, few housing and urban facilities, such as museums, government buildings and a school, which will be mentioned below.

- Facility for culture.
 - *Casa museo Angel Albino Corzo (Museum house)*. It is also the headquarters of the patronage that bears the same name.
 - *Casa escuela de Tradiciones (School house of traditions)*. It is a place where people can learn how to make a traditional mask, to paint crafts, etc., and also has spaces for exhibitions. It belongs to the office of ex-convent of Santo Domingo.
- Facility for education.
 - *Escuela primaria Angel Albino Corzo (Elementary school)*.
- Facility for recreation.
 - *Plaza de Chiapa de Corzo (Main Square of Chiapa de Corzo)*. Here is the place where the fountain is located.

The buildings around the fountain's surrounding context enclose different activities, which are related to the tourism and commerce, concerning to the City Hall and municipality and the last one is housing, which is destined to disappear in a close future due to the increased land use.

The location of the fountain is privileged. It has almost all require services, however the situation of lighting is not much better than the convent complex has.

4.3.2.6.3 Emplacement.

The fountain is located in the core of the historic center, situated on the southeastern extreme of the main square, surrounded and enclosed by a pedestrian circulation area, which is highlighted by a change of texture on floors trough figures of a circle and an inscribed octagon. This space lets a frank view to the fountain (*see image 149*).

On the main square and around there are green areas with three different kinds of trees. One of them is remarkable for its sizes, it is known as *la Pochota (the Ceiba)*, which is one of the important touristic points in city.

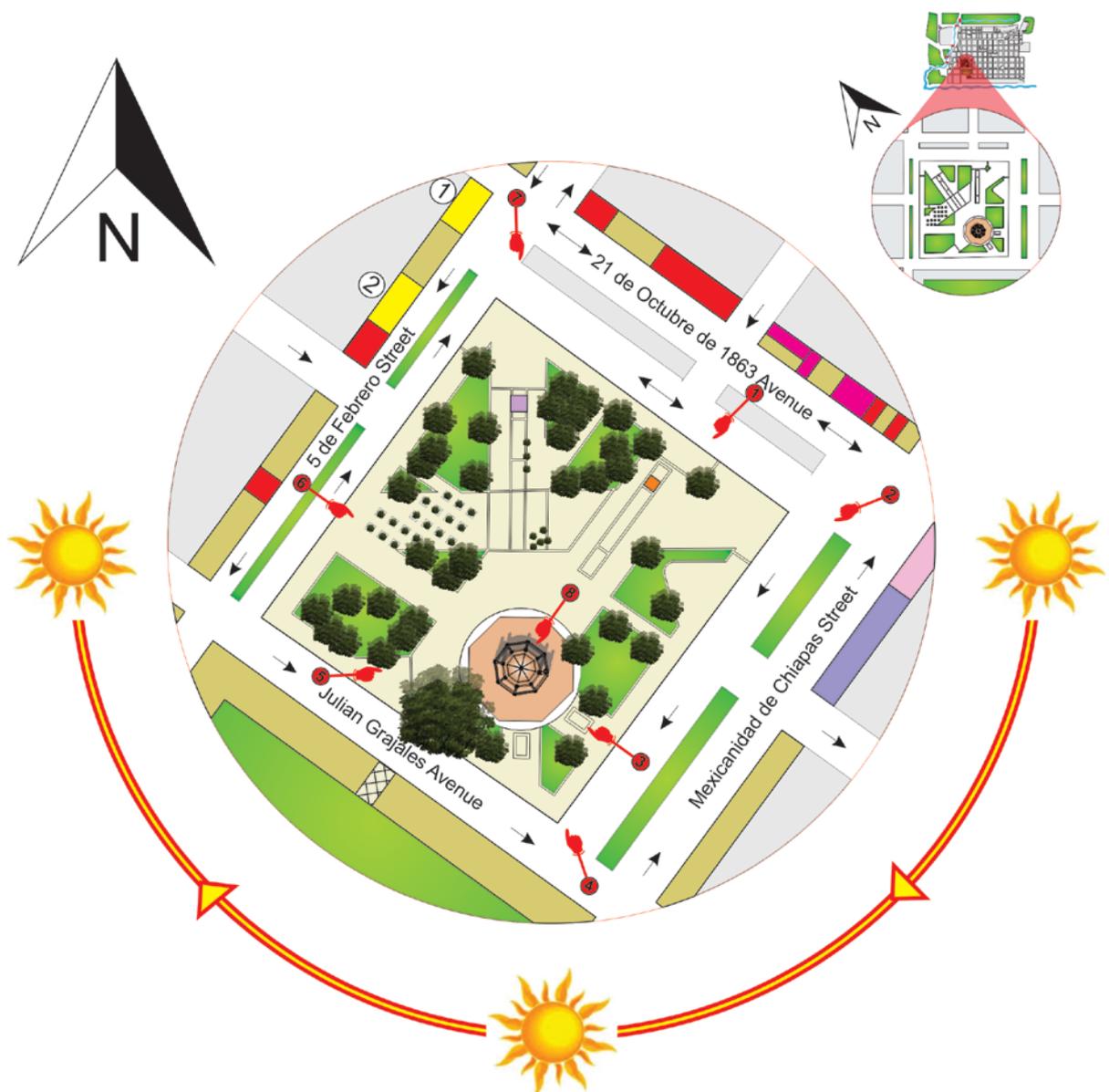
The fountain also shares the square with two other monuments, one is a sculpture of Angel Albino Corzo and the other is watch tower, both were made on XX century, however the most monumental work undoubtedly is the *Mudéjar* fountain.

The main square is rounded by two streets located on the west (*5 de Febrero*) and east (*Mexicanidad de Chiapas*) and two avenues on the north (*21 de Octubre de 1863*) and south (*Julián Grajales*). The fountain is visible from the four cardinal points.

The adjacent to streets; 5 de Febrero, Mexicanidad de Chiapas and avenue Julián Grajales and with a centrifugal distribution there are portals with semicircular arches, which contains walkways that protect people from the inclement weather and conduce them to different stores and to the Town Hall. They are also used as a place for informal commerce (*peddling*).

Principal views are located indeed from the main square, but also is the fountain visible from streets and avenues that surround it. The elevations and hills inside the city allow in the same way to visualize the square with its contents.

The fountain with its masterful construction, in addition to its aesthetic captures the eyes of the people, highlighting easily from the surrounded context.



Symbology			
	Angel Albino Corzo (Elementary school)		Museum
	Angel Albino Corzo (Statue)		North
	Block		One-way Street
	Commerce		Square and Public space
	Government Offices		Sunlighting
	Green area		Town Hall
	Housing		Two-way Street
	Main trees		Walkway
	Main views		Watch Tower

- ① Museum house Angel Albino Corzo
- ② School house of traditions.

Image 149⁴³⁵. Fountain's emplacement and its surrounding context.

⁴³⁵ Idem.



Image 150⁴³⁶. Views 1, North view (see image 149).



Image 151⁴³⁷. Views 2, East view (see image 149).

Both photos show the main square and the fountain. In spite of the wide foliage of trees, it is still possible to appreciate the fountain. On view 1 taken from *21 de Octubre de 1863 ave.*, is visible the watch tower on the first plane. On second plane appears the

⁴³⁶ Google maps 2014.

⁴³⁷ Idem.

fountain. On view 2, intersection between Mexicanidad de Chiapas street and *21 de Octubre de 1863* avenue, on the right we can see the portals of the Town Hall.



Image 152⁴³⁸. Views 3 (see image 149).



Image 153⁴³⁹. Views 4 (see image 149).

⁴³⁸ Idem.

⁴³⁹ Idem.

Photo 3 was taken from *Mexicanidad de Chiapas*. Here we can see the west façade of the fountain, on the right side is visible the Ceiba tree and on the left is an oak tree. Also on this photo we can appreciate the turret with cylindrical form. From this view there are no obstacles that don't let to visualize the architectural object.

Photo 4 was taken from the intersection between *Julián Grajales* avenue and *Mexicanidad de Chiapas* street. From this view we can see, how the fountains emerges from behind of flamboyant's foliage. The Ceiba is also visible.



Image 154⁴⁴⁰. Views 5 (see image 149).

Photo 5 was taken from *Julián Grajales* avenue. The foliage covers more than 50% of the fountain, however it is still visible from this view. It seems that the work of human beings competes with the work of nature for attention.

⁴⁴⁰ Idem.



Image 155⁴⁴¹. Views 6 (see image 149).

Photo 6 was taken from *5 de Febrero* street. Here the foliage of trees covers the frank view to the fountain. Contrast between green and red helps identify the edges of the architectural object.



Image 156⁴⁴². Views 7 (see image 149).

⁴⁴¹ Idem.

⁴⁴² Idem.



Image 157⁴⁴³. Views 8 (see image 149).

Photo 7 was taken from the intersection between *5 de Febrero* street and *21 de Octubre de 1863* avenue. The fountain appears on the back as a visual ending point. On first plane is placed the sculpture of *Angel Albino Corzo*. The red color of the fountain contrast with the green color of foliage.

Photo 8 was taken from north of the fountain. Here we can see the turret and all the architectonics details. It is important to mention that all eight facades are completely frank to the spectator's views.

4.3.2.7 Exterior lighting system.

The fountain doesn't have a proper outdoor lighting. It is intrusively illuminated (*it means indirectly*). The luminaries are placed on the perimeter where they radiant light, which somehow discreetly allow to visualize the architectural object. However, this way of lighting produces light pollution, adding that the type of lamps used, project lights in all directions, without being directionalized to a specific target. Therefore there is also a waste of energy.

These lights are known as streetlights. They are composed of two fluorescent lamps of 100 watts with classic diffuser. Streetlights are located radially at each vertex of the outer

⁴⁴³ Elaborated by the author.

octagon represented by a change of color on the floor (see image 158). There is no charge center destined for the fountain. The power supply is provided from the square.

The intrados of the dome is lit indirectly by 4 High pressure sodium vapour lamps with reflector of 50 watts. They are placed on the inner tambour's crown. The power supply also comes from the central square and do not have a charge or distribution center (see image 160).

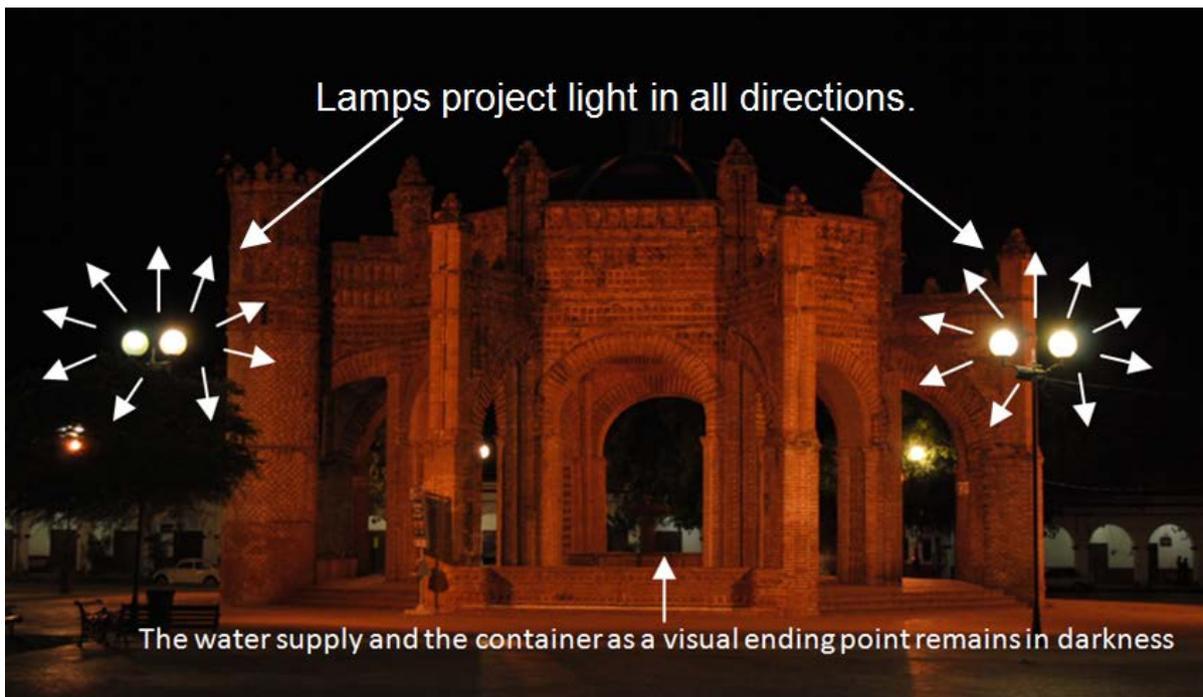


Image 158⁴⁴⁴. Fountain, North-east side.

Two fluorescent lamps of 100 watts with classic diffuser.

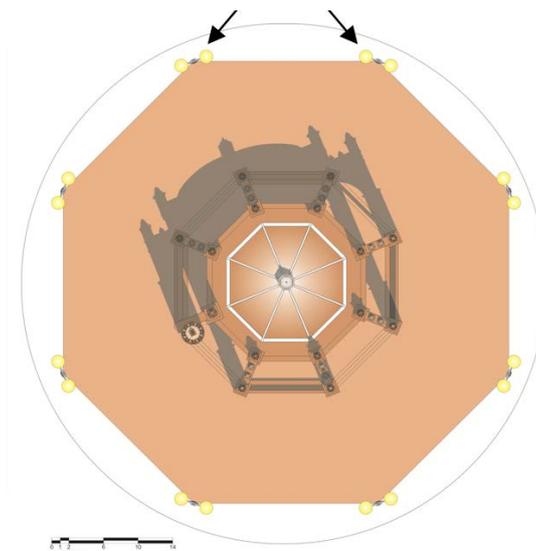


Image 159⁴⁴⁵. Fountain, roofs plan.

⁴⁴⁴ Idem.

⁴⁴⁵ Idem.



Image 160⁴⁴⁶. Interior view and lighting system of the fountain.

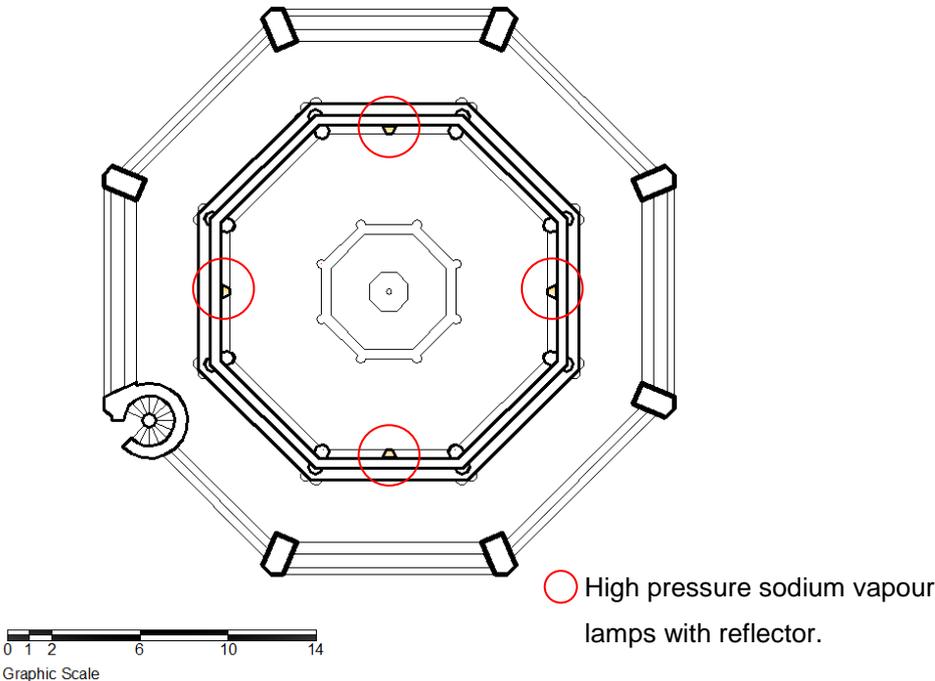


Image 161⁴⁴⁷. Ground floor plan.

⁴⁴⁶ Sparlita 2010.

⁴⁴⁷ Elaborated by the author.

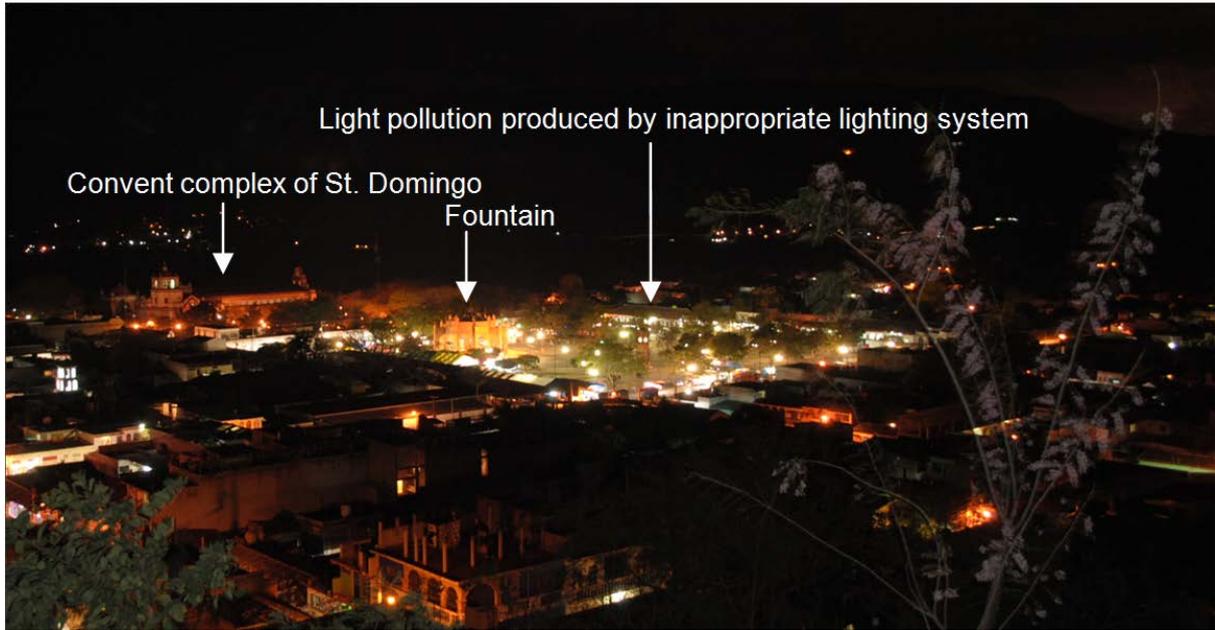


Image 162⁴⁴⁸. Convent complex of *St. Domingo* and the main square of Chiapa de Corzo.

On this image we can appreciate the light pollution over the main square. It is also possible to notice that the convent as the fountain don't have outdoor lighting. As it was mentioned before, both historical constructions are illuminated in an indirect way.

⁴⁴⁸ Elaborated by the author.

Chapter 5. Proposal of outdoor lighting.

5.1 Lighting projects.

5.1.1 Plans: Convent complex of Santo Domingo.

5.1.2 Plans: Fountain of Chiapa de Corzo.

5.1.3 Descriptive memories.

5.1.3.1 Criteria of design.

The color of lights selected was amber and yellow, which were used in order to produce the sensation of warmth, due to the Community of Chiapa de Corzo has a special and ancestral relationship with the sun, therefore its selection was under a conceptual and symbolic approach.

The type of lighting chosen for both historic buildings is focal glow, this according to *Kelly's* lighting functions. It means that only some architectural elements of each case study were illuminated, in order to transmit the necessary information (function of the building, architectural style, materials used, symbolic elements, etc.) to the observer.

Both projects are located in urban public spaces, regarding to the type of light of this kind of areas, it was decided to use the island light. This type of lighting is used when the public space contain or are bounded by architectural objects with historical or architectural significance, which are the main protagonists in the urban landscape.

For the outdoor lighting of both; the Convent complex and the fountain, it was taken in considerations all intrinsic and extrinsic factors, which were already mentioned in chapter 3 of the present research.

The principles exposed in chapter 3⁴⁴⁹ were the basis for the lighting design, as it is shown below.

- Principle of specificity.
The lighting was designed according to the own architectonic characteristics, like: formal, functional, spatial and structural of the convent complex and the fountain.
- Principle of respect for the shape.
All luminaries were strategically placed and selected, in order to avoid an incorrect reading of both architectural objects.
- Principle of contextuality.
The convent complex has a surrounding context which is not illuminated and there is no relevant architecture near to the building. That's why it was chosen to use soft lighting (low levels of luxes), in order to keep the darkness of its context.

⁴⁴⁹In chapter 3, pp. 144-145.

The context of the fountain it's also relevant, due to its history. The main idea was not to compete with the context, but integrated, using intrusive lighting as background. The illumination selected was also soft.

- Principle of respect for the constituent materials of the work.

It was avoided to illuminate those elements with photosensitive materials, such as the wood.

The type of lamp was carefully selected, in order to produce low radiation levels and thereby not affect the constituent materials of both architectural objects.

- Principle of reversibility.

Both projects were developed under the main concept of *Lighting without harming*. It means that both projects seek not only the protection of the environment and human being, but also the structure and the epidermis of the convent complex and the fountain.

To protect the structure and the finishes of both constructions, it was decided not to drill, avoiding holes that could damage irreparably the building. To achieve this, it was necessary to use an alternative way to fix the electrical wiring and luminaires. For this task was proposed to use resin epoxy⁴⁵⁰ or similar.

- Principle of maintenance.

For both projects was designed a maintenance plans, which are mentioned in this chapter, section 7.1.1.4.

5.1.3.1.1 Convent complex.

- North Facade.

The length of the nave in comparison to its height creates a feeling of horizontality, which is accentuated by horizontal moldings that run along the facade. These moldings are placed on the crowns of both stories and which also have the function to divide them visually. With the intention to balance its horizontality, it was proposed luminaires type BCS716 placed to illuminate in ascending way vertical elements of the second story.

In relation to the portal located in the third bay, it is proposed to set two up lights next to the massive buttresses which flank the access. This is intended to emphasize the vertical elements. The semicircular header is also illuminated in the same way. Both elements define and hierarchize through light the entry. To light the massive buttresses was proposed

⁴⁵⁰ See data sheet in annex 2.

luminaires BCS722 and for the semicircular header luminary BCS716. The niches that crown the buttresses will be illuminated with luminaires Master LEDPAR20 7w-50w 830 40°.

The lighting proposal for the second portal is intended to highlight certain elements that compose it, such as, the niches with luminaires Master LEDPAR20 7w-50w 830 40°, merlons illuminated with up lights BCS710 and the high relief is illuminated with the luminary BCS719.

The merlons that integrate not only the north facade, but also the others three remaining facades are illuminated in ascending way with luminaires BCS716. The intention is to highlight the different heights and provide to the observer a scale.

The Lighting of the tower will be in ascending and gradually way, ie, the first story is only illuminated from inside with luminaires Master LEDPAR20 7w-50w 830 40°, therefore, the lighting starts from inside to outside through an embrasure (*intrusive lighting*). The second story will be also lit from inside to outside through two embrasures. To emphasize the verticality of the columns will be placed two luminaires BCS722, one on each side. The third story is also lighted by two up lights placed next to the columns, with the intention of highlighting them with two luminaires BCS719. It is also proposed to change the current luminaires of inside the bell. It is suggested luminaires Master LEDPAR20 7w-50w 830 40° with amber filter. The intention is to visualize the bell tower from the distance, avoiding as much as possible the light pollution.

- West facade.

This is the main facade of the temple and the richest in ornamentation, for such reasons it was proposed to illuminate only the most outstanding details, such as the friezes that divide the stories of the side bays. They are lighted by luminaires BCS710. The use of up lights prints a dramatic effect through light and shadow on the metopes.

The first story of the north bay like the south bay are lighted by luminaires Master LEDPAR20 7w-50w 827 25° with amber filter, located inside of two posts, which are placed at a distance of 1 meter from the façade. The light illuminates the intercolumniation of each bay, revealing the niches and reliefs.

The second story of north bay has not a direct illumination, however through intrusive light vans are indirectly illuminate. In relation to the second story of the south bay, it receives intrusive light from inside and from the outside is directly illuminated by a luminary BCS716. The culmination of both side bays are lighted by luminaires BCS716.

The tower is comprised of two stories, a frieze and a cylindrical culmination. The lower story lacks of direct illumination. It was proposed that the embrasure is illuminated through

intrusive light from inside. The stories are divided by a frieze with two metopes, which are illuminated by a luminary BCS710. The second story is illuminated by luminary BCS719. The lighting proposal for the cylindrical culmination consists of 4 luminaires BCS710 and 4 BCS716, placed alternately around the element. The light projection let to visualize the object like a crown that tops the tower from any angle.

The central bay is divided from the side bays through columns, which are lighted in ascendant way. In the first story are used two BCS716 luminaires, one on each side of the columns. In the second story it is proposed two BCS710 luminaires. In the third story will be used 3 BCS716 luminaires, two at the ends and one that illuminates the niche located in the center. The culmination of the central bay is lighted by 2 up lights with BCS716 luminaires, located at each side of the vane. The Latin cross that crowns the bulrush is directly illuminated by a Master LEDPAR20 7w-50w 830 40° with amber filter.

The frieze that divides the second story from the third is illuminated by 7 luminaires type BCS716. The intention is to highlight the division and architectural details like diamond points located inside of the frieze.

Through uplighting is highlighted and hierarchized the access, for this it will be used two luminaires type BCS719, located at each side and a luminary type BCS716 to light the blind half-circle lunette that crowns the access.

The west façade of the convent has currently two wall sconce, which are recessed into the wall. It is proposed to make modifications to these wall sconce, so that the light is downward, likewise it is suggested to replaced them by two Master LEDPAR20 7w-50w 830 40°, this with the intention of lighting only to the floor. Throughout this façade is proposed to use indirect downward light, in order to illuminate the wall in a degraded way. To achieve this, it will be used Standard TLD Colour yellow lamps, with the purpose to define visually the wall.

- South facade.

The south facade has not too many architectural details. However, it is proposed to highlight certain parts and elements that integrate the facade, as it is shown below:

Like the west façade of the convent, it is proposed for the illumination of the south side lamps Standard TLD Colour, which illuminate gradual and downward the walls that support the roof structures.

The first story of the third plane of the facade has openings, which are accentuated by the use of jambs. It was proposed to light just the vertical jambs, with the purpose to emphasize

the elements by direct upward illumination. Luminaires type BCS710 are suggested to be used in each side of the openings.

The columns of the first plane of the facade are illuminated by ColorGraze Powercore luminaires, this with the intention of balancing visually the horizontal facade of the convent, in the same way it is lighted and highlighted the southern entrance of the first plane that leads the people to the east courtyard

- East Facade.

It was proposed only to illuminate the pedestrian access to the convent by the use of Powercore ColorGraze luminaires, which will be located in ascending way next to the vertical elements that integrate the access, in order to hierarchize the element.

- East Courtyard of the convent.

The lighting proposed for inside of the courtyard is through descending indirect light, which illuminate only pedestrian boundaries, with the intention to preserve the diversity of flora that contains the space and to avoid at maximum the light pollution. The suggested lamps to be used are Standard TLD Colour (yellow).

5.1.3.1.2 Fountain of Chiapa de Corzo.

- Facades.

Due to the fountain design that emerges from the geometry of an octagon, practically all facades are similar. One of the sides has a cylindrical tower, which is one of the two differences. The other difference is that the fountain has four accesses with stairs. They are symmetrically distributed in four sides. The lighting proposal responds to those differences.

The lighting design for the accesses was developed under the concept of transparency. To achieve this it was decided not to light the entrances of the fountain, this with the intention of highlighting the interior's lights, in this way both the water supply and the container are visible from the distance. This invites the people to enter to the space.

The other four sides of the octagon are illuminated with uplights on the ground and when the light encounter an obstacle (*parapet*) projects its shadow on the walls and due to the texture and richness of its component elements, the shadow produces an effect of movement and dramatism on facades. The type of luminaires used is BCS719.

The buttresses of each side of the facades are illuminated in ascendant way, in order to take advantage of the texture and materials. This prints dramatism on the facades. The luminaires used are BCS716 - 60°.

The pinnacles that are on the tambour are illuminated with uplights. The chosen luminaires are BCS716-30°.

The illumination of inside of the cylindrical tower allows highlighting the embrasures through contrast generated by light and shadow, thus revealing its forms. It is proposed to be used luminaires type Master LEDPAR20 7w-50w 830 40° with amber filter.

- Interior.

The interior of the fountain is lit in ascendant way. The luminaires will be placed on the spandrel of the arches, where emerges the tambour. Luminaires project light into the interior of the vault, illuminating indirectly the interior’s space. The luminaires used will be BCS716-60°.

5.1.3.2 luminaires.

The criteria for the selection of luminaires respond to the needs of not only protecting the environment but also to protect the integrity of the historical buildings. In this sense it has been chosen low energy lamps like LEDs and fluorescent.

The colour temperature was selected under the premise that most insects do not see the yellow light. In the case of the lamps don’t radiate this type of colour, then it is necessary to used amber filters.

- Luminaries proposed for the Convent complex of Santo Domingo.

Master LEDPAR20 7w-50w 830 40°.	
Brand	Philips
Voltage	240v / Mains Voltage
Wattage	7W
Equivalent Wattage	Halogen 50W
Shape	PAR20
Lamp Base	E27 / Edison screw
Beam Angle	40°
Beam intensity	500 cd
Dimmable	Yes
Lifetime	45000 Hours
CRI %	>80%
Colour	3000k
Length	90.2mm
Width	63.7mm
Weight	0.156 kg



Table 9⁴⁵¹.

⁴⁵¹ Philips 2011, 364.

Master LEDPAR20 7w-50w 827 25°.	
Brand	Philips
Voltage	240v / Mains Voltage
Wattage	7W
Equivalent Wattage	Halogen 50W
Shape	PAR20
Lamp Base	E27 / Edison screw
Beam Angle	40°
Beam intensity	1000 cd
Dimmable	Yes
Lifetime	45000 Hours
CRI %	>80%
Colour	2700k
Length	90.2mm
Width	63.7mm
Weight	0.156 kg.



Table 10⁴⁵².

ColorGraze Powercore.	
Brand	Philips
Voltage	240v / Mains Voltage
Wattage	35W
Beam Angle	30°x60°
Beam intensity	689 cd
Lifetime	50000 Hours
Lamp colour	Amber
Height	69 mm
Width	610 mm
Depth	71 mm
Weight	2.2 kg.



Table 11⁴⁵³.

TLD Standard Colour.	
Brand	Philips
Lamp voltage	103v
Wattage	36W
Luminous flux	1580 Lm
Dimmable	Yes
Lifetime	15000 Hours
Lamp colour	Yellow
Height	28 mm.
Width	1213.6 mm
Weight	138.400 gr.



Table 12⁴⁵⁴.

⁴⁵² Idem.

⁴⁵³ Philips 2008a, 5.

⁴⁵⁴ Philips 2013a, 29.

BCS710	
Brand	Philips
Number of lamps	6
Lamp colour	Amber (Mono-colour)
Wavelength	590 nm
Flux/LED	42 Lm typ.
Beam angle	60°
Wattage	10W
Supply voltage	230-240 V
Lifetime	50000 Hours
Height	63 mm
Width	156 mm
Depth	67 mm
Weight	0.720 kg.



Table 13⁴⁵⁵.

BCS716	
Brand	Philips
Number of lamps	6
Lamp colour	Amber (Mono-colour)
Wavelength	590 nm
Flux/LED	42 Lm typ.
Beam angle	60°
Wattage	10W
Supply voltage	230-240 V
Lifetime	50000 Hours
Height	63 mm
Width	594 mm
Depth	67 mm
Weight	1.618 kg.



Table 14⁴⁵⁶.

BCS719	
Brand	Philips
Number of lamps	36
Lamp colour	Amber (Mono-colour)
Wavelength	590 nm
Flux/LED	42 Lm typ.
Beam angle	30°
Wattage	50W
Supply voltage	230-240 V
Lifetime	50000 Hours
Height	63 mm
Width	884 mm
Depth	67 mm
Weight	2.760 kg.



Table 15⁴⁵⁷.

⁴⁵⁵ Philips 2013b, 2-3.

⁴⁵⁶ Idem.

⁴⁵⁷ Idem.

BCS722	
Brand	Philips
Number of lamps	12
Lamp colour	Amber (Mono-colour)
Wavelength	590 nm
Flux/LED	42 Lm typ.
Beam angle	60°
Wattage	19W
Supply voltage	230-240 V
Lifetime	50000 Hours
Height	63 mm
Width	1174 mm
Depth	67 mm
Weight	2.806 kg.



Table 16⁴⁵⁸.

↑ Height of measurement	700	5	1	1	0	8	2	1	0	11	2	1	1	16	4	2	1
	650	7	2	1	0	10	2	1	0	13	3	1	1	20	4	2	1
	600	8	2	1	0	13	3	1	1	17	4	2	1	25	6	2	1
	550	11	2	1	0	16	4	1	1	22	5	2	1	31	7	3	1
	500	14	3	1	0	21	5	2	1	28	6	2	1	40	9	4	1
	450	20	4	2	1	29	6	2	1	37	8	3	1	51	12	5	2
	400	28	6	2	1	40	9	3	1	50	11	5	1	64	16	7	2
	350	40	9	3	1	56	13	5	2	68	16	7	2	76	23	10	3
	300	61	13	5	2	82	19	8	2	91	25	10	3	86	33	14	4
	250	99	23	9	3	117	32	13	4	114	40	17	5	94	50	23	6
	200	162	42	17	5	159	57	25	7	139	68	30	8	111	76	38	11
	150	87	82	37	10	108	103	50	14	116	111	59	16	113	109	64	18
	100	148	190	104	29	177	206	124	34	177	194	127	35	153	157	106	29
50	372	425	368	101	311	346	304	84	242	254	226	62	92	102	110	30	
Optic →	NB	MB	WB	WBB	NB	MB	WB	WBB	NB	MB	WB	WBB	NB	MB	WB	WBB	
	10cm				15cm				20cm				30cm				
	Distance from the wall →																

Table 17⁴⁵⁹. LEDline² - Illumination levels (in lux)

⁴⁵⁸ Idem.

⁴⁵⁹ Philips 2008b, 28.

- Luminaries proposed for the Fountain of Chiapa de Corzo.

Master LEDPAR20 7w-50w 830 40°.	
Brand	Philips
Voltage	240v / Mains Voltage
Wattage	7W
Equivalent Wattage	Halogen 50W
Shape	PAR20
Lamp Base	E27 / Edison screw
Beam Angle	40°
Beam intensity	500 cd
Dimmable	Yes
Lifetime	45000 Hours
CRI %	>80%
Colour	3000k
Length	90.2mm
Width	63.7mm
Weight	0.156 kg



Table 18⁴⁶⁰.

BCS716-30°	
Brand	Philips
Number of lamps	6
Lamp colour	Amber (Mono-colour)
Wavelength	590 nm
Flux/LED	42 Lm typ.
Beam angle	30°
Wattage	10W
Supply voltage	230-240 V
Lifetime	50000 Hours
Height	63 mm
Width	594 mm
Depth	67 mm
Weight	1.618 kg.



Table 19⁴⁶¹.

BCS716-60°	
Brand	Philips
Number of lamps	6
Lamp colour	Amber (Mono-colour)
Wavelength	590 nm
Flux/LED	42 Lm typ.
Beam angle	60°
Wattage	10W
Supply voltage	230-240 V
Lifetime	50000 Hours
Height	63 mm
Width	594 mm
Depth	67 mm
Weight	1.618 kg.



Table 20⁴⁶².

⁴⁶⁰ Philips 2011, 364.

⁴⁶¹ Idem.

⁴⁶² Idem.

BCS719	
Brand	Philips
Number of lamps	36
Lamp colour	Amber (Mono-colour)
Wavelength	590 nm
Flux/LED	42 Lm typ.
Beam angle	30°
Wattage	50W
Supply voltage	230-240 V
Lifetime	50000 Hours
Height	63 mm
Width	884 mm
Depth	67 mm
Weight	2.760 kg.



Table 21⁴⁶³.

- Filters.

As previously was mentioned, the filters have the function of filtering the light through the glass and projecting light amber. Technical data and specifications are shown below:

Color filter <u>technical data.</u>	
Brand	Rosco-México.
Swatchbook	Permacolor.
Color filter	#5401 Amber.
Transmission	71%
Description	Dichroic Coated Glass Filter
Substrate	Borasilicate Glass
Thickness	1.75 mm (1.1 mm and 3.3 mm optimal)
Manufactured in	USA.
Available sizes	Sheets. 50 cm x 60 cm.
	Rolls. 60 cm x 7.62 m.
	Rolls. 121 cm x 7.62 m.
	Rolls. 144 cm x 6.4 m.
	Diameter Glass. 34.3 cm.
	Cut to order.

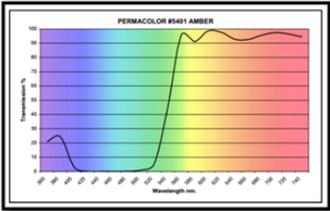


Table 22⁴⁶⁴.

⁴⁶³ Idem.

⁴⁶⁴ Rosco-Mexico 2013.

5.1.3.3 Calculation.

To calculate the illumination of architectural elements were used basically three formulas. The first one is to determine the desired light intensity. The second one is to calculate the luminance level of the surfaces and the third one is to know the amount of luminance of the architectural objects.

- Determine the light intensity.

When it was previously known the required amount of luxes on the surface, then the next formula was used.

$$I = \frac{E \times d^2}{\text{sen } \beta \times \cos \alpha}$$

I = light intensity

E = Illuminance on the surface that is required (Lux)

d = Distance from the light source to the surface to be illuminated.

β = Angle of inclination of the plane to be illuminated.

α = Angle of incidence of the beam on the facade.

- Determine the level of lux.

Determining lux levels of illuminated surfaces are taken into consideration such factors as the intensity produced by the lamp, the position of the light source with respect to the illuminated surface as well as the height of the surface. From the relationship of these factors emerges the following formula:

$$E_{pv} = \frac{I}{(h)^2} \times \cos^2 \alpha \times \text{sen } \alpha$$

E_{pv} = Illumination level at a point on a vertical surface.

I = light intensity

α = Angle of incidence.

h^2 = Height of the illuminate point with respect to the light source.

- Determine luminance levels.

Architectural element characteristics such as texture and color of the material are translated as a percentage which corresponds to the level of reflection; this is related to the illuminance of the surface, resulting in luminance.

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

L = Luminance of the surface.

ρ = the value of the surface reflectance.

E = illuminance level in lux.

π = 3.1416

5.1.4 Maintenance plan.

Maintenance plans of lighting system aim to prolong operation of the system, ensuring that there is no decrease in the luminous flux, which would cause that the luminance of the surfaces are below of the desired levels.

The main causes of the malfunction of the illumination system are:

- Soiling of the lamps.

This is the main cause of the decrease of the luminous flux, which is caused by the accumulation of dirt on the surface of the lamp. In some cases atmospheric pollution contributes to deterioration.

- Malfunction in lamps or in electrical system.

In some cases the lamps do not have the necessary hermeticity and this makes that they are exposed to the atmospheric agents, causing malfunction. It is therefore recommended that the lamps must be completely sealed.

When there are variations in the power line as over or low voltages, this not only impacts in the lifetime of the lamps, but also in whole electrical system.

- Vandalism.

Unfortunately vandalism is a common practice in today's Mexican society, for these reasons, luminaries and accessories must be placed out of reach of people. They must be completely sealed and shockproof.

In general maintenance plans for public facilities are subject to the decisions and schedules of municipalities. In this particular case the Convent Complex of Santo Domingo and the Fountain of Chiapa de Corzo depends directly on the *Dirección de Obras Públicas* of the municipality of Chiapa de Corzo, under the supervision and protection of *Instituto Nacional de Antropología e Historia (INAH)*. Based on the schedule of both government agencies, it will be decided, how often will be the inspections of the lamps and electrical system performance. However, it is considered appropriate to provide the following recommendations.

The maintenance work will be preventive and corrective.

- Conservation.

- The contractor as responsible of his work will provide maintenance during the term of the warranty, which is previously stipulated in the contract of the work. When the guarantee issued then the *Dirección de Obras Públicas* de Chiapa de Corzo will be in charge of maintenance.
- Regular night inspections will be conducted in order to detect anomalies in the lamps.
- Conservation activities may occur simultaneously, for example; cleaning and replacement of lamps.

- Security.

- Renewals, modifications, improvements in the installation, repair, replacement of failed lamps, must be performed by a qualified specialist.
- The specialist must submit a report on the condition of the electrical and lighting system to the *Dirección de Obras Públicas* de Chiapa de Corzo, as well as a copy to the *Departamento de Monumentos* of the *INAH*.

- Schedule of operation.

- In order to produce energy savings and prolong the usefulness of the lamps, they will be on from 20 hours to 00 hours (four hours per day). Except during the celebrations of the *Fiesta Grande de Chiapas*, that takes place in that city in January (*from 4th to 23th January*). Lights will be on from 20 hours to 02 hours (*6 hours per day*), ie, the lights will be on 1346 hours per year.

- Maintenance schedule.

- Luminaires.

- Lamps of the families BCS and ColorGraze Powercore have a lifetime of 50,000 hours, divided by the hours of intended use, the result is a lifetime of 37.1471 years.
- Master LEDPAR20 lamps have a lifetime of 45,000 hours, ie the lifetime their duration is 33.4323 years.
- TLD fluorescent Standard Colour lamps have a lifetime duration of 15.000 hours, which means that the lifetime is 11,144 years.

This in optimal conditions, however, inspections must conduct to verify if there is in each lamp anomalies. In the case of malfunction, then they must be replaced.

- Auxiliary Equipment.
 - Massive replacement of ballasts each 8-10 years.
- Luminaires.
 - Connections and oxidation checking must be made in each lamp replacement.
 - Control of mechanical systems of fixation must be performed in each lamp replacement.
- Lighting control.
 - Control of on and off system of the installation should be performed 1 time every six months.
 - Thermomagnetic protectors should be reviewed once a year.
 - The manhole to the ground should be inspected once a year during the dry season, in order to detect anomalies, which must be repaired as soon as possible.
- Electrical installations.
 - The supply voltage must be measured once every six months.
 - Verification of the continuity of the line connected to ground shall be made once a year.
 - Checking the insulation of the conductors shall be undertaken each 2-3 years.
- Holders.
 - Control of the internal and external corrosion once a year.
 - Deformation control once a year.
 - Control of galvanized steel brackets every 15 years.
 - Controls of Aluminum brackets every 5 years.
 - The union (resin epoxy) between the supports of the luminaries and the contact surface must be reviewed every two years.

Chapter 6: Conclusions.

The lack of normative criteria related to proper exterior lighting of historic buildings and monuments, the null application of lighting principles that contribute to the urban heritage conservation, as well as the disinterest to protect the environment, were the main causes that led to the realization of this thesis.

These causes were the basis for the formulation of the main goal of this research. In order to achieve it, it was necessary to research, study and confront journal articles about heritage conservation and environmental protection, as well as was compared opinions of lighting specialists with experience in historic buildings and monuments.

The studies were conducted through: expert interviews (*lighting designers*), review and study of print and online publications of books, articles, magazines and newspapers. It was also required to attend to seminars and workshops related to the lighting. As a result, was achieved: goals, answer to research questions and the verification of established hypotheses.

6.1 Goals.

The main goal; to establish a scientific methodological base for lighting in urban heritage, was fulfilled when specific objectives were achieved, as it is shown below.

- To establish and define the differences between lighting concepts in the context of urban heritage.

In chapter 1 (1.4 Conceptual approach), it was defined the concept of lighting in architecture and its architectural classification, as well as were also explained the differences between interior and exterior lighting, and the different types of lighting in public spaces. In order to understand what implies urban heritage for this research, it was described concepts like historic building, monument and urban public spaces.

- To study the history of the lighting concept and its transformations.

It was studied the history of lighting concept and its transformations, starting from the beginning of lighting, proposing the necessity of security as responsible of the transition from interior to exterior lighting. The study ended with the new trends of lighting in the current era. In Chapter 2 this goal is mentioned.

- To propose a set of lighting principles that contribute to the urban heritage conservation.

In Chapter 3, entitled; Factors to consider in outdoor lighting design. In this chapter it was established six principles, which were used as a guide to design both examples of lighting projects of the case study. In chapter 5 (5.1.1.3.1 *Criteria of design*) was mentioned how they were applied. These principles are:

- 1) Principle of specificity.
- 2) Principle of respect for the shape.
- 3) Principle of contextuality.
- 4) Principle of respect for the constituent materials of the work.
- 5) Principle of reversibility.
- 6) Principle of maintenance.

6.2 Research questions.

The function of specific objectives in this research, in addition to specify the knowledge, to define the stages, delimit the scope and constitute the main guide, also served as the basis for the formulation of research questions, which were answered as shown below.

- Is it possible to alter negatively the image of historic buildings and monuments through inadequate lighting to the degree of distorting the perception that people have of the work? And if so, what are the causes that generate it?

The changes in perception can be positive and negative, this through strategic placement of luminaires and/or light projections technology. In this regard the lighting designer *Enrique Quintero* said:

“El arquitecto propone una forma geométrica y el diseñador de iluminación dice; la voy a destacar o la voy a cambiar o la voy hacer diferente, porque la iluminación tiene esa facultad, cambiar la forma, cambiar los colores, cambiar las texturas⁴⁶⁵”.

Quintero also said that lighting can break paradigms in how we perceive objects. For example, if there is a geometric element like a cube and some lights are strategically placed to light it, then it would not look anymore like a cube, now this element might be perceived as a cylinder. Lighting gives dual perspectives of objects in the day is a cube, while at night is a cylinder.

⁴⁶⁵ Rodriguez, Alan P. (8/5/2013).

Another tool that helps to change the perception of the object, which it is needed to be illuminated is the video mapping. For example, in the city of Weimar took place from 9 to 11 November 2013 an event with video mapping. The designer was *Czigány László* of Hungary. The topic was titled: Liszt-hitecture.



Image 163⁴⁶⁶. *Stadtschloss* of Weimar, normal view, 09.08.2013.



Image 164⁴⁶⁷. *Stadtschloss* of Weimar. Video mapping projection, 09.08.2013.

⁴⁶⁶ Elaborated by the author.

⁴⁶⁷ Idem.

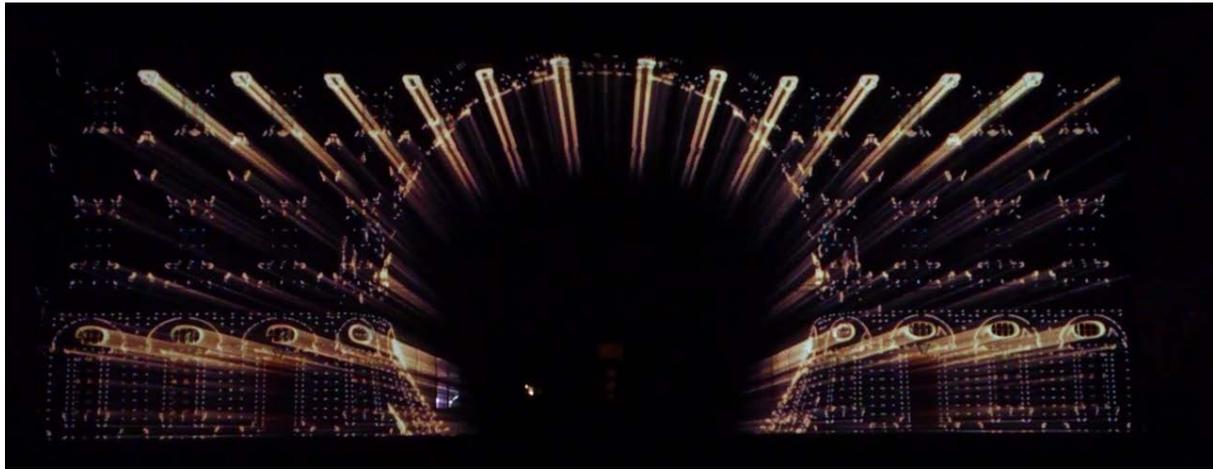


Image 165⁴⁶⁸. *Stadtschloss* of Weimar. Video mapping projection, 09.08.2013.

In the image 163 we can see how the *Stadtschloss* of the city looks like at day. In the image 164, it is possible to appreciate how the designer used a gradient of colors for stories 2 and 3, emphasizing the vertical elements of the facade through a contrast of colors. In the image 165, the lighting shows completely different the building. The designer creates an explosion of sound accompanied graphically with a video of a dark circle in the facade, giving the impression that in the center of the facade there is a huge cavity.

In chapter 3, section 3.1.1.4 (*Shape and volume*) is mentioned how lighting can be used to create different effects on the perception of shapes and volumes.

Now, what are the causes that alter negatively the image of historic buildings and monuments? It was discovered at least five causes that damage the image of the work (chapter 1, section 1.5), which are:

- 1) Excess of lighting.
 - 2) Low light.
 - 3) Bright distracting elements.
 - 4) Misuse of colored light.
 - 5) Inadequate zoning of light.
- Do the lighting designers take into consideration criteria to protect not only historic buildings and monuments, but also the environment?

There are guidelines to reduce environmental pollution, however not all light designers take them into account, possibly because these guidelines are not always regulated by the authorities responsible for the environmental protection.

⁴⁶⁸ Idem.

Regarding to the protection of urban heritage, there are no rules, guidelines or laws that protect historic buildings and monuments from interventions of lighting projects. However lighting designers argue that they follow certain basic rules for the placement of luminaries, however creating holes on surfaces remains a common practice. None of the experts interviewed mentioned an alternative way to set the light equipment without harming the surfaces of buildings and monuments.

- What are the consequences that may generate the inadequate lighting of urban heritage to the environment?

The inadequate lighting produces light pollution (chapter 1, section 1.5, chapter 3, section 3.2.3.2), which has negative impact on the night sky, human health, fauna and flora. Unfortunately, light pollution cannot be avoided 100%, but it is possible to reduce the impact on the environment, through the following recommendations:

- To focus lamps directly to the element, which is needed to be illuminated.
- To ensure that lux levels are not high, for this is necessary to use energy-saving lamps with low intensity, in addition to taking into account the reflection index of materials of the element to be illuminated.
- To establish operating times, thus preventing that lamps are lit throughout the night.
- To avoid using luminaires with white light, because this kind of light attracts more insects and it harm the health, not just to animals, but also to humans.

The improper use of some types of lamps has negative repercussions on the environment, like the mercury lamps, which produce contamination⁴⁶⁹ of soil and groundwater by the waste from lighting equipment⁴⁷⁰.

- What are the factors to consider for a proper illumination of urban heritage?

Two types of factors were categorized, which influence the lighting design. These are intrinsic and extrinsic factors.

- Intrinsic factors.
 - Primary.
Materials, color, texture, shape and volume.

⁴⁶⁹ Weinberg 2013, 22.

⁴⁷⁰ SMA 2002, 10.

- Secondary.
The function of the building and the history (*history of the building and/or the place*).
- Extrinsic factors.
 - Guidelines and laws.
 - The surrounding context.
 - The light pollution.

In chapter 3 of this research is mentioned these factors.

6.3 Hypothesis testing.

This thesis is mainly based on two hypotheses, which were possible answers to the research questions. These hypotheses were tested by this research, determined the following:

- It is possible to reconcile the architecture of the past, environment and technology, this without harming the epidermis of the buildings or monuments.

In section 3.1.1.1 (*Materials and its properties*) are mentioned current lighting systems that exist in the market. It was also elaborated tables with the characteristics of light sources.

Today technological advances that could be found in the market in lighting, offer different solutions and as the years pass, more investigations are being made, which result in significant achievements in the field of lighting.

These advances allow to new generations of lamps to have less impact on the environment, because they consume smaller amounts of energy and generate low levels of intensity, which reduce in the same time the impact on the urban heritage. It can be said that lamp producers are progressing well.

It is a task of lighting designers to contribute to environmental and urban heritage protection, using appropriate lamps and to seek alternatives for the placement of lighting equipment, as it is proposed in this thesis, in this way avoiding to harm to heritage.

In this thesis was determined that indeed: It is possible to reconcile the architecture of the past, environment and technology, this without harming the epidermis of the buildings or monuments. Lighting is a tool that can be used as a linker element between the architecture of past and present technology. If this

combination is harmoniously achieved, then future generations will enjoy during the day and night a proper environment and the architecture of our ancestors.

- It is not necessary to illuminate the entire work to highlight its architectural character.

In Chapter 3, Section 3.1.1.4 (*Shape and volume*) has been clarified and established the use for this research of the term architectural character. It was also exemplified two cases of historic buildings, which helped to determine that the architectural character can be accentuated by lighting.

In two lighting proposals related to the case studies presented in Chapter 7 of this thesis. It can be seen that the character of two historic structures is emphasized without the need to illuminate fully all facades. It was only highlighted some architectural details, using the type of lighting focal glow, according to Kelly's lighting functions (*chapter 5, section 5.1.2.1 Function*).

In the case of the convent complex of Santo Domingo, the architectural language expressed by the elements that compose it, provides a clear message about its character. Even, this message is so strong that if at night there were no artificial lighting, even so it would be readable, therefore, through the proposed lighting it was looked for to highlight some details, in order to reinforce the architectural character.

Regarding to the fountain of Chiapa de Corzo, it was taken advantage of the concept of transparency of architectural design, to highlight the water supplier and its container, which are elements that although they are inside of the fountain, are dominant. The idea was to highlight them using lighting, in order to convert them in elements, which were visible from the distance.

In this thesis was possible to determine that it is not necessary to illuminate the entire facade to highlight the architectural character of the historic buildings.

6.4 Recommendations.

The activity of implementing lighting systems in urban heritage is a trend that is increasing, since each day municipalities and private owners are realizing that it is an option to attract tourism and thus increase the economy of cities. In this context, the following recommendations are made:

- To sustain theoretically lighting designs in the urban heritage, for the protection of historic structures. It can be taken as basis the principles proposed in this research (*3.2.1.1 Lighting principles for the conservation of urban heritage*).

- To take into account the intrinsic and extrinsic factors proposed in this thesis, in order to create appropriate lighting designs (*chapter 3*).
- To regulate the hours of use of lighting systems in urban heritage, with the aim of reducing environmental impact.
- To legislate laws regarding to protect the urban heritage from lighting systems interventions. Guidelines and laws can be based on this research (*3.2.1.1 Lighting principles for the conservation of urban heritage*)
- To raise awareness through training workshops for lighting designers, architects, municipal authorities, of the importance of implementing the following formula of balance:

$$\text{Urban Heritage} + \text{lighting} = \text{urban heritage protection} + \text{lighting technology} + \text{environmental protection}$$

Workshops can be offered, for example in universities and collegiate organizations as the association of architects and restorers. These workshops can promote a culture of maintenance of lighting systems in urban heritage.

- To promote multidisciplinary research of new lighting systems for its use in urban heritage.
- To promote research into alternative ways of lighting intervention in the urban heritage, in order to prevent that historic buildings and monuments are harmed by the inappropriate use of lamps and equipment mounting systems.

6.5 Proposal of research lines.

Through this thesis is proposed to guide further studies regarding to the lighting in the urban heritage, thereby creating new lines of research, such as those suggested below:

- Technical studies.
 - Research of new lighting systems.
 - Study on the impact of radiation from lamps in materials used in urban heritage.
 - Research of alternative mounting systems of lighting equipment for the urban heritage.
- Environmental Studies.
 - Studies of the impact of radiation from lamps on: human health, plants and animals.

- Studies on the effects of colored lighting in plants and animals.
- Studies of the impact of urban heritage lighting on the circadian system.
- Studies of the impact of soil pollution through the waste of LED's.
- Psychological and social studies.
 - Psychological studies of the perception of illuminated shapes at night.
 - Psychological studies of the impact of the different colors of light on the behavior of human beings.
 - Analysis of behavior of the society, when the urban heritage is being illuminate.
 - Comparative analysis of crime rates between areas, where there are illuminated historic buildings and/or monuments and areas where they are not lighted.
- Economic studies.
 - Comparative studies in tourist influx between historical buildings and monuments fully lighted and those who were only partially illuminated.
 - Energy saving studies, when it is established schedules to use lighting in urban heritage.
 - Analysis of the benefits of changing, updating and implementing lighting systems in urban heritage.
- Studies in architecture.
 - Research the benefits or disadvantages of illuminating the urban heritage.
 - Study of the application of design theories in lighting projects.
 - Study of the application of design elements in lighting.

6.6 Contribution of this research.

The contributions of this thesis mainly focus on the expansion of knowledge in the field of lighting in the context of historical buildings and monuments. The following are the main contributions of the thesis.

- It was identified the main causes of the deterioration of heritage through lighting.
- It was identified the main consequences that produce an inadequate lighting design in the urban heritage.
- A set of six principles was proposed in order to contribute to the urban heritage conservation.
- A historical study of urban heritage lighting was made.
- Factors involved in the design of lighting in urban heritage were identified and cataloged.

N.º 7

✦

"DON JOACHIN MONSERRAT"

Ciurana, Cruillas, Crespi de Valldaura, Alfonso, Calatayud, San de la Llosa, Marqués de Cruillas, Cavallero Gran-Cruz, Clavero Comendador de Montroy, y Burriana; y Baylio de Sueca en el Orden de Montesa, Theniente General de los Exercitos de su Magestad, Theniente Coronel de sus Reales Guardias Españolas de Infanteria, Virrey, Gobernador, y Capitán General de Nueva-España, y Presidente de la Real Audiencia de ella, &c.)

POR el presente mando à todos los Vezinos de esta Ciudad, estantes, y habitantes de ella, sin excepcion de Persona alguna, que dentro de quinze dias, contados desde hoy en adelante, pongan una Luz proporcionada dentro de Faról, ò como mejor les pareciere, en uno de los Balcones, ò Ventanas principales de la Casa en que vivieren, todas las Noches, desde las Oraciones, hasta despues de la Queda, que son desde las diez, para que de este modo estén uniformemente iluminadas las calles, y por este medio (acordado, y consultado por la Fiel Executoria de esta Nobilissima Ciudad) se eviten los insultos, pecados, y perjuicios à que la obscuridad alienta, y provoca. Y para que esta providencia tan à beneficio del Publico, tenga la invariable observancia, y subsistencia, que pide, hasta establecerse costumbre, sin alteracion, ni disimulacion alguna, impongo de Multa, à cada uno de los que faltaren à esta generalissima Orden, un peso de moneda corriente por la primera vez; dos por la segunda; y tres por la tercera, con mas seis dias de Carzel: Y à los que fueren offados à quitar alguna Luz, hurtar, ò quebrar Faróles, desde ahora les impongo ocho dias de Carzel. Y encargo à las Justicias de su Magestad zelen, y velen sobre el cumplimiento de esta providencia, su establecimiento, y duracion; à cuyo fin, para que llegue à noticia de todos, y ninguno alegue ignorancia la mando publicar por Vando, y fixar en los Parajes, y Lugares convenientes. Mexico y Septiembre veinte y tres de mil setecientos y sesenta y tres.)

El Marqués de Cruillas.

Por mandado de su Exc.

Bando⁴⁷¹ of Joaquin Monserrat, 1773, Mexico.

⁴⁷¹ AGN, bandos, vol. 5, exp. 76, fs. 258.

Ficha técnica

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Características:

AKEPOX® 3000 Mini Quick es un pegamento de dos componentes, de aspecto gelatinoso, sin disolventes, a base de resina epoxi con un endurecedor poliamino modificado. El producto se caracteriza por las siguientes propiedades:

- endurecimiento muy rápido
- fácil de dosificar y mezclar con el sistema cartucho
- encoge muy poco con el endurecimiento, resultando una tensión mínima en la capa del pegamento
- muy buena resistencia a los álcalis, por eso es adecuado para pegados con hormigón
- excelente aptitud para pegar materiales estancos al gas por la ausencia de disolventes
- buena aislación eléctrica
- apto para el pegado de materiales sensibles a los disolventes (por ejemplo el poliestireno expandido, el ABS)
- el producto no tiene tendencia a cristalizar, por eso no hay problema de almacenaje y buena seguridad de uso
- clasificación según la cooperativa de construcción: **GISCODE RE 01**

Campo de aplicación:

AKEPOX® 3000 Mini Quick es un pegamento que se puede emplear universalmente para el pegado de piedras naturales así como piedras artificiales, metales (hierro, acero, aluminio, cobre), madera, cerámica y diversos materiales sintéticos (PVC duro, poliéster). Debido a su consistencia gelatinosa, el producto tiene una muy buena firmeza sobre superficies verticales. El producto es, debido al endurecimiento muy rápido, excelentemente apto para trabajos de montaje, así como para pegar letras y tarugos. AKEPOX® 3000 Mini Quick no es recomendado para pegar poliolefinas (PE, PP), siliconas, FKW (teflón), PVC blando, PU blando y butilcaucho.

Modo de empleo:

- A. Sistema con cartucho
- sin boquilla mezcladora: utilizable como aparato dosificador
 - con boquilla mezcladora: utilizable como dosificador y mezclador
1. Limpiar cuidadosamente las superficies a tratar y volverlas ligeramente rugosas.
 2. Quitar el cierre del cartucho e introducir el cartucho en la pistola, accionar la palanca hasta que salga el material por los dos agujeros, enroscar mezclador.
 3. Utilizando el sistema sin mezcladores, mezclar bien los dos componentes.
 4. El tiempo de manipulación de la mezcla es de aprox. 3 a 4 minutos (a 20°C). Después de aprox. 30 a 60 min. el pegamento tiene un buen endurecimiento inicial. Las piezas pegadas son cargables después de aprox. 3 a 5 horas (a 20°C). Resistencia máxima después de aprox. 24 horas (a 20°C).
 5. Los utensilios de trabajo pueden ser limpiados con AKEMI Nitro-Diluyente.
 6. El calor acelera y el frío retarda el endurecimiento.
 7. Almacenado en un lugar fresco es utilizable durante al menos 1 año.

Consejos especiales:

- AKEPOX® 3000 Mini Quick no es apto para el pegado expuesto a la humedad.
- Las superficies metálicas deben ser vueltas rugosas antes del pegado para evitar una disminución de la adherencia.
- El pegamento ya espeso o gelatinizado no debe ser utilizado.
- El producto no debe ser utilizado bajo 10°C, porque no se obtendrá un endurecimiento suficiente.
- El pegamento, una vez endurecido, tiene la tendencia de amarillear por la acción del sol.

- El pegamento, una vez endurecido, no se puede quitar con disolventes, sólo mecánicamente o con altas temperaturas (> 200°C).
- Cuando es utilizado correctamente y una vez endurecido el producto no es nocivo para la salud.
- Utilizar sólo boquillas mezcladoras originales AKEMI.

Datos técnicos:

1. Componente A + B: Color: blanco lechoso
 Densidad: aprox. 1.16 g/cm³

2. Tiempo de manipulación

a) Mezcla de 75g componente A + 75g de componente B

a 10°C: 8 a 9 minutos
a 20°C: 3 a 4 minutos
a 30°C: 2 a 3 minutos
a 40°C: 1 a 2 minutos

b) a 20°C y diferentes cantidades

15g componente A +	15g componente B:	}
40g componente A +	40g componente B:	}
75g componente A +	75g componente B:	} 3 – 4 minutos
250g componente A +	250g componente B:	}

3. Proceso de endurecimiento (dureza) a 20°C en una capa de 2mm

<u>15 min</u>	<u>30 min</u>	<u>60 min</u>	<u>2h</u>	<u>3h</u>	<u>4h</u>	<u>5h</u>	<u>24h</u>
30	35	36	43	48	50	52	63

4. Almacenaje: aprox. 1 año en su envase original bien cerrado en un lugar fresco.

Consejos de seguridad: Ver ficha técnica de seguridad CEE.

Observaciones: Estas indicaciones corresponden al estado actual de los conocimientos y de las técnicas de aplicación de nuestra firma. Como la aplicación y tratamiento del producto se encuentran fuera de nuestro campo de control, la responsabilidad del fabricante no está condicionada por el contenido de esta ficha técnica.

Annex 3.

Interview with Enrique Quintero.

- Place of interview:
By Skype.
- Date of interview:
08.05.2013.
- Language of interview:
Spanish.
- **Preguntas.**
 1. ¿Cómo definiría usted a la luminotecnia en el contexto del patrimonio urbano⁴⁷²?
 2. ¿Cuáles son los factores que usted considera en el diseño exterior de la iluminación en el patrimonio urbano?
 3. ¿Cómo podría el contexto circundante ayudar u obstaculizar el diseño de la iluminación?
 4. ¿Qué criterio teórico conservacionista aplica usted para la protección del patrimonio urbano en el diseño de la iluminación?
 5. ¿Qué medidas implementa usted para evitar la contaminación lumínica?
 6. ¿Cuál es su opinión con respecto al uso de “media facades” o “video mapping”?
 7. ¿Cuáles son las nuevas tendencias y retos tecnológicos en la iluminación del patrimonio urbano?
- **Respuestas.**
 - 1) El patrimonio urbano es difícil de clasificar para la luz. Hay ciertos tiempos, monumentos y demás que llevan cierto tiempo. Como un ejemplo podríamos poner aquí en México los que están hechos en el siglo XVI. Todos estos monumentos fueron hechos no para ser iluminados artificialmente sus fachadas. Algunos de ellos contenían digamos instalaciones o nichos, elementos hechos originalmente para una

⁴⁷² Patrimonio urbano se refiere a los edificios o monumentos históricos que conforman la herencia cultural de una ciudad.

iluminación interior, pues yo pienso que en cuanto a las fachadas debe de haber una iluminación muy sobria, que no toque para nada la estructura de la arquitectura, ni dentro ni fuera, es decir, tendríamos que ser muy estrictos porque no sabemos si hacemos una instalación ahora y en 50 o 100 años, las (instalaciones) son distintas, pero ya dejamos agujeros, ya dejamos algo que ya está afectando a la arquitectura.

Por eso yo pienso que se tiene que ser muy sobrio, extremadamente cuidadoso en eso para la preservación. Desgraciadamente en las regulaciones o reglamentos de este tipo de construcciones, hay un ámbito que no está muy claro para esos puntos. Yo he visto muchas construcciones de esa época que inclusivamente más antiguas, que tienen diferentes intervenciones, algunas de ellas muy agresivas, y todas fueron autorizadas por el gobierno. El gobierno pues son temporadas pequeñas de tiempo en el contexto del tiempo de las construcciones, son fracciones nada más, cuando se toman decisiones importantes en un monumento que se pretende que se preserve, que se () siglos, nada es eterno. Pero darle ese cuidado es respetar la historia. La iluminación ya está concebida para arquitectura moderna, contemporánea, en donde se puede hacer todo, donde se puede integrar. Eso es lo que yo creo. En la noche hay vistas muy interesantes de fachadas que son muy tenues y que tienen o dejan inclusive muchas partes en sombra, esas son las que más creo que son las indicadas y luego el tono de colores, unas que las ponen en azules, en rosas, morados para dar un efecto un poco más dramático y ahí es donde creo que la tonalidad debe estar muy restringida, en los tonos blancos en algunos calidos desde luego, llegando hasta inclusive a 2000 grados Kelvin. Y no pasar de frio, no llegar a los 5000 grados kelvin. ... Esto en la experiencia que yo he tenido a lo largo de mi carrera, viendo estos ejercicios, estamos hablando de casi 30 años.

- 2) Una señalización histórica. Es decir, hacer un énfasis en la parte importante desde el punto de vista histórico de la construcción, otra de accesos, porque debe tener una conexionalidad, esta iluminación indicando, seguridad también. Esta seguridad estará integrada a los arroyos, a las comunicaciones viales que tengan esta construcción. Y finalmente el arquitectónico, debe de haber un concepto arquitectónico, un análisis de este y destacar los puntos más interesantes, más arquitectónicos que habría que destacar. Haciendo un balance de esto que quede balanceado este criterio.

- a. Dentro estos factores, ¿también considera usted la historia del edificio?

- i. Si, desde luego, la historia del edificio. La historia del edificio, como que tiene dos ramales, por así decirlo, uno la historia en el contexto que fue construido el edificio. Puede tener un valor político-social, un valor inclusive religioso, en donde hace una buena diferencia, y el otro, la historia de la construcción, es decir, hay construcciones que tienen una historia interesante, en el sentido que fueron construidos por ejemplo en etapas, y las etapas pueden estar, he se nota en ocasiones. Frecuentemente, y eso lo digo en el caso de México, hay construcciones prehispánicas debajo de una construcción colonial, ahí es difícil, entonces ya esta arquitectura es totalmente eh explorada en cuestión de tiempo y de cultura, son dos culturas que son muy diferentes y están asignadas a un mismo sitio. Entonces esto le da un carácter muy muy especial. También el entorno en el caso de México, y de seguramente en otras ciudades, estoy pensando en Roma, por ejemplo, hay espacios arquitectónicos que tienen tres culturas en un mismo lugar. Tres culturas que tienen una diferencia arquitectónica total, pero están conviviendo en un mismo sitio. Pues las historias pueden tener como capas, diferentes visiones.
- b. Ósea ¿que por decirlo así sería el contexto circundante, a usted le ayudaría o le perjudicaría en sus diseños?
 - i. La parte circundante, a veces se toma como una polución en cuestión de luz. El objeto arquitectónico que es considerado como patrimonio, a veces está rodeado de arquitectura moderna y de una iluminación que a veces la tapa, entonces algo que se puede hacer en la fachada es, o algo que se pueda hacer con esta construcción, tendría que competir con el entorno, para eso habría que hacer levantamientos de niveles de iluminación generales, para establecer esto a base de contrastes. Entonces, un elemento arquitectónico que está aislado, es un poco más fácil. Los niveles de iluminación pueden ser muy bajos y con eso lograr muy buenos resultados. Si está muy contaminado arquitectónicamente, desde el punto de vista de iluminación, eso es importante considerar, habría que establecer un contraste más fuerte con los niveles de iluminación, para que destaque. Una cosa es que destaque de todo lo demás y otra cosa es que también se funda en un paisaje, para que se integre, esa es otra posibilidad.

- 3) Primero, una regla básica es que las instalaciones estén en la periferia. Me refiero a la iluminación exterior. Deben estar en la periferia y colocados en elementos independientes de la arquitectura. Generalmente estamos acostumbrados en ver la iluminación de los monumentos, con la luz cenital, con la luz natural. La iluminación artificial plantea que se haga desde abajo en muchas ocasiones. Balancear eso para que estos elementos o estas estructuras den una iluminación también en algunos casos desde arriba. Eso sería básicamente. Desde luego, toda la instalación eléctrica, de control y de más puede ser que este adentro, pero se puede hacer una especie de site externo, para que todo esto esté fuera de la influencia de la instalación arquitectónica.
- 4) Actualmente las cuestiones de certificación y demás que se han visto, se pretende no lanzar la luz hacia el cielo. Eso contamina el cielo mismo, no permitiendo ver las estrellas y en fin. Tener estos puntos. Va un poco aunado con la respuesta anterior, de lanzar las luces desde abajo. Hacer lo menos posible esto y hay programas que se dedican a analizar toda la cantidad de luz que sale del inmueble hacia el exterior, hacia arriba. Ese punto sería muy interesante tener. También se podría tener en porcentajes, en cuanto a la superficie de las fachadas en ciertos edificios y clasificarlos por antigüedad, por ejemplo, concederles el 10 o 12 % de la superficie total de las fachadas. Iluminar nada más esa parte. No hacer una iluminación profusa, exagerada. Cual sería un criterio de una fachada exagerada y cual no? A través de esos porcentajes, digamos que se podría establecer una cantidad. En cuanto más antiguo sea el monumento, requiere yo creo que de menos iluminación, llegando hasta quizás el 5, 4 o 3% de la superficie de la fachada. Otro criterio se aplicaría para la cuestión de interiores. Quizás un poco más complejo.
- a. Esos porcentajes de seguro variarían de acuerdo al color del paramento. ¿No es así?
 - i. Si, desde luego, he si estamos hablando de una construcción muy clara, Esos porcentajes pueden bajar. Porque son superficies que reflejan. Desde luego que sí. Otra cosa sería la rugosidad del material que se está iluminando, no distorsionarlo. Como un buen ejemplo es el David de Miguel Ángel. Esta escultura famosa, está iluminada, imagínese el compromiso de la gente que está iluminando una escultura de ese tipo. ¿Cómo se tendría que hacer? Habría un criterio de que se ilumine esa escultura como lo tuvo el escultor cuando la estuvo realizando. Ese podría ser un parámetro. ¿Cómo sería

entonces? Utilizar la luz natural, porque evidentemente en ese entonces no estaba iluminando la estructura con reflectores artificiales para hacerla. Entonces hay una gran variedad de criterios. Todos estos criterios tendrán que ser culturales y dependerán de la cultura del sitio. Al que están acostumbrados. Pero un criterio general es este, no contaminar el cielo, ese es un buen punto. No hacerla exagerada la iluminación en cuanto a cantidad de iluminación y también en cuanto a los colores. No desvirtuar. Imagínese la obra de Miguel Ángel en un tono morado. Que es lo que opinaría el autor en cuanto a estos tonos, ¿verdad? Podemos tener sorpresas, digamos que reviva Miguel Ángel y que vea el David en un tono morado y diga; Excelente. No sabemos. Estamos recreando una obra artística bajo conceptos muy ambiguos y ahora tenemos otro criterio visual, artístico, estético.

- 5) Esos trabajos se hacen en relación de eventos, no lastiman, pues son proyectores que se ponen solo en cierto tiempo, nada más. Son proyecciones que no lastiman a la construcción, y pueden ser muy interesantes efectivamente eh siempre y cuando sea para eventos, especiales, dos o tres veces al año. Un evento de iluminación, un evento de conmemoración de ese lugar. Yo creo que son muy interesantes. Desde luego que hay muchas fachadas en donde se puede hacer eso. Se antoja mucho hacer eso con una fachada antigua porque se junta algo de hace muchos años con algo actual, en una sola superficie, y se pueden hacer cuestiones creativas muy muy interesantes, que se pueden filmar y preservar. Aunque sea un evento por unos cuantos días. Es un espectáculo que también tiene audio, donde convive la gente, hay una interacción. Yo creo que es muy interesante, porque preserva y no lastima. Siempre y cuando la instalación que se haga no sea invasiva con la arquitectura.
- 6) Yo creo que tenemos muchas ventajas, por ejemplo, hay unos sistemas de control que se manejan por radio. Este sistema de control por radio he tiene un gran beneficio, porque no se tiene que hacer cableado, es decir, un sensor se comunica con un apagador, o da unas instrucciones vía radio. Entonces eso baja mucho la instalación eléctrica que es la que puede ser la agresiva con el patrimonio. Tenemos ahora muchas ventajas, en unos años más habrá mejores avances en la potencia, en el consumo, en el control de la iluminación y eso va a ayudar muchísimo. Ahora, actualmente podríamos pensar que estamos en el futuro, podemos hacer ahora muchísimas que hace un año, un año de tiempo, comparado con lo que estamos

iluminando es apenas una brizna de tiempo. Como decía Carl Sagan. Nosotros tenemos un tiempo muy relativo, relativo a nuestra vida en esta tierra, pero esta tierra y lo que nosotros hemos hecho antiguamente maneja un tiempo muy muy muy diferente. Podemos pensar con una visión, cuando hacemos un diseño, una visión de tiempo, decir, por ejemplo yo estoy diseñando para que esta instalación se pueda preservar en 50, 100 años, cuando menos los puntos de instalación, y que estos sean flexibles para que estos puedan recibir otras técnicas que necesariamente van a estar llegando, a lo largo del tiempo y en un tiempo muy corto. Entonces, hacer las cosas así es algo muy difícil, cuando estamos diseñando esto, pensar que esto pueda estar, preservarse cuando menos en sus puntos más esenciales de instalación en 100 años. Eso es un muy buen ejercicio. Esto va también para la arquitectura moderna, desde luego.

- a. Hablando de que la instalación es necesariamente temporal, diseñando con una duración de 100 años, guardando los puntos focales ¿no es así?
 - i. Así es. Digamos la pirámide que está en el museo de Louvre en París. Yo creo que ha recibido unas 4 remodelaciones en su iluminación, y es una pirámide moderna, que tiene muy pocos años de haberse puesto ¿no? Es totalmente contemporánea, ha tenido ya 4 remodelaciones de iluminación. Ha pasado de halógenos a unidades de descarga, a fluorescentes y ahora actualmente con LEDs, sin embargo la estructura, el concepto de iluminación en cuanto a los efectos y a lo que debe de hacer la intensidad de iluminación se ha preservado, es decir que el proyecto original sigue vigente actualmente y lo que han cambiado son las unidades de iluminación. Se han actualizado, digamos, pero el concepto de iluminación se ha preservado. ¿Qué quiere decir esto? Que este concepto cuando se hizo en un inicio, estuvo bien pensado en todos los aspectos, no nada más en los aspectos humanos, en los aspectos arquitectónicos, los aspectos de atracción hacia un monumento muy muy importante y definitivamente distinto al sitio en donde se está construyendo, entonces era como un reto, entonces se tenía que hacer algo muy sutil, algo que se tendría que ver en este tiempo bien y en 100 años también.
- b. Arquitecto, ¿usted diseño el proyecto de iluminación del monumento a la revolución en la ciudad de México?

- i. No, he se lanzó un concurso y lo ganó algunos de los diseñadores de los cuales formamos un grupo, sin embargo entró una compañía externa y cambió todo el diseño. Si uno va a ver este monumento, uno podría pensar que este diseño es exitoso, interesante que es vistoso, sin embargo un análisis un poco más estricto arquitectónico y desde el punto de vista de iluminación, podríamos decir que tiene muchos puntos que no son adecuados, ni en la preservación del monumento, aunque no es tan antiguo, ni en lo objetivo principal. Pensamos y eso lo hemos discutido los diseñadores aquí en México, que ha sido exagerado. Digamos que la ciudad de México es una ciudad muy grande, que si sería bueno que tuviera un consejo de expertos en donde sino tomara decisiones, si aconsejara que hacer con algunos monumentos y alguna directriz, algún reglamento algunas opiniones generales para que todos estos elementos arquitectónicos que conforman la ciudad, crean un hilo conductor en cuanto a la iluminación. No estamos en desacuerdo que se hayan fijado colores ahí. La construcción es prácticamente moderna, digámoslo así. Sin embargo estuvo muy exagerado y la instalación de los equipos no se hizo al 100% bien, adecuada, como que hubo descuidos, eso no importa que lo diga yo, basta con darse halla una vuelta y ver cómo están colocados los equipos a simple vista se pueden ver. Lo que quiero decir y que se me hace interesante tu pregunta, es que el diseñador de iluminación debería tener en su propuesta mayor respeto. No se le considera como un arquitecto, no se le puede considerar como un científico o como un técnico, ¿verdad? Aunque esto podría tener un poco más valor de peso y de opiniones y un mayor respeto a su proyecto.

7) ¿Qué software utiliza usted para el diseño de la iluminación?

El software que he estado utilizando es el AGI 32, aunque es un programa muy pesado, da resultados muy realistas digamos, sin embargo la utilización de programas un poco menos sofisticados pero más rápidos, lo prefiero para hacer, para tener vistas. El programa de cálculo a mí me sirve, porque compruebo algunos datos técnicos de cantidades de luz, de cómo se va a ver, tener una idea. Pero como comentaba en una ocasión, ese programa no hace el diseño, es una herramienta

más, es un lápiz, ¿no? Con el que yo estoy diseñando. No sé si es en base a como recomendación, utilizar el mejor que se pueda, sin embargo tenerle también su justa dimensión, que es una herramienta. Lo más importante, lo más difícil es para cualquier profesión creativa es precisamente el talento de inventar, de crear algo aparentemente nuevo, porque ahora es difícil crear algo que no se haya ya visto, pero si una combinación de efectos que llamen la atención, que produzcan y que embelesen al ser humano y que lo hagan tener asombro, es difícil en estos días.

- 8) ¿Cuál es el papel que desempeña la función de los edificios en el diseño de la iluminación?

Podríamos pensar que una cuestión es el carácter, el carácter de la arquitectura. Otra cosa para tomar en cuenta es; ¿para que se hizo esta arquitectura? ¿Qué significado esencial puede tener religioso? Institucional, en fin. Analizando todo eso, he ponemos a la arquitectura como una persona, que perfil histórico, psicológico puede tener, y de ahí nosotros podemos pensar, que característica debe tener la iluminación para destacar esto. Esa es una, otra es vamos a iluminar algo que aparente debe de ser más sobrio, como una construcción religiosa, pero darle un tono ligeramente festivo, todos elemento de cambio se permiten en una libertad creativa, ósea, podemos romper paradigmas también. Hacer una tienda comercial, por ejemplo, tiene que ser muy vistosa y no hacerla sobria. Uno monumento oficial que aparentemente es muy serio hacerlo divertido, porque la función del gobierno también es la de que la gente se sienta bien y que piense del gobierno que no solo es serio, sino que tiene una visión más acercada a los sentimientos humanos, por decirlo así.

- 9) ¿Cómo influye la forma y la volumetría en el diseño de la iluminación?

Tomando en cuenta que la iluminación es un velo. Es una actividad del diseño que está comprometida con la arquitectura, el arquitecto y el diseñador de iluminación hace una sociedad creativa. En donde uno depende del otro, s decir, el arquitecto propone una forma geométrica y el diseñador de iluminación dice; la voy a destacar o la voy a cambiar o la voy hacer diferente, porque la iluminación tiene esa facultad, cambiar la forma, cambiar los colores, cambiar las texturas. De esa manera podríamos pensar que también se pueden romper paradigmas, es decir tenemos una forma que es un cubo en la arquitectura, podemos por medio de la iluminación que sea un poco más redonda, entonces tendremos una visión doble de lo que es la arquitectura, en el día es un cubo y en la noche la estamos redondeando, porque ese

tipo de libertades creativas la puede tender el diseñador de iluminación con el atractivo de que esto se puede cambiar, la iluminación puede ser cambiada, la arquitectura es más difícil. Tiene otro problema, que el diseño de iluminación no resiste tanto tiempo como la arquitectura, una arquitectura moderna puede durar unos 200 años quizás, la iluminación no, podrá durar cuando mucho unos 5 o 10 años, es un poco más efímero.

10) En el medio físico, por ejemplo tomando en cuenta lo que es el clima, es decir, los vientos, el tipo de suelo, la topografía ¿usted cree que también son factores que determinar qué tipo de iluminación es la que se va a emplear?

Si por supuesto. Digamos que el objeto es lo que se está iluminando, pero también lo que circunda a este objeto arquitectónico y va decreciendo un poco su importancia, en cuanto se va alejando. No es lo mismo un objeto arquitectónico que se está integrando a un eje vial arquitectónico, a un eje muy grande, por ejemplo, lo que está en Londres, lo que es un City Hall, que es un eje arquitectónico que conecta a través de un puente un museo, con una plaza y al final está una iglesia. En onces todos estos elementos arquitectónicos que son diversos pueden ser unidos por medio de la luz, hacerlos un todo, esto abarca mucho más de la esfera que puede tener el museo, la iglesia o la plaza pública. Una vez que vi el espacio, me pareció que fue un acierto arquitectónico integrado, integrar algo que aparentemente era imposible. La iluminación pude hacer esto. Entonces debe de hacer un análisis de la arquitectura y también un análisis urbano. A donde va a llegar su influencia. A veces es tan fuerte que ese elemento arquitectónico iluminado converge en un espacio muchísimo muy grande, más de lo que nosotros habíamos pensado, es una influencia más allá de lo que la arquitectura tiene. Entonces la iluminación puede expandir la importancia de lo que la arquitectura tiene, la potencia en cuanto a sus efectos en la sociedad, y desde luego en el tiempo.

Interview with Fisher Marantz Stone (architectural lighting design firm).

- Expert interviewed:
Paul Marantz.
- Place of interview:
By Skype.
- Date of interview:
11.14.2012.
- Language of interview:
English.
- **Questions:**
 - 1) How would you define lighting in the context of urban heritage⁴⁷³?
 - 2) What are the factors that you considered in the design of outdoor lighting in urban heritage?
 - 3) How could the surrounding context help or obstruct the lighting design?
 - 4) What theoretical conservationist criteria do you apply for the protection of urban heritage in your lighting designs?
 - 5) What measures do you implement to avoid light pollution?
 - 6) What is your opinion regarding the use of media facades or video mapping?
 - 7) What is the new trend in lighting technology of urban heritage?
- **Answers:**

A lot of buildings of the period that you are discussing were to be seen with daylight because there was not electric light at that time. They use some candles during the night special for Christmas or something like that.

One of the questions of lighting that I am concern is that how light the building in the knowledge that in fact that it has really to be seen at daylight, rather the lighting system is made by contrast a clear vision of what your intent is in terms of what in the building has to be seen original. Now it is ridicules to believe that we in the 20 th century can see with the 16 century eyes. We can't, we bring the whole world information and technology that we

⁴⁷³ Urban Heritage refers to buildings or monuments that form the cultural heritage of a city.

don't even think about it into our ideas of seen. Nevertheless, it is very important that you sit in a beautiful gothic cathedral, and watch the sun shine into the glass windows. You can have an idea what the architect had in mind. And it is important I believe to remember that.

The harms of the buildings: Physical and Aesthetical.

They are the two issues, the physical side it's probably just a matter of technique and developing, in the way how it's going to interface with the building. The heating people have the same problem, the air conditioning people have the same problem, everybody has the same problem. To bring this kind of technology to the building gives a conflict to deal with. That's really a matter of technique and it is the less physical side.

1) Different buildings have different needs, in terms of their responses, there are spiritual buildings, there are government buildings and there are heroic monuments that their aims are to describe the strength of a government, and they are artifacts of history, each one has a different response.

The functional buildings in the urban context today, is basically to establish the bona fide of the place in terms of the history, of strength, wealth, it's power, this kind of things are built to convey and the way you light them has to do with what they aim to do in today's context.

What we need to do with our history, is our history makes them a world heritage sites, the people will come a treasures like Cambodia, etc.

The urban heritage is what we have left over the past, what we do with our past is a very complicated question.

2) What is the goal? The idea of any light designer is firstable to establish what the goal is. If you want the building to be visible at night, what is the reason for it? Why you want to make it visible? It is for tourism, demonstration of power, is it for economic reasons, are you renting the building and you want to attract clients. The main reason is that now we have an active day that run until midnight, we actually have light at night that we never had when these buildings were built.

Any light designer wants to celebrate the material you see. So, you have to consider the material, color of light, and all these.

The best true, any lighting design, any time, it doesn't has to do with historical. In the world of architecture, all this issues are the same issues. I don't think there are different issues for historical buildings. I think the whole challenge of deciding how to light is all they have different requirements.

It is all about to continue the story and bring it to the present.

The function it is important. People who stay there maybe have any idea or maybe not that they are sleeping in a convent.

We want to enable the people to understand what the history is, if they care and make it visible if they want to look. I guess, maybe the 10% of the guess actually do, and the rest just see it a very nice place to stay.

3) (If you light a building you give darkness to the context) All light is related to darkness. Because we don't attempt to recreate like a day time. The surrounding buildings are not part of the project, but it is our responsibility where you can see the surrounding buildings, to make sure that we don't deface the street, because it's part of a narrow street, and we do not attend to compete with the urban context.

4) There is always theoretical basis. Use should be able to say what is the idea of lighting design is in words and image, and how it is related to the building and the concept. In any urban requirement, you should be able to do that, and when you understand what that is, because it has theoretical basis.

5) It is almost a hopeless to avoid light pollutions, at least in the big cities like New York, because there is a gigantic concentration of people.

Sometimes the upper lights are crucial.

6) Video mapping, it is an art idea. I don't think it is a light idea. It is an art idea.

One of the thing that any design, has to achieve a kind of timelessness. Not to be something that you put temporary.

Media facades are necessary temporary.

7) LEDs.

Interview with RDV Collectif.

- Experts interviewed:
Gordon Selbach (Germany) and Victor Meesters (France).
- Place of interview:
The interview took place at the “Platz der Demokratie” in Weimar during the festival for audiovisual projection mapping. The event was organized by Genius Loci, who commissioned the french-german artist collective RDV to produce an audiovisual mapping performance for "Fürstenhaus", a historic landmark in the german cultural city of Weimar that is today home to the Hochschule für Musik Franz Liszt Weimar.
- Date of interview:
12.08.2012
- Language of interview:
English.
- **Questions:**
 - 1) How long does it take to produce a video mapping?
 - 2) What softwares do you use to produce a video mapping?
 - 3) What kind of projectors do you use?
 - 4) How do you determinate the distances and the number of projectors?
 - 5) What is the main objective to use video mapping?
 - 6) What are your expectations? What do you expect from the people?
 - 7) How do you choose the building to work?
 - 8) Who decide it?
 - 9) What are the characteristic that the building most have for a video mapping?
 - 10) It doesn't matter if it is a historical building or new building?
 - 11) Is there any topic for the projection?
 - 12) Do you take into consideration the protection of the building?
 - 13) Is there any previous study related to the impact of the heat and the vibration of the building and of course about the environment?

- **Answers:**

- 1) It depends on the work. Like this one, for the façade half an hour. We have been working with it like one month ago, with two persons. The effects take three days.
- 2) With everything, like adobe suites.
- 3) With the projectors we find, we don't have our own. For this event, we have projectors of the university. There are six projectors, each one with 20000 lumens.
- 4) The best thing is to test. Every projector has different features. We check if the angles, size, light, brightness, resolution are ok. The best thing is to test.
- 5) For me is a hobby, I just try to experiment some kind of architecture, we want to find another way to make space and people involving to a new space. It is some kind of fascinating thing, the night effects comes to live and everything moves. The contemporary concepts, you build a new building with lights.
- 6) Just to spend good time. If you look at this building. We don't see it as a screen, but we actually use the architecture elements like the columns, windows, frames.
- 7) We don't decide them. We are invited.
- 8) I think the festival's committee.
- 9) This one has more details.
- 10) I think, it is also nice to work with a modern building. Modern buildings are more flat. In the old style, we have columns, windows, etc.
- 11) Yes, noise. This one is the universe, how it was created. We respect the buildings and we show its qualities.
- 12) No, we don't.
- 13) We should do that, but we never have the time, or the information. We should do that. This building has been here for more than 200 years, so. We are not projection on the building every day.

Interview with Ethereal Designs (consultancy firm in the field of architectural lighting design).

- Experts interviewed:
Jaspreet Chandhok & Vilas Prabhu
- Place of interview:
By Skype.
- Date of interview:
11.21.2012.
- Language of interview:
English.
- **Questions:**
 - 1) How would you define lighting in the context of urban heritage⁴⁷⁴?
 - 2) What are the factors that you considered in the design of outdoor lighting in urban heritage?
 - 3) How could the surrounding context help or obstruct the lighting design?
 - 4) What theoretical conservationist criteria do you apply for the protection of urban heritage in your lighting designs?
 - 5) What measures do you implement to avoid light pollution?
 - 6) What is your opinion regarding the use of media facades or video mapping?
 - 7) What is the new trend in lighting technology of urban heritage?

- **Answers:**

- 1) Jaspreet Chandhok

a) *Illuminating a monument, space or symbol of historic significance while maintaining the dignity & charm of its cultural value against the background of the current day urban development and corresponding nightscape.*

When we think in the context of urban heritage, we talk about lighting a monument, when it is taking a special care to recreate the history behind the structure and whatever the ancient philosophy of architecture in that place, while considering the existing background, the existing skyline and the current city

⁴⁷⁴Urban Heritage refers to buildings or monuments that form the cultural heritage of a city.

scenario, which probably could be too bright, too much in height in overlooking the monument in our context.

1a In your experience, what do you think are the problem of lighting in U.H. that you face?

- Jaspreet Chandhok

Well, because this kind of factors, which become relevant for any lighting design project, we will not talk about those, specifically talking of urban lighting in a urban heritage outdoor environments. Very important is the style of architecture & lighting techniques relevant to that era, and if such light techniques can be integrated in the current scenario. Then secondly the scale of the structure relative to the neighboring architectural environment, like very often the heritage monuments, they are not skyscraper, or they are not very tall, the city ... the main skyline could be the (the body) Particular monument in the context, so the scale, the style, and the, in the existing backgroundregarding the urban style line, are the details of this particular monument, which monument ... details of been lost, you know, this, what lighting could do is selectively bring out into notice some details and probably overlook some depending on what really the monuments stands for, so, of course if there's mood/ atmosphere that the monument demands, for example; if it is a church as against of if it was a depending of what mood the space demands..... and the socio-ecological considerations & particular emphasis to sustainability. In the sense that a (that's there's) no damage to the structure.

- Vilas Prabhu

When we talk about urban heritage, we will try to put it in this context. Most of the heritage structures are not very tall, compare to other structures. Ok this is number one, number two, also has been found basically look after, images, photographs, something that could help to interpret in the movies, such kinds of civilization. What we have found, I like to light very often, highlighting each really aspects of the architecture universally, very close, quite selective. So probably if you can recreate that kind of atmosphere today. You don't have even to highlight every aspects of the monument or the heritage structure. Much people back into those days in the streets, they told me what was the atmosphere.

2)

a) *The standard factors: location, surroundings, angle & distance of viewing, features, material, finishes, ecological factors, installation, maintenance, cost (capital & running), sustainability etc*

b) *Specific factors: The style of architecture & lighting techniques relevant to its era of creation. The scale relative to the neighbouring architectural environment, the smaller architectural details or art work in the context of the scale and conservation, the mood/ atmosphere that the monument demands. socio-ecological considerations & particular emphasis to sustainability.*

- Jaspreet Chandhok

The street light in the neighborhood, the colour on the monument, the colour in the neighborhood. And relative the high that we have talking about, I think we have been talking about high elements, or relatively high with respect to the neighborhood, and additionally the street light which is receiving, which may not concern depending on, how, in what kind of location of the monument is. Particular when we talk about urban context in very often overcrowded cities you would probably not find the monuments, I believe it, it would have an impact of the lighting from the streets, or near environment or other architectural structures which are illuminated.

2b. How do you decide what colour of light you are going to use?

- Jaspreet Chandhok

That's completely contextual, for example, we had made lighting project of the Western Railways Head Quarters, which has a architecture. With stone and white plaster, there we prefer so we use yellow light on the stone, because is not render all the colours. Kind of, give you feel the history. Where it was white or plaster, there white light was used. So, in some structures where there's a lot of loud lighting in the neighborhood, there we also use colours, like for example, we use blue, cyan, but in very small proportions and on very small (issues), not really illuminating (major) sources, we also in certain locations we use amber, and very rarely red, which is particularly, at the high ... the most of the structures, or when the evening sky, when you sit against the evening sky, and then you can feel the setting of the sun.

So the colours are very natural, and they are taken from the nature, that's what we feel, rather than been very because, probably it doesn't go with historical structures, the others colours go with technology more than the environment. Which It is not the context when you are working with this kind of structures.

Note: (It depends on the material colours) they take the colour of the nature, because the modern colour lighting is not for this kind of context).

- Vilas Prabhu

I just go back to the same thing, when we are lighting a heritage structures, I want to see the people go back to those.

People want people to use the technology. They want the experience, how this objects would have looked in those days, so specially talking about, probably in such case the people would have used a warm tones, I would take any colour, but I would play probably with a little bit intensity in that direction, the colour would be in the warmer side, because in ancient days there was only one colour of artificial light, or the people used fire, so the colour was warm. So I'm not strict to warm colours, Ok, you have a dance club in a very ancient heritage structure, so you can use any kind of colour, but yes, as I told you before, the variation would be probably in the intensity.

3)

- a) *skyline, spill, colours, relative height*

(*Amanora town centre mall*)

- Jaspreet Chandhok

Well sometimes, like I spoke about, in some heritage structures we use very low level of light, sometime the surrounding lighting. It is something that you deepens on, particular in urban context and dense cities, were you find a lot of within kilometers of space, the streets lights from an approaching road, the lights from the, or sometime the reflecting lights of the neighboring architectural structures, becomes something which will, rather you like it or not, it would contribute to in some sense to your structure as well. So white lighting sometimes, you can actually take advantages of that, and like the given example, we can actually have laser visual blocks, for example in the case of large landscapes you can have laser for lights depending on something, some other structures in the surrounding because of the reflect of light, you can have laser visual blocks in your, but at the same time, sometimes when you are doing something of specific of controlling, very minimalist details of carry architectural then the street lights probably will coming in the entrance, because the direction of light that you want to cause, having this impact in the context of the background the reflecting lights that's is already receiving. So yes, it can help because sometime you can actually

use that as a background toit will determinate the lights levels, ... to complete the dark background that you need.

3a. And the background remains dark?

- Jaspreet Chandhok
Sometimes the dark context helps and sometimes even the light context is maybe an advantage because you get some street lights. Whatever it is the context you have to consider it and go ahead.

4)

a) Haven't applied any recorded theories in architectural lighting. Lux-hour concept has been applied in delicate artwork which incidentally has always been in an indoor environment in our projects.

- Jaspreet Chandhok
Actually, frankly we do not have the chance to apply any theories in outdoor lighting, but when we have found frescos and painting then we use the concepts. In outdoor we didn't apply any theories. We just Points of not having to damage the structures using conducts externally and factors of that kind, but not Theories.

4a. In India is not necessary to support an intervention by a theory?

- Jaspreet Chandhok
There are some basic rules, I don't say that's there is a Theory, but there are some basic logic points to follow, as I told you, having not exposure conducts, do not have wiring within the structures. We don't have any kind of council work.

4b. How do you hold the lamps and the wire?

- Jaspreet Chandhok
You can always use nails. You can have always the conducts on the surface of the structure, spikes or conduits, and then you nail the clamp. When you nail the structure is not that much damage that you are causing as against if you were confine the conduits into the finishing So, that's a compromise, that the conduit more significant than the lighting of the structure is the conservation of the structure, the sustainability of the structure itself.

5)

a) *Smaller component of uplight, limiting the illumination of dense trees, angles of throw, controlling trespass, using flat beams or elliptical beams to avoid skyward spill*

- Jaspreet Chandhok

Using smaller sources of uplight, I don't say that we avoid light pollution, no it doesn't happen, because finally your vision of viewing the structure is mostly upward, from human eye level perspective, so you look upward, so if the light is put on the top facing down, then you will see the sources of light more than watch, so the factor is that we have to, very often depending on lighting, I won't deny that, but at the same time we always try to get so particularly more LEDs are coming to the market, flat beam optics, but using this things you can actually do uplighting, inject control the kind of light beam that's is going to the sky.

- Vilas Prabhu

I think today's technology, they are very precisely, so all these will helps us to avoid light pollution.

6)

Factors that may demand it are busy surrounding environment, shallow depth of field, dense traffic locations... in which case we prefer slow dynamic graphics over videos.

- Jaspreet Chandhok.

Well in case of the context that we are talking about, the historic structures, I don't think we can. Well this things always needs the advance of technology they are very today, they are very significant lighting ideas, they sell very significant ideas, the it will be more notice than the background which you are really lighting up. So in very rare impact, I don't think we have used video mapping in historic structures, in fact, even in modern structures we use this things only in very rare circumstances, where there is and you really have to fight for attention, the building has to fight for attention, even in that situations we don't really use video. Instead we use slow motions graphics, which suppose to drive you parallel to the structure, because this things usually becomes relevant because it causes moving traffic and you really need to fight for attention. This is the idea of using dynamic lights.

- Vilas Prabhu

In case, let say that video mapping is been used to express or communicate very historical significant monuments, in that case, rather idea of lighting some, is much better, so the people are coming around to have lights moving

around and then you have in the background of Hollywood and then you will see the story and the history of the structure. So probably, I would like to go forward in the case of that Video mapping is been used to communicate the history.

6a. Have your lighting projects a message to the people?

- Jaspreet Chandhok

Yes, one of the things that we increasingly see is, that competition is not in the quality of light, but people try to have this structure, or the people try to increase the level of illumination to get a stand of. even if we are doing just a detail, or even if we are doing a showroom in a part of a Mall, which is a lot of light in common spaces and in the neighboring shop, we try to keep our lighting level in control, in fact low, and just giving significant to the product on the space rather than illuminating everything in competition with the environment, so exactly that's happen because, probably a ambient light will be low, but you are, much in that intervention is actually becomes let us competing in terms of numbers but automatically standing out, for what in terms of outlet is (men) to said. So the message thing is just about distinguishing how much is sufficient rather than what are doing the neighbor, yes, I think particularly in much heritage structures I recall that we have not use much of light we always use small sources of light, instead of, you know? You can show the magnificent of the structures by highlighting some important features and not really lighting the whole, maintaining the dignity of the space.

- Vilas Prabhu

I think one is the message part and other make the design responsibly. What happens if everyone wants to have everything illuminated? It is good, bad? So, I think, point number one is the message, what you can always communicate, it is that possible? You do, it has to be done very responsibly, do not over light. When we say responsibly, it means, we try not only to get a sustainably design. We try to ensure that the running cost is low, which is one of the ruin the cost of the LED's, so the running cost has to be low. And it depends on the situations, as much as possible, as simples as that, We try to communicate that we are very responsibly to the environment, to our products that we use, to our citizens and to our cities.

6b. How do you protect the environment (Insects, birds, animals, etc.) from the light?

- Jaspreet Chandhok

This is one of the things that we do, we do not upright dense streets, because We selective lightup.

- Vilas Prabhu

We switch different items from different times, which is that the light won't be on from 7 o'clock in the evenings to 7 in the mornings. No. so you have lights gradually go off in certain time, this only give you; a sense of the process of lighting, some sense of security, at the same time we try to respect the psychology of the space.

7)

a) *smaller light sources, tunable white, grazing, dimming, elliptical/ flat beam optics*

- Jaspreet Chandhok

The most common answer I hear to that question is, LED's, but I do not say that LED's by itself is the new trend of lighting technology, the smaller sources which are coming to the market, but not necessary LED's, LED's is just one of the sources, I always stand by smaller sources been the bum of the modern technology and I am disagree with the people who say LED's is the new trend, the smaller new sources are coming to the market, and also, tunable white, grazing, dimming, elliptical/ flat beam optics.

Interview with Dr. Acharawan Chutarat.

- Place of interview:
By Skype.
- Date of interview:
11.29.2012.
- Language of interview:
English.
- **Questions:**
 - 1) How would you define lighting in the context of urban heritage⁴⁷⁵?
 - 2) What are the factors that you considered in the design of outdoor lighting in urban heritage?
 - 3) How could the surrounding context help or obstruct the lighting design?
 - 4) What theoretical conservationist criteria do you apply for the protection of urban heritage in your lighting designs?
 - 5) What measures do you implement to avoid light pollution?
 - 6) What is your opinion regarding the use of media facades or video mapping?
 - 7) What is the new trend in lighting technology of urban heritage?
- **Answers:**
 - 1) I am not sure if we need to define it. My opinion is lighting design principles would apply strategies would be different depending on different urban, social, cultural context and the needs of such location for specific project.
 - 2)
 - Appearance of luminaire that should appear to be suitable for such style
 - Size / material / color of luminaire that should not interfere with architectural features
 - Installation method that should not destroy architecture, safe for public, less wiring

⁴⁷⁵ Urban Heritage refers to buildings or monuments that form the cultural heritage of a city.

- less maintenance
 - Color temperature that is suitable of surface material with flexibility for color changing features for special event
 - Intensity of light source that considers its relationship with background. Minimum light level with visible lighting language that is proper for its position would be best to reduce light pollution and to preserve.
 - Selection of lamp, luminaire and control that is suitable for specific objects.
- 3) It depends on situation and location of such site. Sometimes garden or tree helps for: hiding light source, mounting lighting fixtures, silhouette effect for silent mood, softening atmosphere for friendly mood, creating leave shadow (moon light effect), good lighting designers should be able to adapt such environment into potential in design, rather than seeing as a problem.
 - 4) I have not done project that requires such protection in urban heritage yet. If I would, there is IESNA lighting handbook and other resources available for references. Also there is no regulation on urban heritage exist in our country yet.
 - 5) Beam angle/proper reflector/equipment that is suitable to object with minimal percent of light spill, light distribution that does not cause discomfort glare or disability glare and proper light composition can provide city beautification rather than to light everywhere without strategies, this helps reducing light pollution.
 - 6) If media for moving is displayed once in a while as a festival, it is nice and beyond expectation. But it is not for everyday. It depends on context.
 - 7) Well, social interaction, green/sustainable lighting design, daylight integration, flexible and adaptable features.

7.1 In your experience, what do you think are the problem that you face in lighting design in historical buildings or monuments?

I don't have any questions or problems. These are normal questions and problems that we must solve, depending on context. I enjoyed all projects I did.

I have no chance to go back to take photos to those projects. One project I did for heritage was a palace that belongs to our king's daughter. It is Sra Pratum Palace, 2009, Bangkok Thailand. I had to present work to her directly during mock up or real opening day. So no chance to take any photo. It is a private palace that she lives and used to host important guests only. We renovated and invent LED to

integrated into old-style lighting fixture, instead of to see exposed lamp (see attached pic). And for façade light, we searched for installation location with proper maintenance without glare or being seen if the lighting fixtures are not same style or only lighting effect is needed. I have no pictures. We tried to minimize numbers of lighting fixtures to reduce installation point that would destroy the building. So we had to look for such strategies that light can provide both façade lighting to see detail in short / long distance view and ambient lighting for surrounded garden/walk way.

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Weiterbildung	
Softwares	<ul style="list-style-type: none"> • Autocad • Neodata • Light Wave
Architekturdesign und Bau	<ul style="list-style-type: none"> • Seminar: Denkmalpflege von gebautem Erbe (2008) • Seminar: Allgemeinen Konzepten der Innenarchitektur (2006) • Seminar: Abdichtung und Oberflächen (2004) • Qualifikation zum Bajareques Technik (2001) • Seminar: Bioklimatische Architektur (1997)
Beleuchtung	<ul style="list-style-type: none"> • Tagung: Nachtlanschaft Beleuchtung in historischen Gebieten (2014)

	<ul style="list-style-type: none"> • Seminar: Licht – Illumination und Beleuchtung in historischen Gärten (2012) • Seminar: Architektonische Außenbeleuchtung (2010) • 2. Weimarer Lichttag-Workshop für gutes Licht (2009)
EDV-Kenntnisse	

Softwares:	Autocad, Archicad, 3ds Max, Neodata, Light Wave, Corel Draw, Illustrator, Freehand und MS Office-Programme
Sprachkenntnisse	

Deutsch	Sehr gut in Wort und Schrift
Englisch	Sehr gut in Wort und Schrift
Spanisch	Muttersprache
Auszeichnungen	

12/2002	Universidad Autónoma de Chiapas, Fakultät für Architektur Mit Auszeichnung abgeschlossen, Fünfter Platz der besten Studenten der Generation Nummer 43 der School of Architecture
12/2002	Universidad Autónoma de Chiapas, Fakultät für Architektur Abschluss der Diplomarbeit mit Auszeichnung, Thema: "Anpassung und Erweiterung der Werkstätten im Museum für Lackkunst in Chiapa de Corzo, Chiapas"
Mitgliedschaften	

09/2005 –	Nationaler Ausbilder im architektonischen Bereich. La Secretaria del Trabajo y Previsión Social. (Ministerium für Arbeit und soziale Wohlfahrt, Mexiko)
11/2006 –	Architektenkammer Chiapas, Mexiko
Fähigkeiten / Interessen	

<ul style="list-style-type: none"> ✓ Hohe Kunden- und Partnerorientierung ✓ Gute Beraterkompetenz und diplomatisches Geschick ✓ Teamfähigkeit ✓ Pünktlichkeit 	



Alan Paul Rodríguez Schaeffer, M. A.U. Architekt.

Publications.

Rodriguez, Alan P. (2003): Adecuación y ampliación de talleres artesanales en el Museo de la Laca en Chiapa de Corzo, Chiapas. Diploma Thesis. Universidad Autónoma de Chiapas, Tuxtla Gutierrez, Chiapas, Mexico. Facultad de Arquitectura.

Rodriguez, Alan P. (2009): Proyecto de intervención de la Capilla del Rosario en el Templo de Santo Domingo de Guzmán en San Cristobal de Las Casas, Chiapas. Master thesis. Universidad Autónoma de Chiapas, Tuxtla Gutierrez, Chiapas, Mexico. Facultad de Arquitectura.

Rodriguez, Alan P. (2012): Estudio Iconográfico e Iconológico del Patrimonio. El Retablo principal de la Capilla del Rosario de Santo Domingo de Las Casas. Chiapas. México. In Vegueta, Anuario de la Facultad de Geografía e Historia (12), pp. 11–16. Available online at <http://revistavegueta.ulpgc.es/ojs/index.php/revistavegueta/article/view/1/1>, checked on 10/1/2014.

Rodriguez, Alan P. (2012): Lighting: from the theatre to the cities. A scintillating relationship against the darkness. In Cuadernos Latam Urbana 1, pp. 9–18. Available online at http://latam-urbana.org/cuadernos/cuadernos-latam_abril_2012/, checked on 10/1/2014.

Ehrenwörtliche Erklärung

Ich erkläre hiermit ehrenwörtlich, dass ich die vorliegende Arbeit ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Die aus anderen Quellen direkt oder indirekt übernommenen Daten und Konzepte sind unter Angabe der Quelle unmissverständlich gekennzeichnet. Bei der Auswahl und Auswertung folgenden Materials haben mir die nachstehend aufgeführten Personen in der jeweils beschriebenen Weise unentgeltlich geholfen:

1. Prof. Dr. phil. habil. Hans-Rudolf Meier
2. Prof. Dr. phil. habil. Frank Eckardt
3. Prof. Dr. Raquel Puente García

Weitere Personen waren an der inhaltlich-materiellen Erstellung der vorliegenden Arbeit nicht beteiligt.

Insbesondere habe ich hierfür nicht die entgeltliche Hilfe von Vermittlungs- bzw. Beratungsdiensten (Promotionsberater oder anderen Personen) in Anspruch genommen. Niemand hat von mir unmittelbar oder mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen.

Die Arbeit wurde bisher weder im In- noch im Ausland in gleicher oder ähnlicher Form einer anderen Prüfungsbehörde vorgelegt.

Ich versichere ehrenwörtlich, dass ich nach bestem Wissen die reine Wahrheit gesagt und nichts verschwiegen habe.

Weimar, 7. 10.2014

A handwritten signature in black ink, appearing to read 'Alan Paul Rodríguez Schaeffer'.

Alan Paul Rodríguez Schaeffer, M. A.U. Architekt.