A Guideline of Apply Local Architectural Features in Luminaire Design

by

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Abstract

This study is about how to apply the aesthetic elements that are extracted from local architecture as inspiration to luminaire design. After research and analysis of the areas of the world from a cultural perspective, this thesis finds the architecture that can represent the culture of that region. Then, the project uses the aesthetic elements from that architecture as design inspiration and applies it in luminaire design. The effectiveness of the design method is illustrated by an example analysis. The delivery of a set of sample luminaire will include concepts, computer models, and final physical models as a demonstration of the design guideline.

When people see luminaire with local characteristics, it not only helps people to see the local characteristics of the culture that inspired the design but also helps the surrounding environment to create a local cultural atmosphere.

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List of Abbreviations

CRI   Color Rendering Index

HID   High-intensity Discharge

HPS   High-pressure Sodium

IC   Integrated Circuits

IIDA   Interior Design Association

LED   Light Emitting Diodes

LPS   Low-pressure Sodium

OLED   Organic Light-emitting Diode

UNESCO The United Nations Educational, Scientific and Cultural Organization

CHAPTER 1: INTRODUCTION

1.1 Problem Statement

With the development of the times, information circulation is fast. Society faces globalization. In order to avoid this situation from continuing to develop, the sustaining of cultural diversity is crucial. Culture can be a balancing force versus globalization (Razzaghi & Ramirez, 2005). Culture is unique to each location in the world. Every place has its own characteristics that belong to that place, because it was passed down from generation to generation. Every corner of the world we can see today is the "product" of that area's culture. Although the characteristics of "products" will change due to changes in the times, these underlying characteristics have already been formed. What we need to do is to identify their main features and use these features as inspiration for design.

Some brands do not know how to innovate to improve product value. In fact, culture can be the source of design innovation and inspiration, and culture can also play a role in the intuitive use of products (Razzaghi & Ramirez, 2005). The addition of cultural elements can not only encourage local culture, but also promote people from different cultures to recognize the brand, thereby improving product value. Architecture is the embodiment of culture, and the cultural characteristics of the region can be obtained from buildings in different places. Designers can use this method to help more people appreciate the local cultures.

1.2 Need of Study

Now society is slowly entering globalization. With the development of the Internet, popular culture media and international travel, we can learn about the culture of different regions, but it is also the main embodiment of cultural globalization. In the context of

globalization, it is very meaningful to design products with cultural uniqueness. Globalization has a negative effect on the substitutability of culture. Many non-physical aspects of designing a product are ignored or overlooked in most product development processes. These often-disregarded non-physical characteristics include, among others, the pleasurability of objects, the experience and emotion in design, the sense of connectedness with product, and the soul of product and culture (Razzaghi & Ramirez, 2005). Culture is a unique trace of human life in different regions. Therefore, we should innovate our own product within our culture and pass on this unique heritage. Otherwise, some cultures will become extinct. People have begun to realize the importance of culture, so cultural sustainability and promotion plans have been developed. This project has similar goals as these plans, to preserve and promote unique, especially endangered, cultures.

This study is about applying local architectural features in luminaire design to achieve the purpose of cultural inheritance and improve product value. This research explores culture and its diversity. There must be some features in different cultures that represents that region. There are a wide range of carriers that can represent culture, but this study focuses on local architectural features to inspire lamp design. The lamp is an indispensable decoration product, you can see its existence everywhere. The place where it is can set off the feeling that the environment brings to people. Lamps and lanterns in different environments can give people different feelings. When people see luminaire with local characteristics, they will think of the local culture.

1.3 Objectives of Study

The objective of this thesis is to provide a framework for the designer to identify aesthetic elements in the architecture, and to further apply these elements to the luminaire design while

clarifying the relationship between architectural culture, product value, and the luminaire design. The following is the summary of this study:

- To study the relationship between culture and design

- To study the relationship between luminaire, interior and architecture

- To study the relationship between culture and architecture

- To study and research traditional architectures from four main cultures, which are Western culture, Middle Eastern culture, South Asian culture, and East Asian culture.

- Summarize the features of architecture from rhythm (repetition) and building facades (regular, flowing, progressive, radiation, gradation).

- Define the methodology to identify the aesthetic elements in architecture, which inspires luminaire design.

- To study material and texture in architecture, which inspires luminaire design.

- Define design elements in luminaire design.

- Apply the design inspirations to decorative lighting by color, form, proportions.

- Propose the design procedure

- Apply the design guideline to luminaire design

1.4 Definition of Terms

Aesthetic- Relating to the enjoyment or study of beauty, or showing great beauty (Cambridge Dictionary, 2021).

Architecture- The art and science of designing and making buildings, or the style of a building (Cambridge Dictionary, 2021).

Color Rendering Index (CRI)- Is how well light will show true colors. This is an attempt to measure whether all the colors are properly rendered by the light from a given source and whether certain colors may be missing (Schiler, 1992).

Color Temperature- One way of rating the tint of the light from a particular source is Color Temperature, which comes from the theoretical relationship between the temperature of an object and the color of the light (Schiler, 1992).

Culture- A way of life of a group of people--the behaviors, beliefs, values, and symbols that they accept, generally without thinking about them, and that are passed along by communication and imitation from one generation to the next (Ifte Choudhury, n.d.).

Culturally Diverse- A system of beliefs and behaviors that recognizes and respects the presence of all diverse groups in an organization or society, acknowledges and values their socio-cultural differences, and encourages and enables their continued contribution within an inclusive cultural context which empowers all within the organization or society (Belfield, 2012).

Cultural Region- An area occupied by people who share one or more culture traits in common (language, religion, idea, material culture); or a spatial unit that functions politically, socially, technologically or economically as a distinct entity, or an area perceived by its inhabitant to be culturally distinct from its surrounding area (Alam, 2019).

Decorative Design- Involves the application of color, line, texture, or pattern to an object. May be used to enhance a structural design or may be simply a work of art. It may be used to enhance a structural design or may be simply a work of art (West Ada, 2021).

Decorative Lighting- Lighting that enhance the beauty of your home or any living space indoors and outdoors (Caddy, 2017).

Globalization- The word used to describe the growing interdependence of the world's economies, cultures, and populations, brought about by cross-border trade in goods and services, technology, and flows of investment, people, and information (Peterson Institute for International Economics, 2018).

Interior Design- Defined as the professional and comprehensive practice of creating an interior environment that addresses, protects, and responds to human need(s). It is the art, science, and business planning of a creative, technical, sustainable, and functional interior solution that corresponds to the architecture of a space, while incorporating process and strategy, a mandate for well-being, safety, and health, with informed decisions about style and aesthetics (IIDA, 1994).

Luminaire- The devices which contain the lamp and can be of any form from a simple lamp-holder to a cut-glass crystal chandelier (Pritchard, 1978).

Structural Design- An integral part of the structure itself—when the structure and design cannot be separated (West Ada, 2021).

1.5 Assumptions

In this study, it is assumed that designers can use the aesthetic elements obtained from local architecture as local cultural inspirations and apply them to luminaire design. Also, this study assumes that the designer's goal is to design luminaire with different cultural characteristics. This can not only be applied to different styles of environment but also improve people's awareness of environmental styles. For brands, they can expand consumer groups with different cultures. The collection of all relevant resources is considered to be reliable for further verification.

1.6 Scope & Limits

For this study, the culture research is focused on the general Western culture, Middle Eastern culture, South Asian culture, and East Asian culture. Other cultures were not researched. This study will select an architectural example representing local cultural characteristics for design in each cultural area, and the buildings selected are either existing, preserved, or have historical records. The purpose of this paper is to improve the product value. However, some products do not need cultural aspects to improve their value, but the procedure can be applied for convenience goods/products, shopping goods/products, and specialty goods/products. This paper takes the design of luminaire as an example.

1.7 Procedures and Methodology

Clarify the relationship between culture, design, luminaire, and architecture.

Develop a guideline for applying local architecture feature to the luminaire design:

- Analyze the characteristics of architectures from rhythm which includes repetition and building facades

- Summarize the relationship between these architectural aesthetic elements and luminaire design which is styling analysis through the rhythm analysis

- Summarize the construction material and texture of architecture as a reference to design luminaire

- Summarize the types and characteristics of lighting bulbs

- Apply lighting source, styling and material to the design of luminaire

Demonstrate how to use the guideline through design practice:

- Select an architecture from each culture as examples to analyzed rhythm, texture, and styling

- Choose the building of the Western countries to continue demonstrate design guideline

- Based on styling analysis and texture analysis, do sketches and develop design concepts

- Confirm final concept and use material to make model

1.8 Anticipated Outcomes

The main result of this study is to provide designers with new design guidelines for the design of luminaire with regional cultural characteristics. This study will extract cultural characteristics from buildings, and then apply those elements in the design of luminaire. This study takes cultural elements extracted from different architecture as an example to show the design process and design method.

CHAPTER 2: LITERATURE REVIEW

This topic is about how to apply cultural elements from architecture in luminaire design to achieve the purpose of cultural inheritance and improve product value. This chapter discusses the relationship between culture and design, luminaire and architecture.

2.1 Culture

A culture is a way of life of a group of people--the behaviors, beliefs, values, and symbols that they accept, generally without thinking about them, and that are passed along by communication and imitation from one generation to the next, said by Ifte Choudhury (n.d.).

Culture is symbolic communication. According to Kroeber and Kluckhohn (2021): culture consists of patterns, explicit and implicit, of and for behavior acquired and transmitted by symbols, constituting the distinctive achievements of human groups, including their embodiment in artifacts; the essential core of culture consists of traditional (i.e. historically derived and selected) ideas and especially their attached values; culture systems may, on the one hand, be considered as products of action, on the other, as conditional elements of future action. That shows culture is the foundation of design. Different cultures lead to different designs. There is a proverb from China: The unique features of a local environment always give special characteristics to its inhabitants. Items were produced in the context of the time. Although some cultures evolve over time, the products of those times can be passed on in a modern way.

The Inglehart–Welzel (2015) cultural map of the world is a map, or more precisely, a scatter plot created by political scientists Ronald Inglehart and Christian Welzel based on the World Values Survey. Welzel and Inglehart's (2008) grouping of culture is fundamentally based

on religion, language and geographical location. According to the map (Figure 2.1), the results

show that people of different religions have different traditional values, such as law-rational

values, survival values, and self-expression values. Based on the Welzel-Inglehart cultural map,

the cultural classification and religious distribution are consistent. In addition, language and

geographical location also affect the development of culture to some extent.
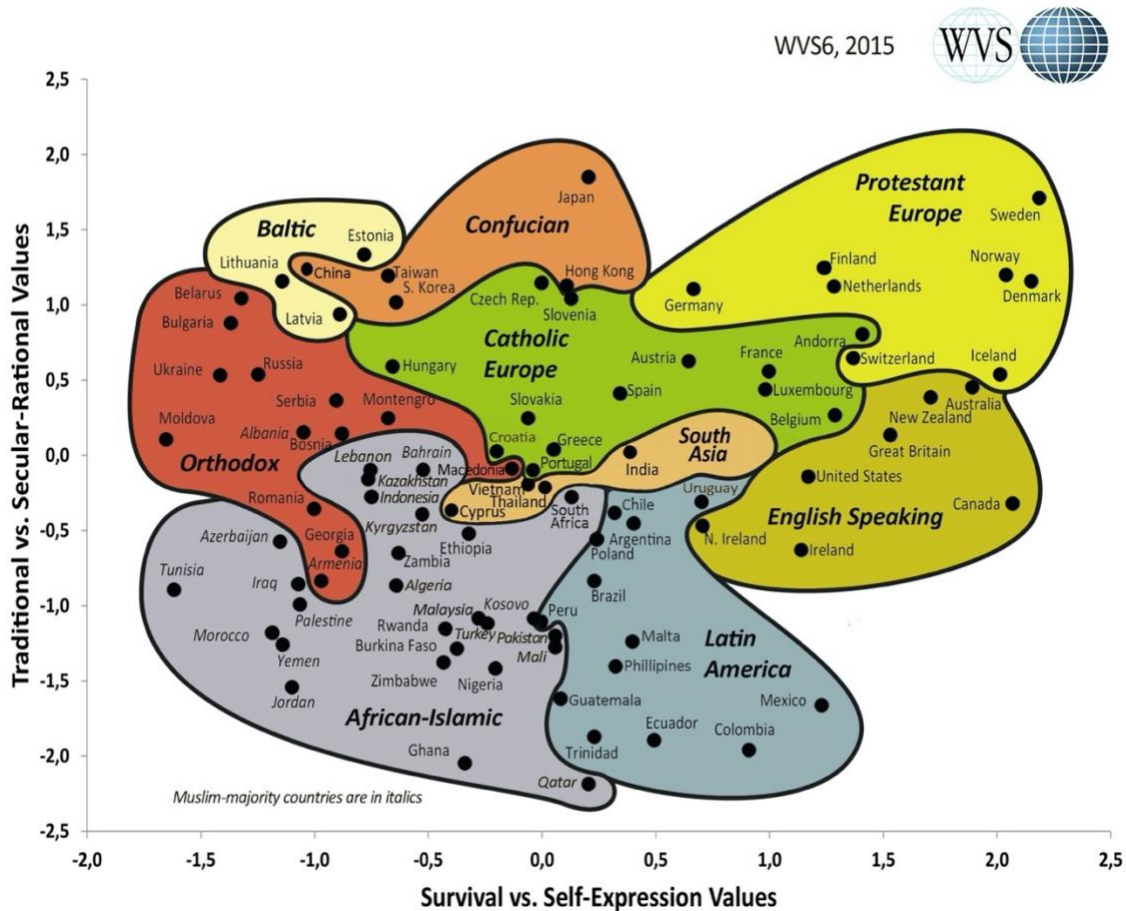
Figure 2.1 Cultural Map Welzel and Inglehart (2015)

Alam (2019) gives us the definition of cultural region: "A cultural region is an area

occupied by people who share one or more culture traits in common (language, religion, idea,

material culture); or a spatial unit that functions politically, socially, technologically or

economically as a distinct entity, or an area perceived by its inhabitant to be culturally distinct

from its surrounding area" (p.144). Alam (2019) said that Jan O. M. Broek and John W. Webb (1967) grouped the culture realms of the world in to two broad categories- major and minor cultural realms. Among major cultural realms they include occidental (Western European), Main Islamic (North African-South-West Asian; Arab-Persian), Indic (Indic, Hindu) and East Asia (Sinitic). Among minor culture realms they include Southeast Asia, Meso-Africa (Negro-Africa) and Southern Pacific (Melanesian-Polynesian).

Alam (2019) pointed out that cultures are always in a state of flux and territorial limits of cultural regions keep on expanding and contracting. According to Alam (2019) and Inglehart–Welzel (2015), we can roughly divide the world into four main cultures based on religion and geographical location: Western culture, Middle Eastern culture, South Asian culture, East Asian culture.

2.1.1 Cultural Globalization

With the development of the Internet, popular culture media and international travel, we can learn about the culture of different regions, but the internet is also the main embodiment of cultural globalization.

UNESCO's website says that the current era of globalization, with its unprecedented acceleration and intensification in the global flows of capital, labour, and information, is having a homogenizing influence on local culture. While this phenomenon promotes the integration of societies and has provided millions of people with new opportunities, it may also bring with it a loss of uniqueness of local culture, which in turn can lead to loss of identity, exclusion and even conflict. This is especially true for traditional societies and communities, which are exposed to rapid 'modernisation' based on models imported from outside and not adapted to their context

(UNESCO, 2017). In the context of globalization, it is very meaningful to design products with cultural uniqueness.

Razzaghi and Ramirez (2005) write that many non-physical aspects of designing a product are ignored or overlooked in most product development processes. These often-disregarded non-physical characteristics include, among others, the pleasurability of objects, the experience, and emotion in design, the sense of connectedness with product, and the soul of product and culture. Therefore, it is a good to use cultural characteristics injected into the design; otherwise, some cultures may disappear entirely. Not only that, but globalization also limits innovation. Sander and Jurgen (2015) say that globalization strengthens tendencies for information overload of individuals and thereby reduces their abilities for creative thinking. Globalization fosters more and more the manufacturing of internationally standardized products and enhances imitation instead of innovation.

2.1.2 Cultural Diversity

Due to the problem of cultural globalization, we need to look at the importance of cultural diversity. It is a good way to use our own culture to design products, in order to achieve preservation of cultural heritage.

While the functionality of designing a product is important, the non-physical aspects cannot be ignored. From Razzaghi and Ramirez's (2002) article: "Even so, industrial designers the world over are being challenged and encouraged by the International Council of Societies of Industrial Design to foster cultural diversity in the face of world globalization" (p.3). Thus, industrial designers are exhorted to implement the cultural wants, preferences and attributes of people into the products that they create, in order to make them culturally suitable and pleasurable for use by all potential users.

"Samuels (2002) also suggested the necessity of redefining industrial design in order to subsume 'culture' in the definition of industrial design as a goal for optimizing the lives of individual users" (cited in Razzaghi & Ramirez, 2005, p.3). To reflect the importance of cultural diversity, UNESCO's governing body, the General Conference, adopted the UNESCO Universal Declaration on Cultural Diversity in 2001 (UNESCO, 2017)

2.1.3 Cultural Heritage

"'Heritage' is a property, something that is inherited, passed down from previous generations" (Khan Academy, 2014). To achieve cultural inheritance, it is necessary to know what is worth passing down. Franchi claims that cultural heritage often brings to mind artifacts (paintings, drawings, prints, mosaics, sculptures), historical monuments and buildings, as well as archaeological sites…Today, towns, underwater heritage, and the natural environment are also considered part of cultural heritage since communities identify themselves with the natural landscape" (Khan Academy, 2014). There are many aspects to realize and complete cultural inheritance.

In an era of globalization, cultural heritage helps us to remember our cultural diversity, and its understanding develops mutual respect and renewed dialogue amongst different cultures (Khan Academy, 2014). The protection of cultural heritage is also against globalization.

2.2 Culture and Design

If we continue to study the influence of culture on design, Razzaghi and Ramirez (2005) proposed that if product users find products culturally closer and meaningful to them, the following results can be expected as a consequence: "Culture can be a resource for design innovation and inspiration. Culture can play a role in the intuitive use of products. Culture can be

a balancing force versus globalization. Culture can set trends and fashions" (p.6). This can also be said to be the benefit of culture to design. To sum up, from multiple perspectives, integrating culture into products is beneficial to both industrial design disciplines and product users. Their words also illustrate the relationship between culture and the market: the market can also help promoting culture through the circulation of products.

Razzaghi and Ramirez (2005) claim that recognizing and extracting values from cultures and later, the interpretation of those values into some meaningful aspects of product concepts requires extensive knowledge of the fields of industrial design, culture, sociology, anthropology, psychology, and others. Further to this, values are non-physical and most of them unconsciously influence the designer, and as a result, are intangible and potentially ambiguous to understand. By using distinctive elements of different cultures in design, that culture can be inherited in this way and cultural diversity can be realized.

From a design perspective, as Damian Madray (2017) said, design thinking is "human-centered" focusing on the problem of an individual, solving it and scaling to reach more humans with that problem. That's great and has shown amazing results over the years. However, this framework presents little opportunity to think about the long term impact these innovations have on us, as social beings. This means the design is for people. We innovate for the better life of people. It's part of the culture. Since the design is to serve people, then different areas need different services. It depends on the living habits of different regions, so different regions will have different design ideas; in other words, design is influenced by culture.

As a theory, Anne-Marie Willis (2006) in her paper writes: "That designing is fundamental to being human — we design, that is to say, we deliberate, plan and scheme in ways which prefigure our actions and makings — in turn we are designed by our designing and by that

which we have designed (i.e., through our interactions with the structural and material specificities of our environments); That this adds up to a double movement — we design our world, while our world acts back on us and designs us " (p.80). That means basically everything that we design, everything around us, from our language to our homes, to our cities, tools, planes, bedrooms, kitchens, religions, sports, brings us back to design. It shows that the social environment is inseparable from the design, and we get design inspiration from the environment, which means that the design becomes part of the culture.

Austrian architect-designers Josef Hoffmann and Koloman Moser, who cofounded the Wiener Werkstätte said: "As long as our towns, houses, rooms, cupboards, utensils, clothes, jewellery, language and feelings fail to express the spirit of the times in a clear, simple and artistic manner, we shall remain indefinitely far behind our ancestors and no pretence will conceal our lack" (cited in Gorman, 2003, p.63). This ststement not only shows that the product reflects the culture of the society at that time but also shows that culture is the premise of design. They also indirectly point out the importance of cultural inheritance. They believe that we can integrate the cultural spirit into our daily life to achieve cultural heritage.

Decoration

Lamps are not only essential products but also decorations. People can choose different styles of lamps and lanterns to add to the design effect of the space.

Decoration can also enhance product cultural value, as Dresser (1837) said: "The beautiful is lovable, and, as that which is lovable, takes hold of the affections and clings to them, binding itself firmer and firmer to them as time rolls on. If an object is beautiful, we do not tire of it; fashion does not induce us to change it; the merely new does not displace it. It becomes as an old friend, more loved as its good qualities are better understood" (p.17). Decoration has

purposes. Decorations can reflect emotions and cultural spirit. Good decorations are like old friends: the more meaningful they are, the more they will be cherished. If a lamp is designed with cultural characteristics, then whenever people see it, they can associate it with the local cultural spirit. If the product is used for a long time, it will achieve the function of cultural communication.

However, in today's society, not all products can be integrated with cultural elements to improve the product value. Some products can maintain their value without using this method, such as industrial products. Singh (2018) divides the products into two broad categories (Figure 2.2). Consumer products can achieve that purpose, especially shopping products, and specialty products. These products can be designed under the influence of the designer's own culture.

Dresser (1837) also mentioned that decoration should not only be meaningful but also useful: "There are other principles governing the production and application of ornament which we must now notice, the first of which is utility, for the first aim of the designer of any article must be to render the object which he produces useful" (p.17). The lamp is an important lighting tool that people can see everywhere, and its styles can help the space to add different effects. If the cultural spirit is transmitted through lamps, the lamps themselves can play the role of cultural inheritance, and the lamps can also affect people's impression of space.

Yee (2007) talks about the relationship between residential aesthetics and people: "Residential work is personal in nature, reflecting a family's tastes and styles" (p.25). He says that every residence is unique. He takes Bouyea and Associates as an example, saying that they work with clients, architects and interior designers to create distinctive environments that express the clients' personal values and preferences while showcasing the aesthetics of their homes. It

proves that the interior is designed according to different people, which will definitely reflect the cultural characteristics of that person. This also shows that design and culture are closely related.
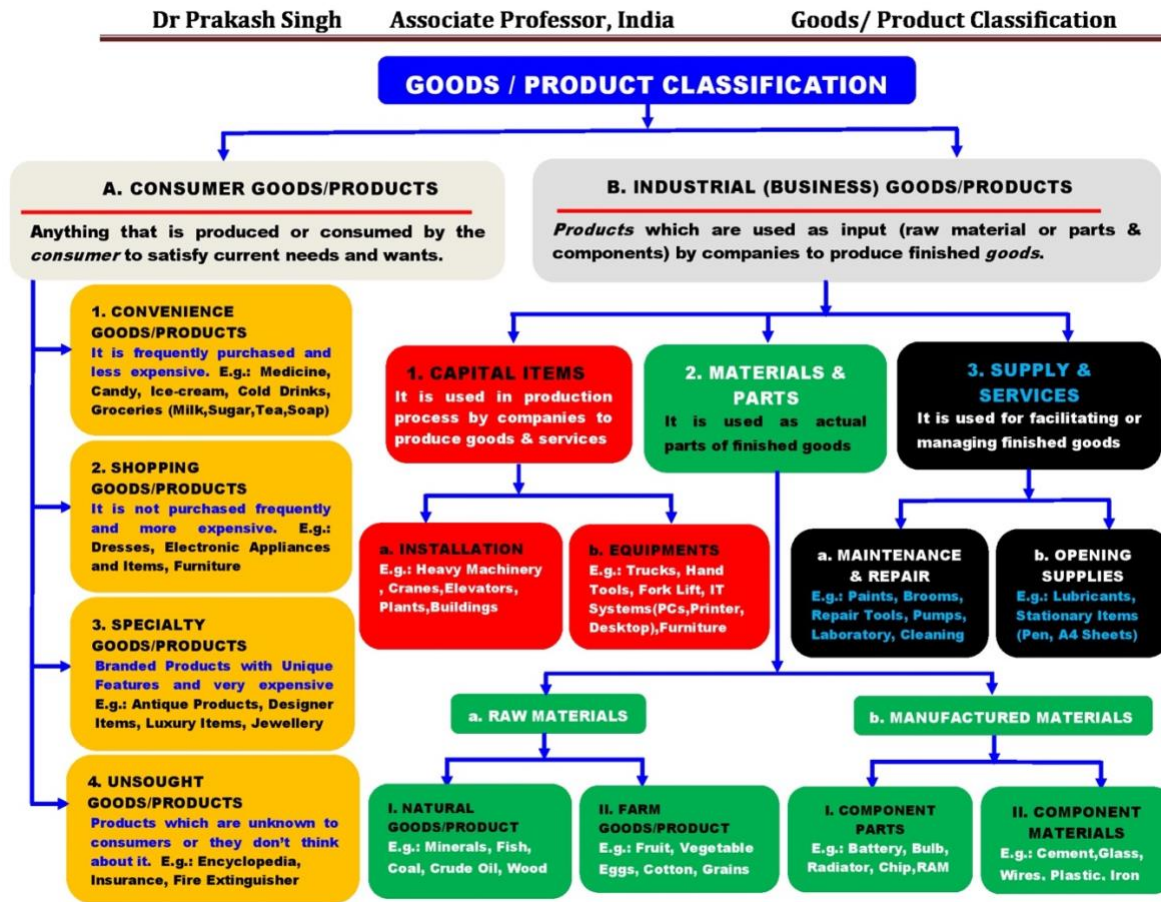
Figure 2.2 Dr Prakash Singh's Product Classification (Singh, 2018)

2.3 Luminaire

"These are devices which contain the lamp and can be of any form from a simple lamp-holder to a cut-glass crystal chandelier" (Pritchard, 1978, p.34). Pritchard defined the function of the luminaire: provide a means of suspending the lamp in space, control the distribution of the light form the lamp, protect the lamp, decorate the interior, and contain the control gear for the lamp.

2.3.1 The Relationship Between Lighting, Interior and Architecture

"The history of great architecture is about buildings that adapt creatively to light. One focus of architecture is the connection between what people see and a building's construction. Architects rely on light and its ability to reveal form as a way of creating that connection" (Meyers, 2006, p.20). Light is an important element of architectural design. The layout of light should be considered when designing the structure of the building, because the creation of light makes people feel connected to the building. Light allows people to know more about the structure and function of buildings.

>Lighting is an indispensable element in modern architecture. As Karlen and Benya (2003) said in their book: "Lighting is the jewelry of architecture and, in many building types, plays a significant role in building style, period, or motif" (p.18). Lights can influence the style of architecture. They can reflect the characteristics of local architectural culture, and the relationship between lights and buildings is complementary. In fact, everything in the interior accentuates the theme, and the lights are no exception. Tregenaz and Loe (1998) argue: Underlying all design criteria there is a single idea: The purpose of lighting is to give information. It is to enable the people in a building to perceive the nature of the space they are in, what other people are doing, and what they have to accomplish in a task. Our concern is not ultimately with physical illumination of room surfaces but with people's perception. And fundamental to lighting design is that how something is lit affects this perception (p. 41).

It all depends on where and how the lights are placed. Light in different places and in different devices has different effects on vision and perception.

Pile (1994) discussed the need of lighting. He said that lighting will normally fall into three categories: light for specific visual functions, general lighting, and special lighting. Light for specific visual functions is often called task lighting, such as reading, writing, and eating. General lighting provides a comfortable level of light for finding one's way around a space, location objects, and seeing people and objects and is often called ambient light. Special lighting focuses attention on specific objects or areas and generates variety and contrast to make a space lively and interesting, even to add aesthetic impact and is often called accent lighting to describe the strong light concentrated on painting, a display of objects, or simply on wall.

In these places where lights are needed, designers also need to think about the way to install them. At this point, Turner (1998) discussed in his book about light fitting:

A light fitting performs a number of functions. It enables the electrical

connection to the lamp itself, it protects the lamp, and it directs or diffuses the

light from the lamp. In an indoor situation, the most important aspect of a fitting

in the way in which it controls the flow of light (p.36).

Phillips (2000) divided lighting equipment into direct-mounted fitting, suspended fittings, track-mounted fitting, concealed lighting/remote source, and portable fitting. He says that mounted directly on to a ceiling or wall structure is the simplest method. Suspended fittings can both enhance the appearance of the space through the way the light is distributed and are enjoyed for themselves. They add an element of furniture to a space and are often of a decorative nature. Track can be mounted directly on to structure to the multiple circuit tracks. It can have different arrangements of light distribution. Concealed lighting can be defined as lighting systems where the sources are concealed from view by the fabric of the building, and they are generally thought of as a way of providing indirect lighting to walls or ceilings. Portable lamps provide local light

at the control of the individual whilst increasing the amount of light on the work for function, many of which were very decorative to suit the interior design for the space.

There are specific names to describe different kinds of fixtures. Egan and Olgyoy (2002) gives some examples: troffer to describe long recessed fluorescent units, opening flush with ceiling; high hat to describe incandescent down light unit recessed in ceiling; sconce is always assumed to be wall-mounted and a chandelier to be pendant; coves always refer to up lighting; slots refer to direct wall-washing down lights; and valance lights are direct-indirect fixtures.

The installation method depends on the building structure and visual effects. Different methods of installation will have different visual effects. Turner (1998) stated "Light distribution is a function both of the lamp and the fitting, since in most cases the fitting controls the direction and power of the light source" (p.40). According to Karlen and Benya (2003), light can be distributed in several ways. They can produce different effects. In addition to the six shown below (Figure 2.3), there are two other types: asymmetrical luminaires and adjustable luminaires.
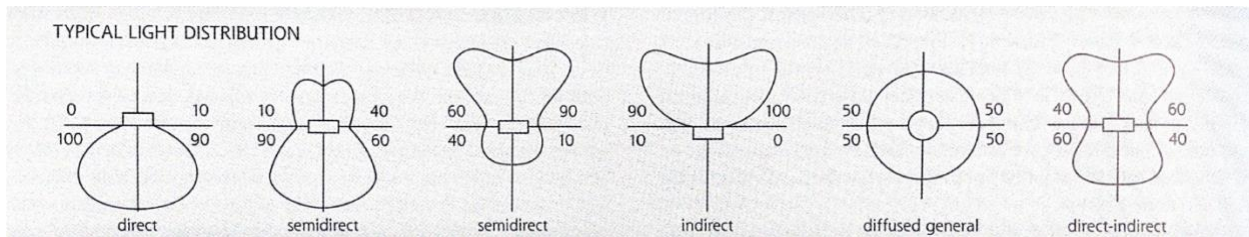
Figure 2.3 Light distribution (Karlen & Benya, 2003)

2.3.2 Decorative Lighting

In many building types, decorative lights play an important role in the architectural style, which can make the space sparkle. The function of decorative lamp is not only to provide light, but also decorate and show the beauty of the space.

"Decorative light, of course, is best if it is also functional. Therein lies the challenge for the designer- seek out and specify functional decorative lighting. Decorative lights can set the scene for a project" (Steffy, 2008, p.276). In addition to the installation of lamps in the required position, the cultural characteristics of decorative lights embodies are actually reflect their function: setting the scene. On a practical basis, if aesthetic elements of cultural characteristics can be added, it can bring people a better visual experience. Turner (1994) emphasized that the application of aesthetics is very important. He said that texture is the key to affecting aesthetic elements: "Over and above the practical aspects, the aesthetic effects of textures in diffusing and transforming light are significant" (p.67).

Not only texture, but materials are an important element as well. Different materials and textures will result in different effects. "Materials are key to understanding light in architecture because they directly affect the quantity and the quality of the light. Two qualities of materials- their finish and their color- are most important in this regard" (Millet, 1996, p.67). In terms of materials, Bean (2014) concludes as follows: "In general, luminaires are manufactured from metal, plastic or sometimes glass" (p.166). Sheet steel, sheet aluminum, aluminum castings, plastics. These are the most common materials for making luminaires, but they can also be made from other materials. Jankowski (1997) discussed the many materials that can be used to customize luminaires, like glass, parchments, papers, fabrics, brass, and acrylic.

2.4 Architecture

Burden (2003) gives the definition of architecture: "The art and science of designing and building or restoring structure or groups of structures, in keeping with aesthetic and functional criteria" (p.12).

"Architecture, like civilization itself, was born on our prehistory, and much as the other arts was plural from the beginning" (Ching, Jarzombek and Prakash, 2017, p.1). Architecture has a long history. It is the product of human development. With the development of the times, architecture is not only a building, but also a work of art that can express the culture of the time. As Caffin (1937) said, how age after age built not only to meet the needs of living but also to embody its ideals of the present and the future life; how hand in hand with growing skill in workmanship was evolved superior achievement in artistic beauty.

Caffin (1937) also mentioned that architecture, sculpture, and painting share the distinctive title of Fine Arts: "Of all the Fine Art, Architecture is the closest to the life of man. It has been developed out the primitive necessity of providing shelter from the elements and protection against the assaults of all kinds of aggressors" (p.7). French (2003) also believes that architecture is the closest to people's lives:

> Architecture belongs to everybody. unlike painting or music, which can be avoided or denied, the history of architecture, the enduring remains of the past, is all around us. Our experience of architecture is of the buildings, the everyday spaces of towns and cities, that frame the lives of ordinary people (p.13).

The Relationship Between Architecture and Culture

Ballantyne (2002) mentioned the relationship between building and architecture: "Architecture is produced when a building and a culture come into contact and connect in such a way that something valuable happens" (p.115). This shows that architecture is the embodiment of culture. Ingersoll (2019) said that:

> Architecture, more than any other culture expression, affects everyone. It originated in response to the act of dwelling: first as an adaptation to natural

condition such as mounds, caves, and tree trunks, and then as the reproduction of such shelter. From the outset, humans created architecture as a second nature (p.2).

With the development of the times, architecture has become a symbol of a region, even a symbol of a culture. As Strike (1994) said: "The simplest starting point is the idea of a building as a symbol" (p.25). He adds that architecture can serve as a symbol in many ways: the type of building, its structural system, its details, its materials. These all reflect the social situation at that time.

Architecture is regional and can be expressed in different ways depending on the surrounding environment.

> What architects do is to design buildings with an eye not only to their practical utility but also with an eye to their culture value, trying to give them a shape that is in some way appropriate. What it is that makes a building appropriate will be different in different circumstances, depending on what the surrounding buildings are like, what method of construction can be used, and what role a building plays. (Ballantyne, 2002, p.22).

The buildings are built from local materials and have different building styles in different regions because of the different environments and cultures. French (2003) has the same idea that architecture can be seen as a response to the primary human need for shelter (and comfort). Different cultures have all produced different kinds of buildings. Variations in climate initially, and later in religious beliefs and economic systems, resulted in different "traditional" or vernacular buildings, using the most easily available local materials (French, 2003). Thus, traditional architecture is the product that best reflects the regional culture. "Traditional" refers to

those societies or elements of societies that are small-scale, are derived from indigenous and often ancient cultural practices (Wills, 2014).

Architecture is the embodiment of human intelligence. As Roth and Clark (2014) said "Architecture is the crystallization of ideas, a physical representation of human thought and aspiration, a record of the beliefs and values of the culture that produces it" (p.165). People usually combine the best technology with architecture. "Architecture might also be physical proof of scientific achievement, of technological progress, with the tallest buildings and widest spans. On a domestic scale, ordered and well-serviced living spaces might be seen as representative of a highly evolved civilization" (French, 2003, p.11).

CHAPTER 3 DESIGN GUIDELINES

This chapter will develop the design guidelines to design luminaire by summarizing the rhythms which includes repetition and building facades of architecture. This includes how to design luminaire and how to use architectural elements to design luminaire. It will analyze the light source and materials used in the luminaire as well.

3.1 Design Inspiration Analysis

3.1.1 Identify Aesthetic Elements from Architecture

Parmar (2017) said architecture is replete with the potential to be a piece of artwork that can inspire and uplift. Architecture is all about building geometry which has to be in harmony with Cosmic Geometry. It is rhythm which facilitates this.

"This architectural rhythm is read by visually scanning the surface, much as one might scan, say, a musical score, reading the patterns the notes make through time" (Roth and Clark, 2014, p.79). Different architectures have different rhythms. As Parmar (2017) said that rhythm in architecture is defined as "A unifying movement characterized by a patterned repetition or alteration of formal elements or motifs in the same or a modified form." Hence, rhythm in architecture can be expressed as a repetition of elements such as lines, shapes, forms or colours resulting on organized movement in space and time (Parmar, 2017). Figure 3.1 shows the repetition of architectural structure, and Figure 3.2 shows the repetition of structure and pattern. Parmar (2017) add that rhythm in architecture can also be followed on facades of a building which can be regular, flowing, progressive. Thapa (2018) also mention that rhythm can be acquired through radiation and gradation. Progression relates a sequence or transition produced

by increasing or decreasing one or more qualities; it is ordered systematic change. Radiation is when elements or spaces are arranged around a center point as in a spiral then it gives radial impression. Gradation is evolvement of forms and colors. Figure 3.8 shows the gradient of building structure and Figure 3.9 shows the gradient of structure and pattern.

Combining the analyses of Parmar (2017) and Thapa (2018), Figure 3.3 summarizes the rhythm of the architecture: rhythm is established by using repeated forms. In architecture, repetition refers to a pattern in which the line, size, shape or color is used again and again throughout the design. Rhythm in architecture can also be followed on facades of a building which can be regular (Figure 3.4), flowing (Figure 3.5), progressive (Figure 3.6), radiation (Figure 3.7) and gradation.

Figure 3.1 Repetition of Structure, Mülimatt Gymnasium (Kapellos, 2012).

Figure 3.2 Repetition of Structure and Pattern, Hypostyle hall, Great Mosque at Cordoba, Spain

(Adil, n.d.).
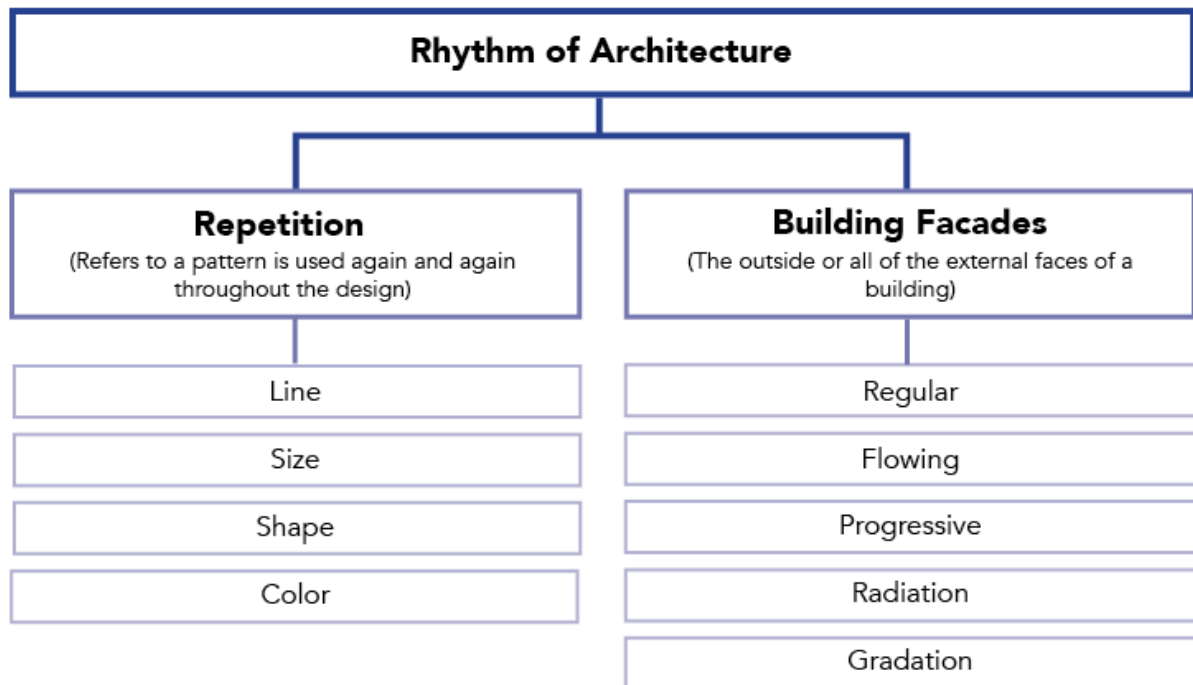
Figure 3.3 Rhythm of Architecture

Figure 3.4 Regular, Clock Shadow Building; Milwaukee, WI (Ganga, 2013).

Figure 3.5 Flowing, Bird's Nest Stadium for the 2008 Beijing Olympics (Morari, n.d.).

Figure 3.6 Progressive, Egypt's Great Pyramid (Jarus, 2018).
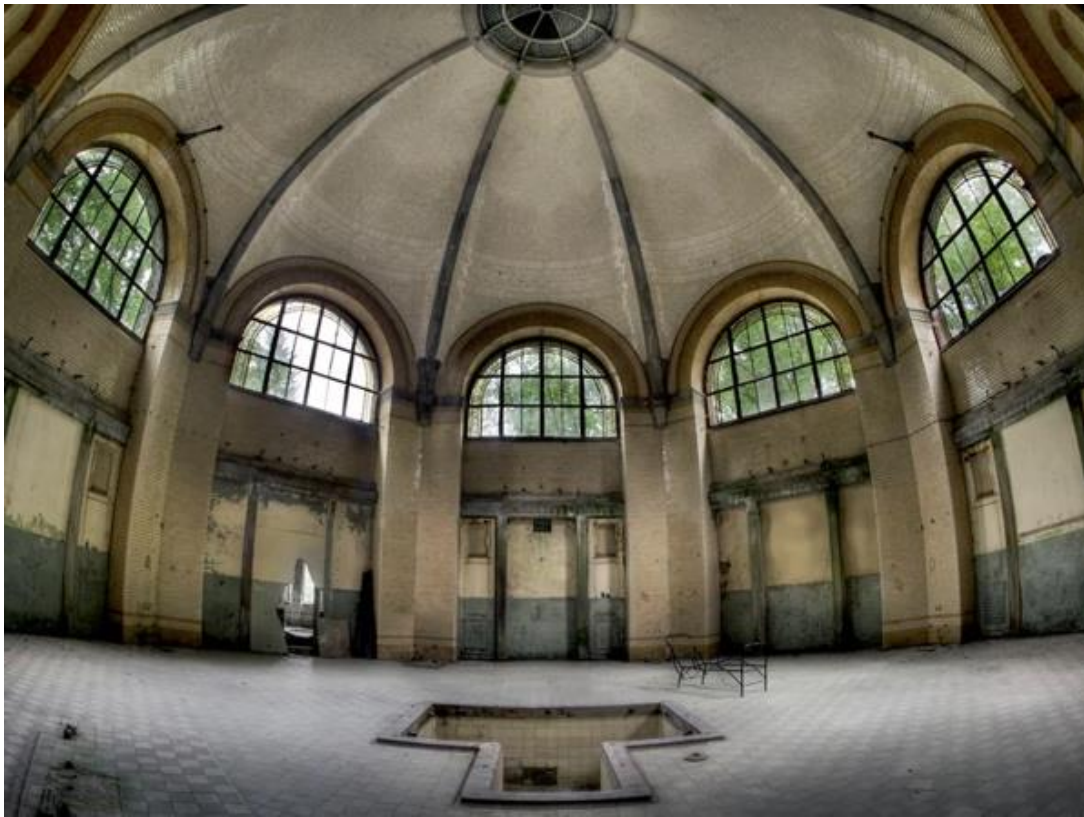
Figure 3.7 Radiation, Soviet-Era Architecture (Flaherty, 2014).

Figure 3.8 Gradation of Structure, Sydney Opera House (Lovett, n.d.).
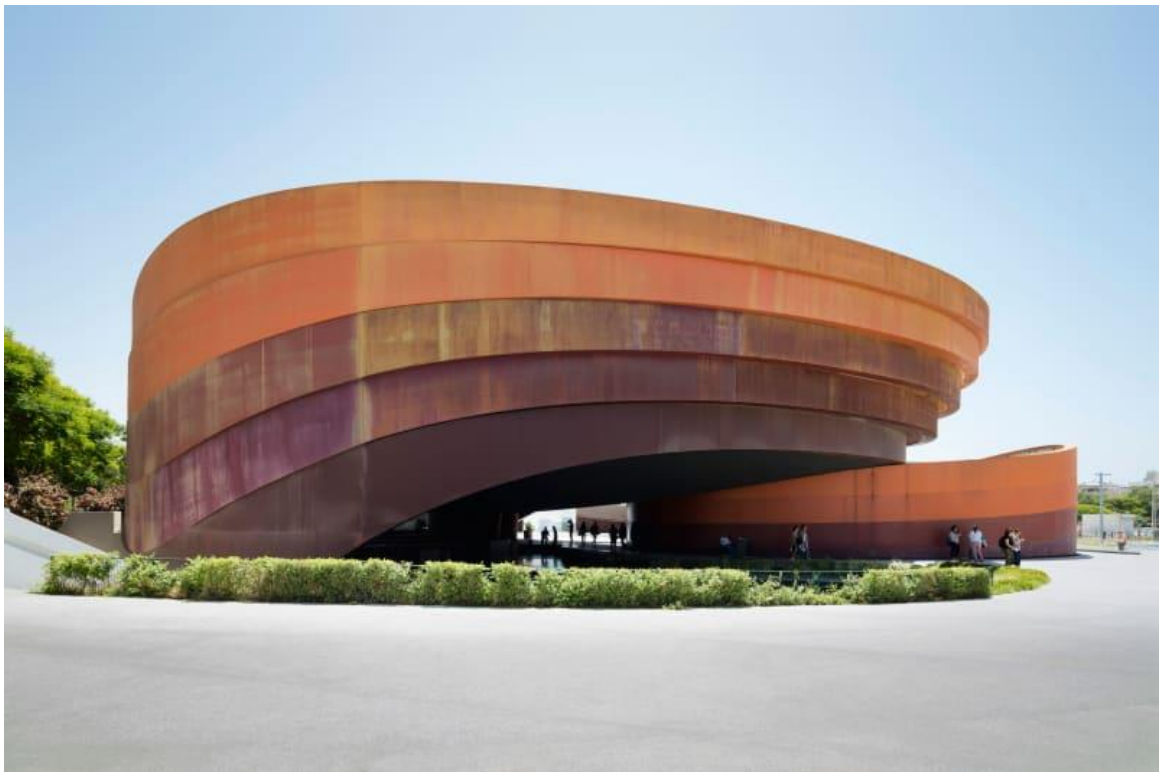
Figure 3.9 Gradation of Structure and Color, Design Museum Holon (Ota, 2010).

The above is to express that buildings will have these elements, but not all buildings will have these elements. Everyone looks at it from a different perspective, and it may not be possible for some buildings to be placed exactly in which category. But we can observe which category a certain building is more inclined to.

Designers will create the following Table 3.1 Rhythm Analysis to analyze the rhythm of architecture, including pattern's repetition (line, size, shape or color) and building facades (regular, flowing, progressive, radiation or gradation).

Table 3.1 Rhythm Analysis

Rhythm	Elements		Descriptions
Repetition	Line	Name	
	Shape	Name	
	Color	Name	
	…		
Building facades	Regular/ flowing/ progressive/ radiation/ gradation		

3.1.2 Construction Material and Texture

As mentioned in Chapter 2, architecture is regional and can be expressed in different ways depending on the surrounding environment. The buildings are built from local materials and have different building styles in different regions because of the different environments and cultures. Different cultures have all produced different kinds of buildings. Variations in climate initially, and later in religious beliefs and economic systems, resulted in different "traditional" or vernacular buildings, using the most easily available local materials. Therefor the material in the building is an important part of reflecting the character of the building and would give inspiration for the design. If we take the materials that are used in the building into the consideration of lighting design, it may give designers more inspiration. The material considered here is not the application of the material itself, but the feeling that the material brings to people.

Roth and Rassmussen (2012) analyzed the type of texture in architecture. They classify texture as optical texture and tactile texture (See Figure 3.10). The optical texture of the building refers to its visual pattern at the large scale, whereas and tactile texture refers to what can be physically felt with the human hand (Roth & Rassmussen, 2012).
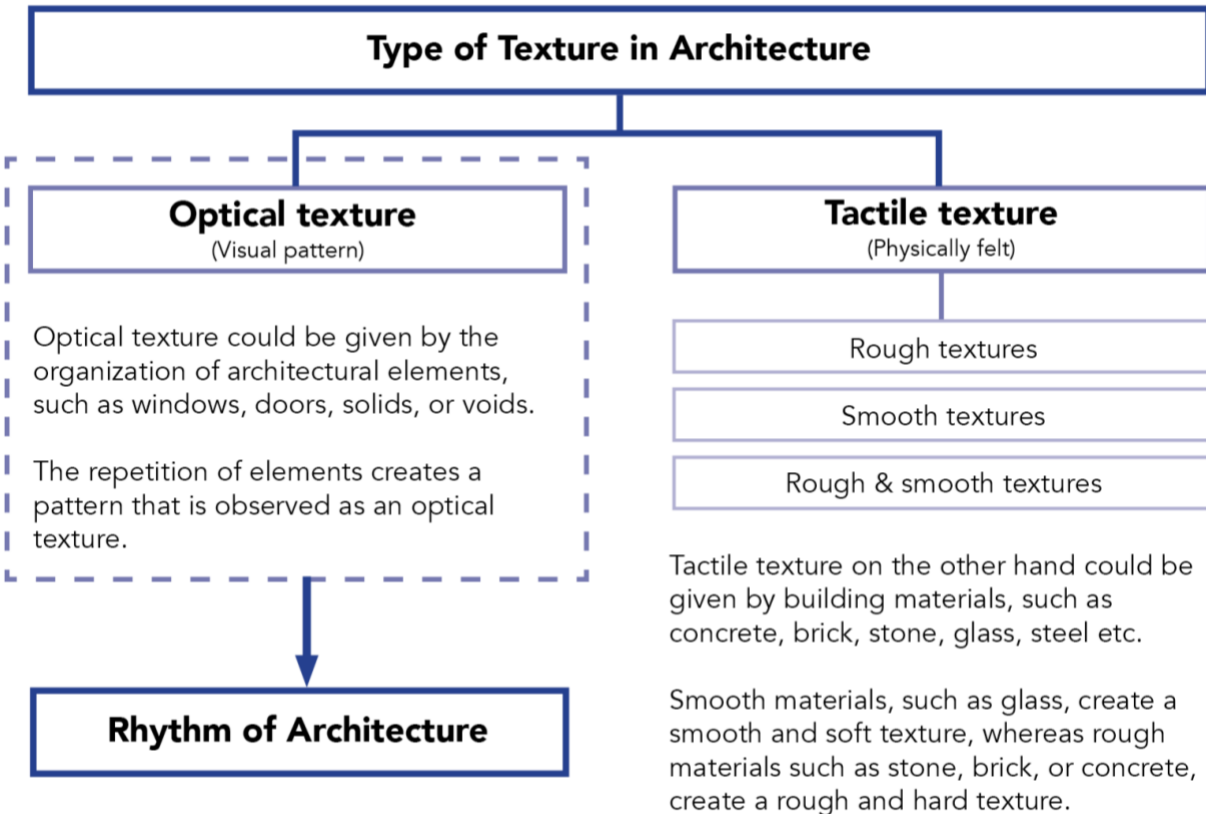
Figure 3.10 Type of Texture in Architecture

Optical texture could be given by the organization of architectural elements, such as windows, doors, solids, or voids. The repetition of elements creates a pattern that is observed as an optical texture. Tactile texture on the other hand could be given by building materials, such as concrete, brick, stone, glass, steel etc. Smooth materials, such as glass, create a smooth and soft texture, whereas rough materials such as stone, brick, or concrete, create a rough and hard texture (Roth & Rassmussen, 2012).

Since Chapter 3.1.1 is all analyzed from a visual perspective, optical textures can default to the contents of Chapter 3.1.1. This part will focus on tactile texture. Roth and Rassmussen (2012) analyzed that there are three tendencies in architecture in terms of the use of tactile

texture: the use of rough textures, the use of smooth textures and the use of both textures to create contrast. They noted that every material should be used in accordance with its character. Steel and glass have sharp and smooth surfaces for example. Concrete has very much potential to create a tactile and optical texture because it takes shape of the molding form to which it was poured into, and it also takes the texture of the material of that molding form. For example, Figure 3.11 shows creating rougher texture by the joints of concrete.
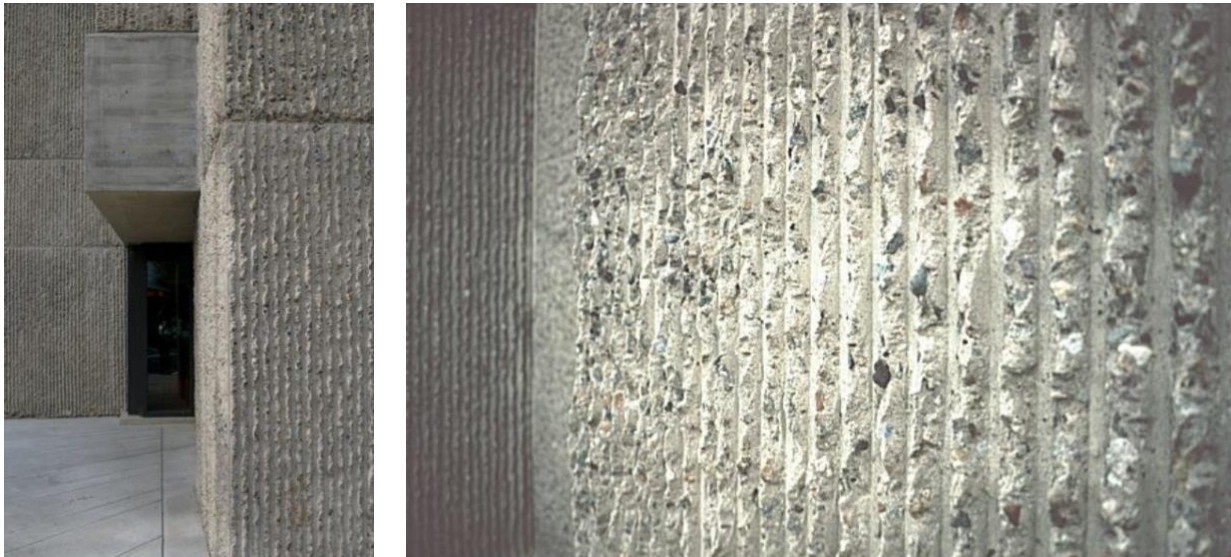
Figure 3.11 Rougher Texture, Art and Architecture Building at Yale University (Rudolph, 2012)

Different materials give people different feelings. When designing lightings, designers could create lightings with the characteristics of materials, which could let the architecture and the lighting look like a series. This allows the lighting to better interpret the characteristics of the architecture. Ebster and Garaus (2015) enumerated different materials and summarized the feelings that they bring to people. See Figure 3.12.

Material	Associations for consumers
Brick	Durable, cozy, and natural
Glass	Fragile, modern, and fabricated
Wood	Natural and handmade
Iron and steel	Historical
Stainless steel	Aggressive and professional
Metals	Cold, sterile, and precise
Machined metal	Durable, robust, and technologically superior
Polymers	Bright, cheerful, and humorous
Ceramic	Rigid, cold, durable, hygienic, and long lasting
Plastic	Playful and low quality

Figure 3.12 Materials used in store design and their consumer associations (Ebster & Garaus,

2015)

Designers will create the following Table 3.2 Texture Analysis to analyze the

construction materials and textures of architecture, including rough, smooth, and both rough and

smooth.

Table 3.2 Texture Analysis

Architecture	Materials	Texture type	Descriptions
Name	Name	Rough/ Smooth/ Both rough and smooth	

3.2 Design Elements in Lighting Design

According to Steffy (2008), in the decorative lighting design, the designer can specify lighting by three categories: lamping, styling and finishes (Figure 3.13). Lamping means light source. Styling is a visual expression which includes color, form, proportions. Finishes are usually represented by materials and textures.
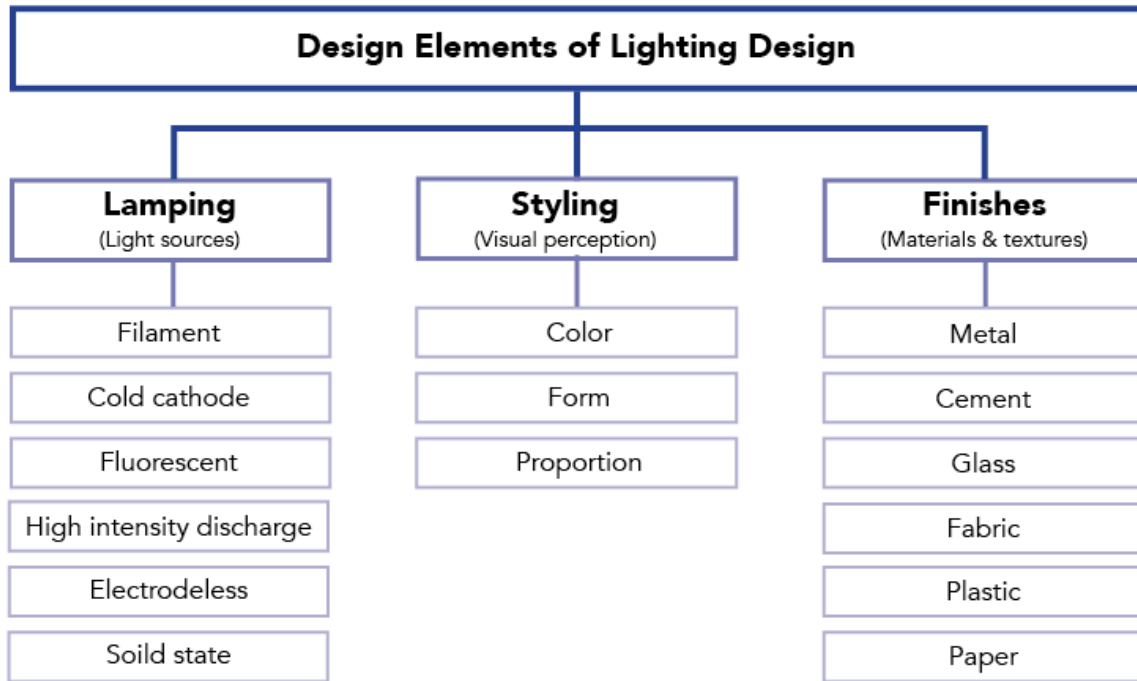
Figure 3.13 Design Elements of Lighting Design

3.2.1 Light Source

Light sources include artificial lighting and daylight. In this study, we focus on artificial light rather than daylight. As Pile (1994) said in his book: "To the designer, artificial light has the potential advantage of being totally controllable in terms of brightness, color, placement, and quality" (p.301). Artificial light has more room for creativity. Designers would create different styles of lighting with those aspects.

The light bulb is artificial, and there are many types of light bulbs on the market. They can be classified in different ways. Steffy (2008) he divides them into six categories based on architectural lighting design. He said that for the purposes of architectural lighting design, there are six general families of electric lamps: filament, cold cathode, fluorescent, high intensity discharge, electrodeless, and solid state (encompassing LED, and emerging OLED technologies).

The following will be introduced separately in combination with Steffy's classification. When he says filament, he means incandescent lamp, because the idea behind an incandescent lamp is a heated filament, invented by Thomas Edison, one of the oldest and most familiar of light sources.

Combining Steffy (2008) and Karlen and Benya (2003), an incandescent lamp can be classified as standard incandescent lamps, Tungsten-halogen lamps (TH or simply halogen lamps) and low- voltage. Incandescent lamps have several types and different shapes (Figure 3.14). Standard incandescent lamps use tungsten filaments that generate a warm-colored white light and last about 750 to 1000 hours. Tungsten-halogen lamps give off whiter light and last longer than standard incandescent lamps and last about 2000-10000 hours. They are extremely hot and need special protection for safety. Halogen infrared incandescent lamp (HIR) are about twice as efficient as standard tungsten filament incandescent lamps. Low-voltage is particularly popular for specialty lights and for display lighting in retail, museums, homes, and other applications. They typically last about 4000-5000 hours. Low-voltage and Tungsten-halogen lamps are smaller than regular lamps, with the smallest filaments.

A-19   A-23   B-10½   BT-37   C-7   DC-17   F-15   G-40   PAR-38   R-30   S-11   T-6   T-10   MR-16   T-4 Mini-Can   T-4 D.C. Bay   T-6 R.S.C.   T-4 R.S.C.
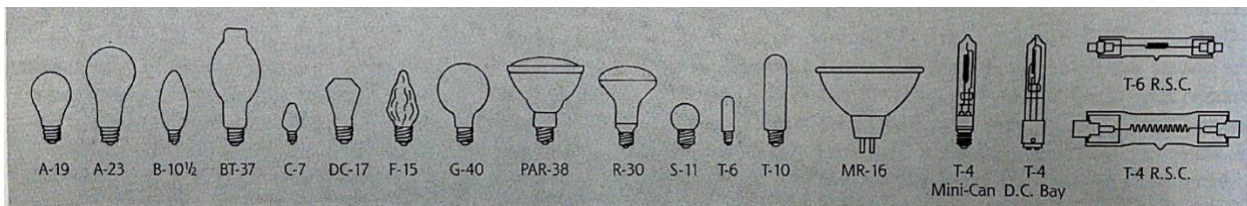
Figure 3.14 Incandescent Lamp Shapes (Steffy, 2008).

A cold cathode is a cathode that is not electrically heated by a filament. As Karlen and Benya (2003) said, cold cathode lamps are closely related to fluorescent lamps in operating principles. Cold cathode lamps include cold cathode fluorescent lamps (CCFLs) and neon lamps. They can last 20,000 to 40,000 hours and are used for architectural lighting applications.

Based on Turner (1998), and Karlen and Benya (2003), fluorescent lamps operate by passing an electrical current through a gas or vapor contained in a glass bulb. Fluorescent lamps use the principle of fluorescence, in which minerals exposed to ultraviolet light are caused to glow. Electric energy excites the gas inside the lamp, which generates ultraviolet light. Phosphors are designed to radiate particular colors of white light, thus enabling the choice of both the color temperature (Figure 3.15) and Color Rendering Index (CRI) (Figure 3.16) of a lamp. They have excellent color, dimming, and many other features expected of modern light sources. Steffy (2008) mentioned that they are longer-lived than filament lamps and the typical rated life ranges from 10,000 to 30,000 hours. Most common fluorescent lamps are standard straight and U-bent Lamps. They are preferred for general illumination because of their cost effectiveness and energy efficiency.

Figure 3.15 Color Temperature (Bergum, 2019).
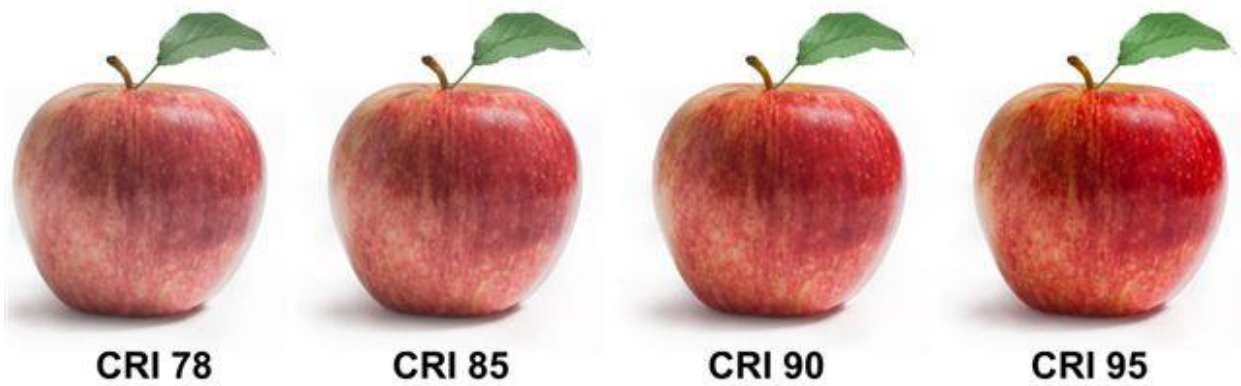
Figure 3.16 Color Rendering Index (CRI) (2021, April 9)

Another type of fluorescent is compact fluorescent lamps. There are two types of compact fluorescent lamps. One is screw-base (Figure 3.17) which directly place incandescent lamps in incandescent lamps sockets. One is plug-in-base (Figure 3.18) which fits into sockets in luminaires designed specifically for compact fluorescent lamps. Induction lamps also count as fluorescent lamps because they produce gas in the lamp to give off ultraviolet energy. Steffy (2008) added that induction lamps count as electrodeless lamps because they use radio waves rather than an electric arc to cause the gas in the lamp to glow.

The principle of an electroless lamp is that it has no electrode or cathode. There are two categories of electrodeless lamps: light emitting diodes lamps (LEDs) and induction lamps. Steffy (2008) said that LED lamps are fully electronic or solid-state devices with no traditional filaments or cathodes that are subjected to high voltages or currents. LEDs allow for tantalizingly brilliant colored light in an ever-changing intensity and color, including white but manufacturing tolerances have not yet perfected the preciseness of color and whiteness. Solid-state electronics means semiconductor electronics: electronic equipment using semiconductor devices such as transistors, diodes and integrated circuits (ICs). Solid-state encompasses LED, and emerging OLED technologies.
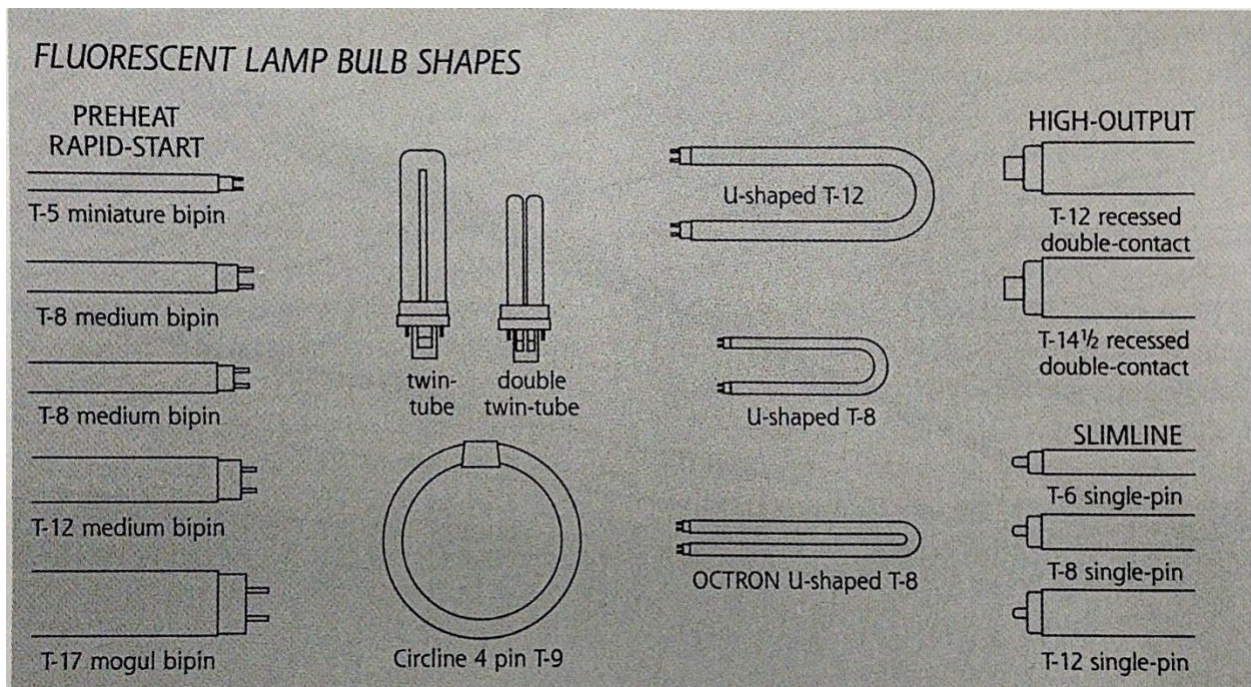
Figure 3.17 Fluorescent Lamps screw-base (Steffy, 2008).

Figure 3.18 Fluorescent lamps plug-in-base   Figure 3.19 HID shapes (2015, July 8)
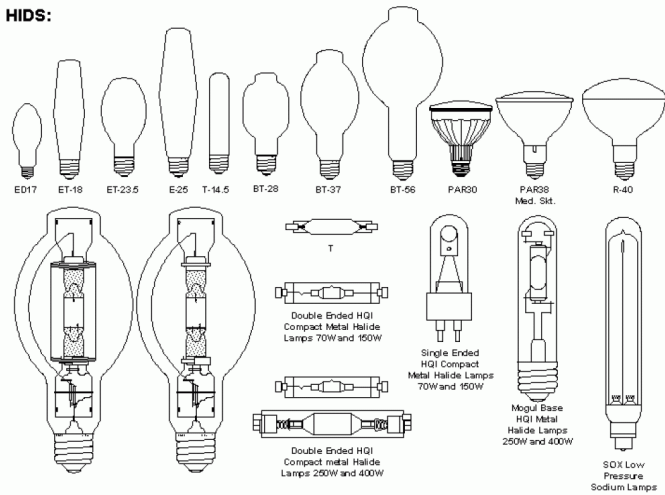
HIDs are so named because they can produce a lot of light through high-pressure steam discharge. They are several shapes (Figure 3.19) and three types: metal halide lamps, sodium lamps and mercury vapor lamps. Metal halide lamps produce white light of a good color quality and are available in many sizes. It can be used in track lighting and table lamps to gauge lamps for lighting stadiums. Steffy (2008) adds that from the perspective of architectural lighting, Ceramic metal halide lamps are the most appropriate for use because they are excellent candidates where efficient, long-life, near-incandescent color accent or general lighting is desired. Sodium lamps tend to be yellowish in color; these color deficiencies limit use to lighting roads, parking lots, heavy industrial workspaces, warehousing, security lighting, and other applications where light color is not important. High-pressure sodium lamps (HPS) exhibit a golden-pinkish light that tends to create spaces with a distinctly brown or dirty quality. Low-pressure sodium lamps (LPS) emit monochromatic yellow light, creating stark scenes devoid of

color altogether. Mercury vapor lamps are an older type, emitting poor color and are inefficient. They are used as streetlights and security lights but are almost never used in new construction.

We mentioned that light sources have different color temperatures. Color Temperature is one way of rating the tint of the light from a particular source, which comes from the theoretical relationship between the temperature of and object and the color of the light (Schiler, 1992). Color temperature also plays an important role in space, Tregenaz and Loe (1998) say: "Colour variation can enhance perception of time, and mark the change from day to night; it can give clues about differences in temperature and be linked with other environmental senses" (p.63). The lower color temperatures make people feel warm and relaxed, like when the sun is going down. Cooler color temperatures make people feel clean and refreshed. In general, values below 3300K are classified as warm and values above 5300K as cold. They said that warm sources are associated with small-scale and informal interiors. Warm sources can be preferred at low levels of illuminance while cool colors tend to require high levels. Steffy (2008) analyzed that lower color temperature reinforces the impressions of privacy and haziness. Experience shows great success with lamps in the 2700K to 3000K for many residential, hospitality, new, and restoration projects. 3500K seems the upper limit accepted in most commercial applications. The following figure summarizes the general usage scenario (Figure 3.20).
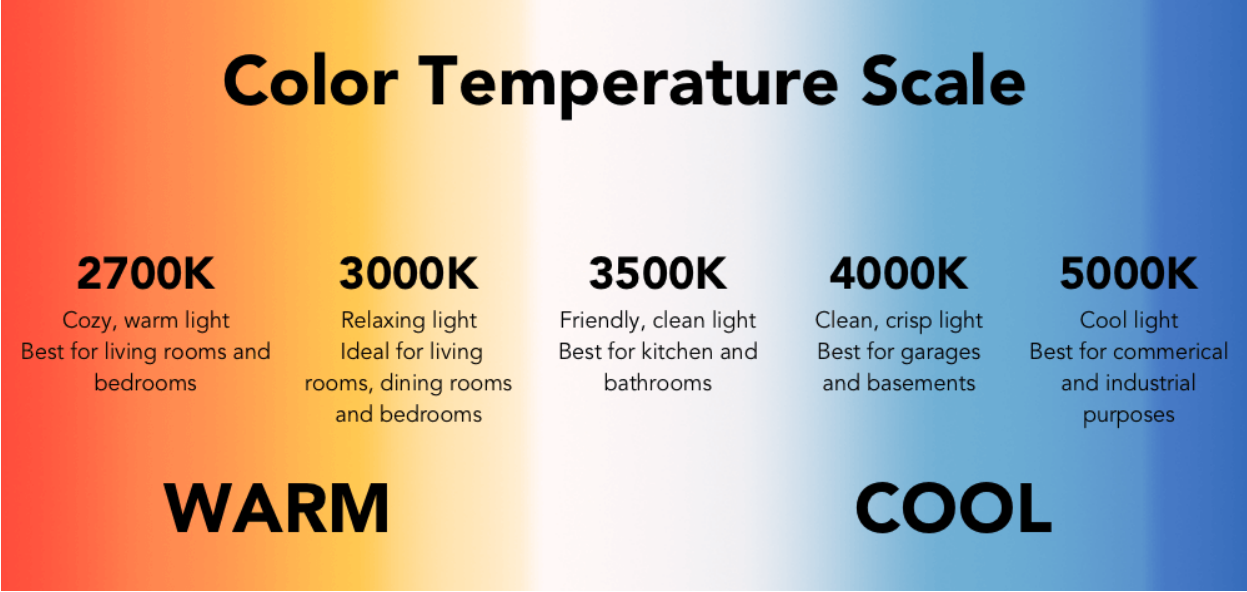
Figure 3.20 Color Temperature Usage Scenario

3.2.2 Styling: Aesthetic Elements in Decorative Lighting

Styles can establish a general visual perception. Like Steffy (2008) said we can show style through color, form, and proportion. Designers will create Table 3.3 Styling Analysis to summarize descriptions related to the color, form, and proportion.

Table 3.3 Styling Analysis

Rhythm	Elements		Style-Elements	Descriptions
	Line	Name	Color/ Form / Proportion	
Repetition	Shape	Name		

			Color/ Form / Proportion	
	Color	Name	Color/ Form / Proportion	
	…	…	Color/ Form / Proportion	
Building facades	Regular/ Flowing/ Progressive/ Radiation/ Gradation		Color/ Form / Proportion	

3.2.3 Material and Texture

As mentioned in Chapter 2, the most common materials used to make lamps are sheet steel, sheet aluminum, aluminum castings and plastics. However, there are other materials that can be used to make lamps, such as glass, parchments, papers, fabrics, brass and acrylic. Metal finishes are usually used in frames, housings, luminaire bodies, and the like, and they can run the gamut. Most diffusers are glass and acrylic. Manmade synthetic materials are also available as shades for luminaires, like fabrics and paper. Mica, alabaster, and onyx are a few natural materials that, when properly cut and finished, transmit light (Steffy, 2008).

In addition to these, Chapter 3.1.2 also mentions the construction materials and textures. Designers would not need to use architectural materials as materials for designing lighting but could use the following materials to imitate textures.

The following are some of the most used materials in lamps: metal, cement, glass, fabric, plastic, and paper.

Metal

Metal is a popular choice for pendant and wall mount framing because of its strength-to-weight ratio. Unlike some other materials, it will hold its form for years to come. Metal can be textured or smooth, natural, or finished in a vibrant color, which makes it especially versatile. The smoothness in texture and form you can get with a cylindrical metal shade is unmatched for adding a futuristic feel to any mid-century lamp (Luce, 2019). Figure 3.21 is an example of lamps that are made with metal.

Bean (2014) introduced metal material: Mild steel has mechanical strength and ductility, but it is heavier than aluminum and because it is subject to corrosion it normally needs to be painted. Typical uses are battens, recessed box luminaires, control gear trays, coated reflectors and covers. Sheet aluminum is a popular material for reflectors and louvers. The reflector grades are 99.8 per cent or super purity at 99.9 per cent. The LM6 (12 per silicon) alloy is most used for castings because of its excellent corrosion resistance. Typical uses would be street lighting luminaires, floodlighting bodies, and interior spotlights.
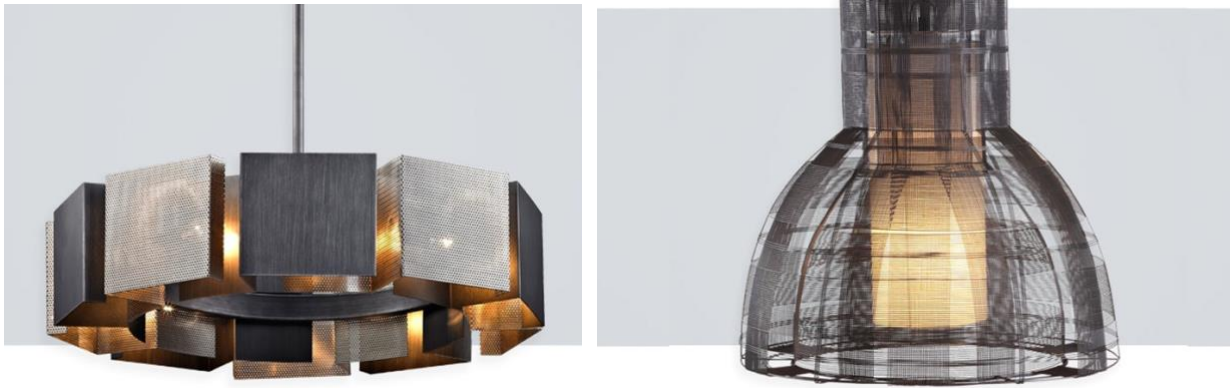
Figure 3.21 Lighting designs using metal mesh (Tan, 2017).

Cement

Cement has a weighty and organic look and usually comes complete with a more textured finish. It can create a brutalist effect, especially when used in sconces, or be more refined, using slow and smooth geometric flourishes that meld nicely with contemporary and transitional décor (Luce, 2019). Figure 3.22 is an example of lamps that are made with cement.

Figure 3.22 Cement Lighting Design (Team Yellowtrace, 2016).

Glass

According to Pritchard (1978) and Luce (2019), glass is primarily an aesthetic choice for lamps, one that allows designers to cleverly use variable textures, tones, and thickness to create light play and geometric intrigue. Glass is not light in weight, but it is both heat-resistant and heat-absorbent. Its wear resistance, luminescence, and its ability to be blown into a variety of shapes and colors make it in many ways more suitable than plastic for decorative tungsten lighting. Before synthetic compounds, glass was used in many ways. It was transparent or semi-transparent material of choice for lamps, windows, vases, drinkware and pretty much everything else. Figure 3.23 is an example of lamps that were made with glass.

Figure 3.23 Example of glass table lamp (Touch of Class, 2021).

Fabrics

Fabrics add texture, light diffusion, and shadow play to easily have an old-fashioned and sophisticated look. Because different fabrics offer such a variety of colors and patterns, there are so many different styles that can be derived from the fabric tone and texture (Luce, 2019). By utilizing high textures, and bright colors and patterns, fabric can be a playful solution to designs (Juniper-design, 2019). Figure 3.24 is an example of lamps that are made with fabrics.

Figure 3.24 Example of Fabrics Lamps (IDFdesign, 2021).

Plastic

Combining Pritchard (1978) and Bean (2014)'s viewpoint, there are two main types of plastic in use: thermoplastic (which can be re-melted) and thermosets (which cannot be re-melted once they have been cured). Acrylics and polystyrene have been widely used for diffusers and refractors, but the new building regulations place some restriction on their use in interiors. Acrylics material is supplied in sheet or granule form and is available as clear, opal, or colored. It is shaped by pressing while softened by heat or extruded into a continuous shape. Acrylic comes in any shape, any size, and any color. Polystyrene is supplied in powder form and has similar properties but does not have such good stability and tends to be brittle. It is cheaper. Figure 3.25 is an example of lamps that are made with plastic.

Figure 3.25 Different colors in plastic lighting (Hubert, 2021).

Papers

Paper is environmentally friendly. It seems that paper lighting, that is, lighting made from used pulp, cardboard, and paper, can also provide several opportunities for designers. Although paper may appear to be the simplest material, it has a high tolerance for design forms, and designers can feel at ease to make bold designs. In the right hands, it can be something truly elegant, modern, and magical (Edwards, 2017). Figure 3.26 is an example of lamps that are made with paper.
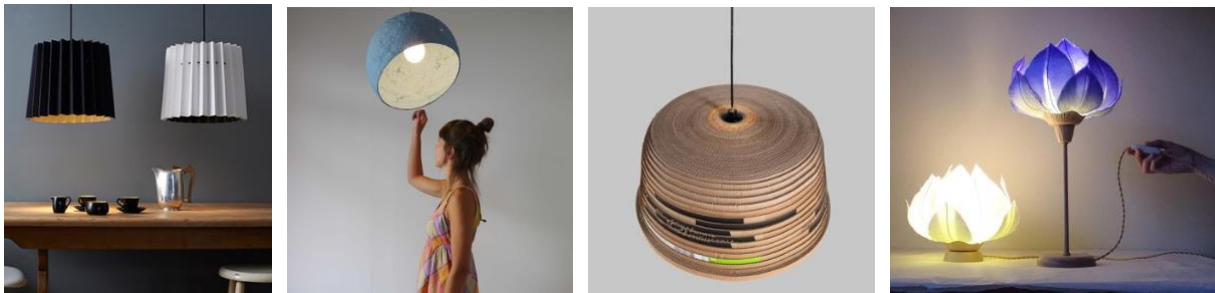

Figure 3.26 Example of Paper Lamps (Edwards, 2017/2019).

CHAPTER 4 DESIGN GUIDELINE APPLICATION

This chapter is an application of the design guidelines, which will be developed into a design flow chart based on the design guidelines in the previous chapter. This chapter will take one architecture example from each culture (Western culture, Middle Eastern culture, South Asian culture, East Asian culture) to analyze as examples and will choose one of them to achieve a design result that satisfies the product function and contains features of that architecture.

4.1 Design Process

The following procedures and methods were used in this study (Figure 4.1).

First, choose a traditional architecture of a place and use it as a design inspiration. Analyze the overall direction of the building according to the rhythm - repetition and building facade. It then sorted out features that the building could use as design elements. St. Basil's Cathedral in Russia was chosen in this chapter. St. Basil's Cathedral has a long history and has a strong relationship with the Russian culture and social environment.

Then designer should decide what type of light bulb and material to use. This depends on the performance, the surrounding environment and personal preference. Convert the St. Basil's Cathedral architectural design elements into elements that can be used as lighting styling.

After confirming the overall style of the lamp, the designer will utilize design guidelines to create the concept. All concepts are based on St. Basil's Cathedral. Designer will choose the better solution for further refinement. After improvement, the best solution will be prototyped to verify the validity of the design guidelines.
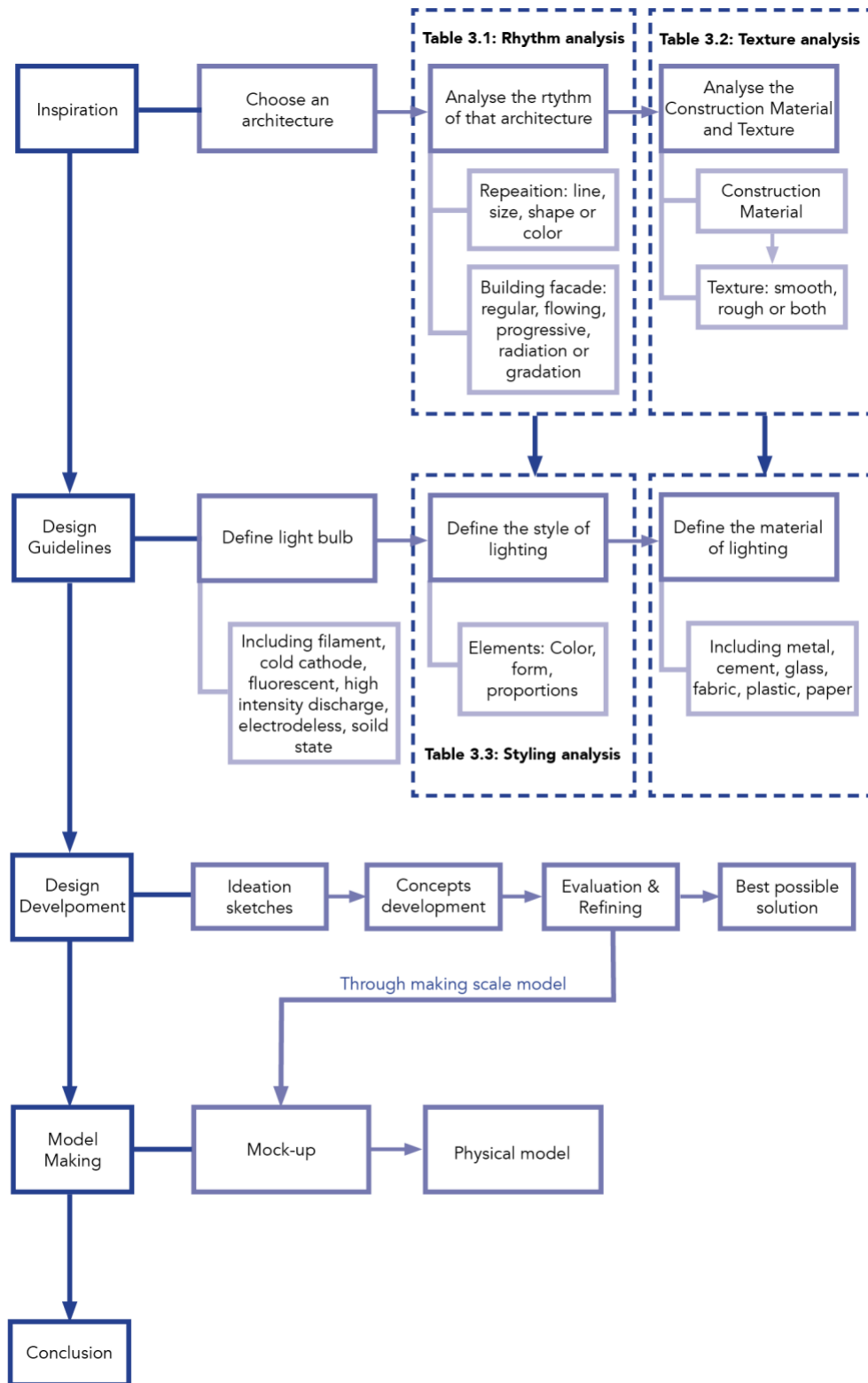
Figure 4.1 Design Process Flow Chart

4.2 Design Inspiration Analysis of Four Main Culture

This section will show how to use Table 3.1 Rhythm Analysis, Table 3.2 Texture Analysis and Table 3.3 Styling Analysis.

The following will analyze the rhythm, construction texture, and styling of four architectures from each culture (Western culture, Middle Eastern culture, South Asian culture, East Asian culture) that is mentioned in Chapter 2 and Chapter 3. This chapter will show how to use Table 3.1Rhythm Analysis, Table 3.2 Texture Analysis and Table 3.3 Styling Analysis.

Rhythm includes pattern's repetition (line, size, shape, color) and building facades (regular, flowing, progressive, radiation, gradation). Styling is a visual expression which includes color, form, proportions. Texture type includes rough, smooth, and both rough and smooth.

4.2.1 Western ulture: St. Basil's Cathedral, Moskva, Russia

According to McBride (2009), St. Basil's Cathedral located in Moskva, Russia. It is known more officially as the Cathedral of the Intercession on the Moat and built by order of Tsar Ivan IV (Ivan the Terrible) to commemorate the capture of the Tatar stronghold Kazan in 1552. Barma and Postnik Yakovlev may have been the architects of the cathedral, but scholars dispute the authenticity of their identities: it may have been one architect, or another person whose name was a combination of the two. Legend holds that the architects were blinded by Ivan the Terrible after they completed the Cathedral so that they could not replicate such a beautiful structure.

In Russian culture, the cultural connection and connotation of St. Basil's Cathedral is a general concept of power, unity, and continuity. However, people find that it is more appropriate for the Russians to use the cathedral as a tomb of a popular and sacred critic, rather than as a monument to the victory of a cruel monarch. The cathedral has nothing to do with the power and continuity of the government or political system, but with the determination of the Russian

people to find unity among cultural representatives, a unity that is more durable than this fickle and sometimes oppressive system. *Time Magazine* declared in March 1934 that the building was "Russia's newest and greatest monument" and would become "the largest and tallest building in the world" (McBride, 2009).
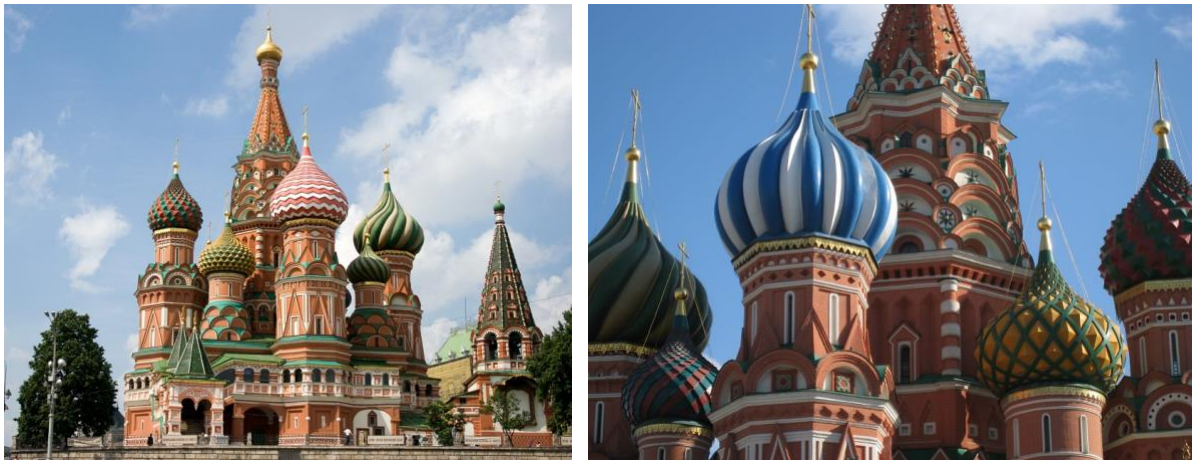
Figure 4.2 Saint Basil's Cathedral (Brady, 2010), (Goldsmith, 2009)

Table 4.1 Rhythm Analysis of Saint Basil's Cathedral

Rhythm	Elements		Descriptions
Repetition	Shape	Swirling radial Deformed sphere Hexagonal pyramid	When seen from the top, the eight domes surrounding the ninth dome in a circular fashion appear to form a star (University of Pennsylvania, 2018).

			The Cathedral is recognizable by its "nine multi-hued onion domes" of various sizes and distances from one another, and by the "gold-plated garlic dome that crowns the lofty central spire." (McBride, 2009).
		Arch Triangular Parallelogram	The design on the exterior wall of the church. The arch can be seen from the outside.
	Line	Triangular wave Arc	The design on the exterior wall of the church. The arch can be seen from the outside.

	Color		The vivid multicolored pattern on its domes appeared only in the 17th – early 18th century. The original Cathedral was painted mostly red and white (Bridgetomoscow, n.d.). The church acquired its vivid present-day colors more than 100 years after its construction. The bright pattern of the church domes makes it look like a blossoming garden of heaven (Bridgetomoscow, n.d.). Part of its distinctive appearance can be attributed to the colorful domes and vivid redbrick towers (University of Pennsylvania, 2018).
		275441 AA1927 D31335 AA5F3A FA9D00 C79F21 397C9F coolors F5EEE6	
Building facades	Progressive Radiation		The onion domes and spires of St. Basil's Cathedral rise above Moscow's Red Square, and captivate our collective imagination of Russia (McBride, 2009).

		The center of the composition is the main tent-roofed Church of the Intercession, around which there are eight other pillar-like domed churches. In plan, the cathedral forms an eight-pointed star. (Bridgetomoscow, n.d.). See Figure 4.3 The nine multi-colored onion domes have different heights, with the highest one in the middle, followed by the four on the corners, and finally the four in the middle. It has a progressive effect.

Figure 4.3 The plan of St Basil's cathedral (Bridgetomoscow, n.d.)

Table 4.2 Styling Analysis of Saint Basil's Cathedral

Rhythm	Elements		Styling-Element	Descriptions
Repetition	Shape	Swirling radial Deformed sphere Hexagonal pyramid	Form Proportion	When seen from the top, the eight domes surrounding the ninth dome in a circular fashion appear to form a star (University of Pennsylvania, 2018).

				The Cathedral is recognizable by its "nine multi-hued onion domes" of various sizes and distances from one another, and by the "gold-plated garlic dome that crowns the lofty central spire." (McBride, 2009).
		Arch Triangular Parallelogram	Form	The design on the exterior wall of the church. The arch can be seen from the outside.
	Line	Triangular wave Arc	Form	The design on the exterior wall of the church. The arch can be seen from the outside.

| | Color | | Color | The vivid multicolored pattern on its domes appeared only in the 17th – early 18th century. The original Cathedral was painted mostly red and white (Bridgetomoscow, n.d.).

The church acquired its vivid present-day colors more than 100 years after its construction. The bright pattern of the church domes makes it look like a blossoming garden of heaven (Bridgetomoscow, n.d.).

Part of its distinctive appearance can be attributed to the colorful domes and vivid redbrick towers (University of Pennsylvania, 2018). |

| Building facades | Progressive Radiation | Form Proportion | The onion domes and spires of St. Basil's Cathedral rise above Moscow's Red Square, and captivate our collective imagination of Russia (McBride, 2009).

The center of the composition is the main tent-roofed Church of the Intercession, around which there are eight other pillar-like domed churches. In plan, the cathedral forms an eight-pointed star. (Bridgetomoscow, n.d.). See figure 4.3

The nine multi-colored onion domes have different heights, with the highest one in the middle, followed by the four on the corners, and finally the four |

			in the middle. It has a progressive effect.

Table 4.3 The construction materials and textures analysis of Saint Basil's Cathedral

Architecture	Materials	Texture type	Descriptions
Saint Basil's Cathedral	Brick Wood	Smooth	The cathedral is an extraordinary structure with eight claustrophobically small chapels huddled around an incredibly tall central nave. The whole thing was built from a new material—brick, which covers a timber frame.

4.2.2 South Asian Culture: Jama Masjid, Delhi, India

The Friday Mosque is the congregational mosque of Old Delhi (Shahjahanabad), the seventh Islamic city built on the site of Delhi (Figure 4.4). The mosque was commissioned, like Shahjahanabad itself, by Shah Jahan (r. 1628-1658), the fifth Mughal ruler of India. The mosque is also called the Masjid-i-Jahanuma, or 'the mosque commanding a view of the world,' as it is

sited on a high plinth atop a natural hillock. At the time of its construction, it was the largest

mosque in the subcontinent. Due to its magnificence and size, the Friday Mosque of Old Delhi is

often regarded as the apotheosis of Indian mosque design (Archnet, n.d.). Some details of Jama

Masjid are shown in Figure 4.5.

Figure 4.4 Jama Masjid, Delhi (Ahmed, n.d.)
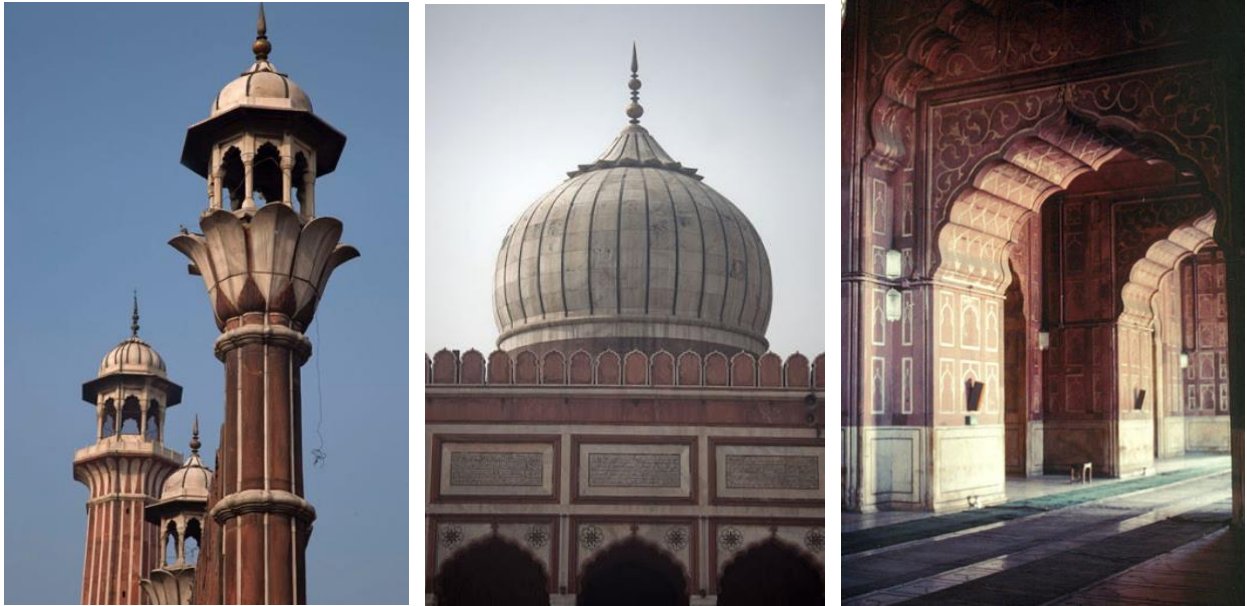
Figure 4.5 Details of Jama Masjid, Delhi (Traveladventures, 2015), (Williams & Williams, n.d.)

Table 4.4 Rhythm Analysis of Jama Masjid Junagadh

Rhythm	Elements		Descriptions
Repetition	Shape	Cusped Arch	Cusped arched recesses flank the iwan on either side and at each level.
		Lotus- shaped	Its eastern, entry elevation is dominated by a central projecting pishtaq with slender minarets at its corners; these culminate in white marble chhatris atop lotus-shaped capitals.

			In Islamic architecture, pishtaq is a rectangular frame around an arched opening, usually associated with an iwan (Oxdord, 2021).
		Octangle	The eastern elevation is further adorned with an intricate arched arcade atop the parapet, with a total of twenty-five white marble domes crowing the structure with different size. Four convex fluted minarets rise above the parapet; the eastern minarets associated with the arcade rise higher and are finished with octagonal domed chhatris.
		Circular	At the top of Chhatris and indoor roof. Chhatris are elevated, dome-shaped pavilions used as an element in Indian

			architecture. The word Chhatri means "canopy" or "umbrella."
	Line	Radiation line	At the top of Chhatris and indoor roof. The chhatris or cenotaphs have shikhars (spiral) on the top that closely resemble those of the temples built in the Nagar style (Ministry of Tourism, Government of India, 2021).
	Color	824A33 9E5C45 AEA79F E0DCC9 EFEAD4 coolors	Above the arch, the half-dome of the pishtaq iwan is clad in red sandstone with white marble strips and flanked on either side by five smaller cusped arches. Above the line of arches is a white marble blank frieze with Arabic inscriptions framed in red sandstone.
	Regular		

Building facades	Radiation	The whole building is regular. Chhatris is the most iconic structure in the building, and it has shikhars (spiral) on the top.

Table 4.5 Styling Analysis of Jama Masjid Junagadh

Rhythm	Elements		Styling-Element	Descriptions
Repetition	Shape	Cusped Arch	Form Proportion	Cusped arched recesses flank the iwan on either side and at each level.
		Lotus- shaped	Color Form Proportion	Its eastern, entry elevation is dominated by a central projecting pishtaq with slender minarets at its corners; these culminate in white marble chhatris atop lotus-shaped capitals.

				In Islamic architecture, pishtaq is a rectangular frame around an arched opening, usually associated with an iwan (Oxdord, 2021).
		Octangle	Form Proportion	The eastern elevation is further adorned with an intricate arched arcade atop the parapet, with a total of twenty-five white marble domes crowing the structure with different size. Four convex fluted minarets rise above the parapet; the eastern minarets associated with the arcade rise higher and are finished with octagonal domed chhatris.

		Circular	Form Proportion	At the top of Chhatris and indoor roof. Chhatris are elevated, dome-shaped pavilions used as an element in Indian architecture. The word Chhatri means "canopy" or "umbrella."
	Line	Radiation line	Form	At the top of Chhatris and indoor roof. The chhatris or cenotaphs have shikhars (spiral) on the top that closely resemble those of the temples built in the Nagar style (Ministry of Tourism, Government of India, 2021).

	Color		Color	Above the arch, the half-dome of the pishtaq iwan is clad in red sandstone with white marble strips and flanked on either side by five smaller cusped arches. Above the line of arches is a white marble blank frieze with Arabic inscriptions framed in red sandstone.
Building facades	Regular Radiation		Form Proportion	The whole building is regular. Chhatris is the most iconic structure in the building and it has shikhars (spiral) on the top.

Table 4.6 The construction materials and textures analysis of Jama Masjid Junagadh

Architecture	Materials	Texture type	Descriptions

Jama Masjid, Delhi, India	Marble stone Sandstone	Smooth	Above the line of arches is a white marble blank frieze with Arabic inscriptions framed in red sandstone.

4.2.3 Middle Eastern Culture: The Great Pyramid, Giza, Egypt

The Great Pyramid of Giza (Figure 4.6) is a defining symbol of Egypt and the last of the ancient Seven Wonders of the World. It is located on the Giza plateau near the modern city of Cairo and was built over a twenty-year period during the reign of the king Khufu (2589-2566 BCE, also known as Cheops) of the 4th Dynasty. Until the Eiffel Tower was completed in Paris, France in 1889 CE, the Great Pyramid was the tallest structure made by human hands in the world; a record it held for over 3,000 years and one unlikely to be broken. The pyramid rises to a height of 479 feet (146 metres) with a base of 754 feet (230 metres) and is comprised of over two million blocks of stone (Mark, 2016).

Figure 4.6 The Great Pyramid of Giza in Egypt (Leow,2019).

Figure 4.7 Details of Pyramid (Wonderopolis, 2010)

Table 4.7 Rhythm Analysis of The Great Pyramid

Rhythm	Elements		Descriptions
Repetition	Shape	Triangular Pyramid Rectangle	Its sides rise at an angle of 51°52′ and are accurately oriented to the four cardinal points of the compass. Pyramids have a unique geometric shape. In geometry, a pyramid is defined as a polyhedron made by connecting a polygonal base (a two-dimensional shape with three or more straight sides) with a point at the top, called the apex (Wonderopolis, 2010). The base of the pyramid is a triangle, and the lateral faces are also triangles. Rectangular blocks can be seen piled up on the side.

	Color		The Great Pyramid's core is made of yellowish limestone blocks, the outer casing (now almost completely gone) and the inner passages are of finer light-coloured limestone. These blocks of white Tura limestone would have given the pyramid a smooth surface and been quite bright and reflective. The interior burial chamber is built of huge blocks of granite (Calvert, n.d.).
Building facades	Progressive		It was built from the inner, rough, locally quarried core stone, which we see today, and the angled, outer blocks laid on horizontal tracks to form a staircase (Figure 4.7). At that time the spaces were filled with plaster. The fine outer casing stones, which have long since been removed, were laid with great precision.

				At the very top of the pyramid would have sat a capstone, known as a pyramidion, that may have been gilt. This dazzling point, shining in the intense sunlight, would have been visible for a great distance (Calvert, n.d.).

Table 4.8 Styling Analysis of The Great Pyramid

Rhythm	Elements		Styling-Element	Descriptions
Repetition	Shape	Triangular Pyramid Rectangle	Form Proportion	Its sides rise at an angle of 51°52′ and are accurately oriented to the four cardinal points of the compass. Pyramids have a unique geometric shape. In geometry, a pyramid is

				defined as a polyhedron made by connecting a polygonal base (a two-dimensional shape with three or more straight sides) with a point at the top, called the apex (Wonderopolis, 2010). The base of the pyramid is a triangle, and the lateral faces are also triangles. Rectangular blocks can be seen piled up on the side.
	Color	855F32 B1916A EDBF73 F6D697 EFDBB8 COOLORS	Color	The Great Pyramid's core is made of yellowish limestone blocks, the outer casing (now almost completely gone) and the inner passages are of finer light-coloured limestone. These blocks of white Tura limestone would have given

				the pyramid a smooth surface and been quite bright and reflective. The interior burial chamber is built of huge blocks of granite (Calvert, n.d.).
Building facades	Progressive		Color Form Proportion	It was built from the inner, rough, locally quarried core stone, which we see today, and the angled, outer blocks laid on horizontal tracks to form a staircase (Figure 4.7). At that time the spaces were filled with plaster. The fine outer casing stones, which have long since been removed, were laid with great precision.

| | | | At the very top of the pyramid would have sat a capstone, known as a pyramidion, that may have been gilt. This dazzling point, shining in the intense sunlight, would have been visible for a great distance (Calvert, n.d.). |
| | | | |

Table 4.9 The construction materials and textures analysis of The Great Pyramid

Architecture	Materials	Texture type	Descriptions
The Great Pyramid, Giza, Egypt	Limestone	Rough	The Great Pyramid's core is made of yellowish limestone blocks, the outer casing (now almost completely gone) and the inner passages are of finer light-coloured limestone.

4.2.4 East Asian Culture: The Hall of Prayer for Good Harvest, The Temple of Heaven, Beijing, China

The Temple of Heaven (Figure 4.8), founded in the first half of the 15th century, is a dignified complex of fine cult buildings set in gardens and surrounded by historic pine woods. In its overall layout and that of its individual buildings, it symbolizes the relationship between earth and heaven – the human world and God's world – which stands at the heart of Chinese cosmogony, and the special role played by the emperors within that relationship (UNESCO, 1998).

The Hall of Prayer for Good Harvest (Figure 4.9), also known as the Hall of Prayer for Grain, is the main building of the Temple of Heaven. It was the place where emperors of the Ming and Qing Dynasties prayed for good harvest. The main hall, 38-metre-tall structure, was built on a three-story white marble round platform surrounded by white stone carvings 6 meters high, which was the altar of prayer for grain. Figure 4.10 shows some details of The Hall of Prayer for Good Harvest.
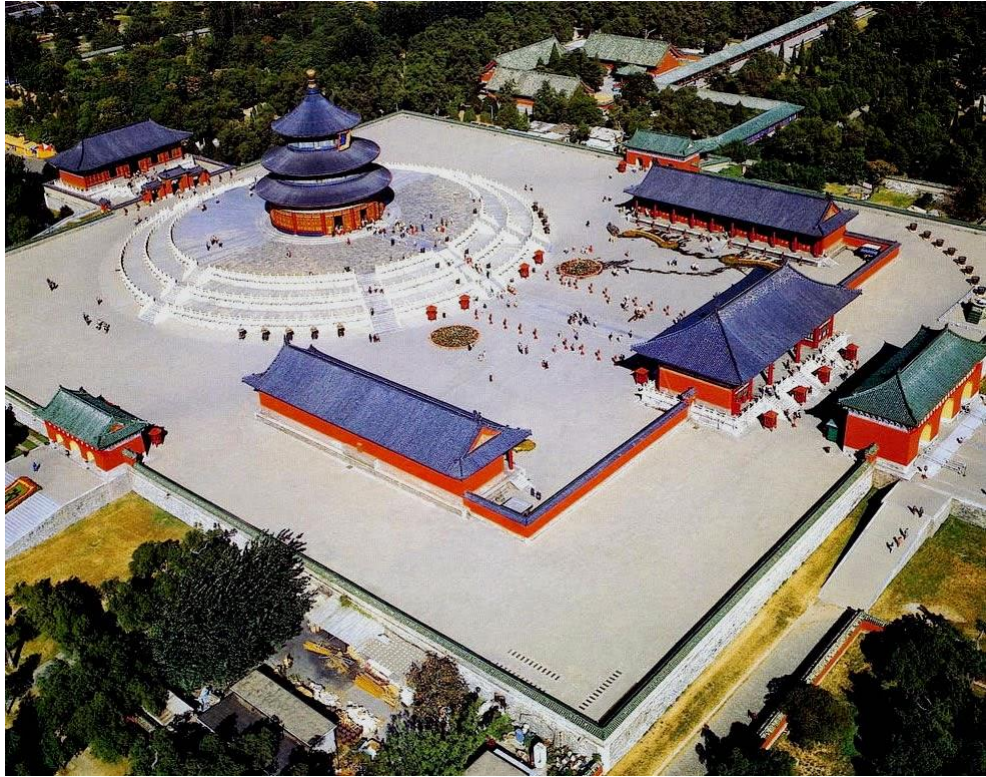
Figure 4.8 Bird's eye view of the Temple of Heaven (Ang, n.d.)
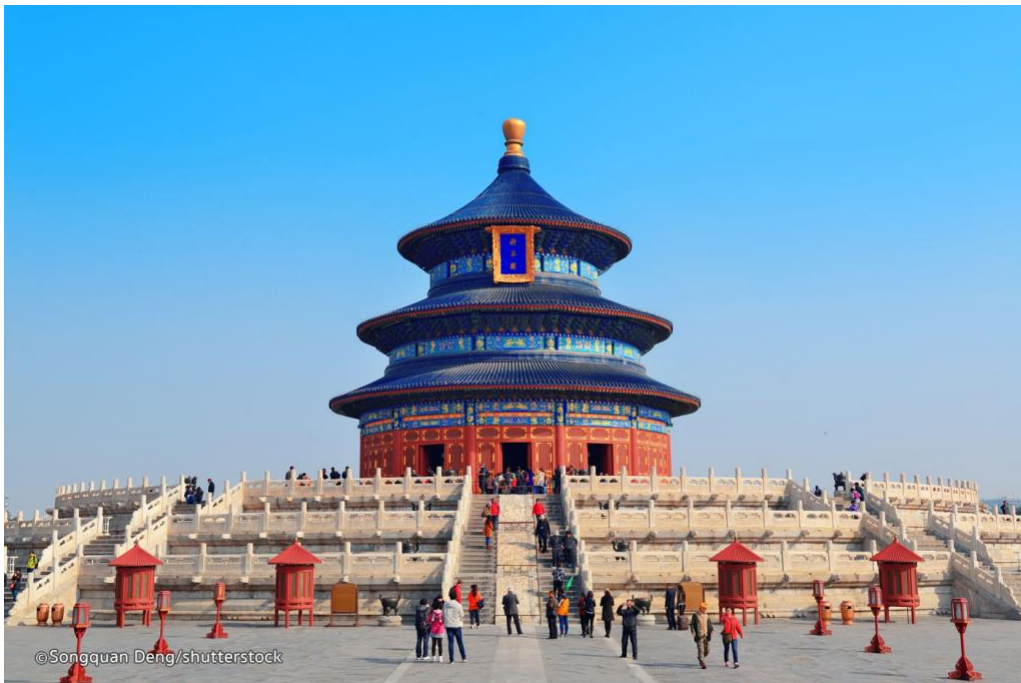
Figure 4.9 The Hall of Prayer for Good Harvests
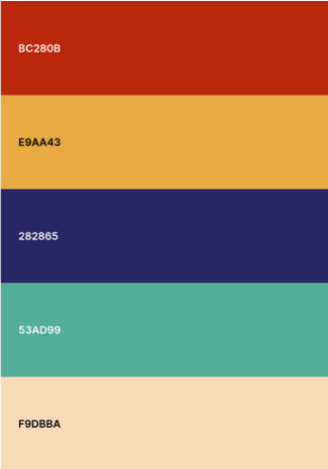
Figure 4.10 Detail of The Hall of Prayer for Good Harvest

Table 4.10 Rhythm Analysis of The Hall of Prayer for Good Harvests

Rhythm	Elements		Descriptions
Repetition	Shape	Circular Conical Cylindrical	The Temple of Heaven is an axial arrangement of Circular Mound Altar to the south open to the sky with the conically roofed Imperial Vault of Heaven immediately to its north. This is linked by a raised sacred way to the circular, three-tiered, conically roofed Hall of Prayer for Good Harvests further to the north. (UNESCO, 1998).

			Twelve supporting cylindrical columns can be seen from the outside.
		Dragon Cloud	The pattern is painted on the outside of the building.
		Rectangles	The windows and doors on the lowest level are rectangular. They were arrayed round the circular wall but there are only three doors.
	Line	Radiation line	The wooden slats on the roof extend outward in a circular shape from the center.

	Color		It is a gilded gold roof, blue tiles and red pillars, resplendent painted three-story circular hall with double eaves. Traditionally, red represented warmth and the highest amount of yang – as in yin-yang – energy. The association of red is with positive mojo and good fortune. The roof of the temple is covered with blue, yellow and green colored glaze, which symbolizes heaven, earth and all things. Yellow was another prominent color in old Beijing, and it was associated primarily with the emperor. Connected to the element of earth, yellow represented the very foundations of Chinese civilization in antiquity.

BC280B

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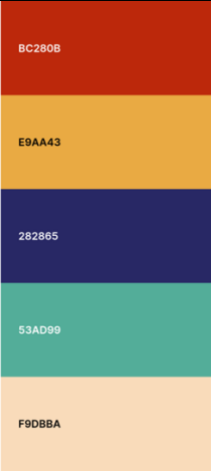
			The color blue symbolized heaven and heavenly blessings
Building facades	Radiation Gradation Progression		The Hall of Prayer for Good Harvests has three layers of eaves; each layer is covered with blue colored glaze symbolizing the heaven. The layer-by-layer eave creates an atmosphere of getting closer to heaven. The three-story roof is a progressive form: gradually increasing from top to bottom.

		The wooden slats on the roof extend outward in a circular shape from the center.

Table 4.11 Styling Analysis of The Hall of Prayer for Good Harvests

Rhythm	Elements		Styling-Element	Descriptions
Repetition	Shape	Circular Conical Cylindrical Rectangles	Form Proportion	The Temple of Heaven is an axial arrangement of Circular Mound Altar to the south open to the sky with the conically roofed Imperial Vault of Heaven immediately to its north. This is linked by a raised sacred way to the circular, three-tiered, conically roofed Hall of Prayer for Good Harvests further to the north. (UNESCO, 1998).

				Twelve supporting cylindrical columns can be seen from the outside. The windows and doors on the lowest level are rectangular. They were arrayed round the circular wall but there are only three doors.
		Dragon Cloud	Color Form Proportion	The pattern is painted on the outside of the building.
	Line	Radiation line	Form	The wooden slats on the roof extend outward in a circular shape from the center.
	Color		Color	It is a gilded gold roof, blue tiles and red pillars, resplendent

				painted three-story circular hall with double eaves. Traditionally, red represented warmth and the highest amount of yang – as in yin-yang – energy. The association of red is with positive mojo and good fortune. The roof of the temple is covered with blue, yellow and green colored glaze, which symbolizes heaven, earth and all things. Yellow was another prominent color in old Beijing, and it was associated primarily with the emperor. Connected to the element of earth, yellow represented the very foundations

Building facades	Radiation		Form Proportion	of Chinese civilization in antiquity. Blue symbolized heaven and heavenly blessings
	Gradation		Color Form	The Hall of Prayer for Good Harvests has three layers of eaves; each layer is covered with blue colored glaze symbolizing the heaven. The layer-by-layer eave creates an atmosphere of getting closer to heaven.
	Progression		Color Form Proportion	The three-story roof is a progressive form: gradually increasing from top to bottom. The wooden slats on the roof extend outward in a circular shape from the center.

Table 4.12 The construction materials and textures analysis of The Hall of Prayer for Good Harvests

Architecture	Materials	Texture type	Descriptions
The Hall of Prayer for Good Harvest, The Temple of Heaven, Beijing, China	Wood Marble stone	Smooth	The Hall of Prayer for Good Harvests is a magnificent triple-gabled circular building, 36 m (118 ft) in diameter and 38 m (125 ft) tall, built on three levels of marble stone base, where the emperor prayed for good harvests. The building is completely wooden, with no nails.

4.3 Analysis of Design Elements in Lighting design

      This section will select St. Basil's Cathedral from western culture to continue applying the design guideline. Light source, styling and finishes are three design elements in lighting design. Chapter 4.2 Design Inspiration Analysis of Four Main Culture is already analyzed the styling, so this chapter will analyze light source and finishes to design a lamp.

This lamp is used to decorate the home, so it is good to choose compact fluorescent lamp, because they are long-lived and typical rated life ranges from 10,000 to 30,000 hours. Also, they are preferred for general illumination because of their cost effectiveness and energy efficiency.

According to Table 4.2 Styling Analysis of Saint Basil's Cathedral, texture should be close to smooth texture when designing the lamp. Designer would use wood as lamp structure because Saint Basil's Cathedral uses wood as well. To have light transmission, cardstock can be used to make the lampshade. It has a high tolerance for design forms and has a smooth texture, which conforms to the texture analysis in Table 4.2.

4.4 Design Development

Designers use the elements and style-elements on the Table 4.2 Styling Analysis of Saint Basil's Cathedral as inspiration to draw sketches. The available elements are swirling radial, deformed sphere, hexagonal pyramid, triangular wave, arch, semicircle arc, triangular, parallelogram, progressive, radiation and color. Swirling radial, deformed sphere and hexagonal pyramid, progressive and radiation can be used in design form and proportion. Triangular wave, arch, semicircle arc, triangular, parallelogram can be only used in design form. Color can be only used in color.

The designer decides which elements to use in the design, not necessarily all elements must be applied. The application of the elements can be no less than three (see Figure 4.11 and Figure 4.12).
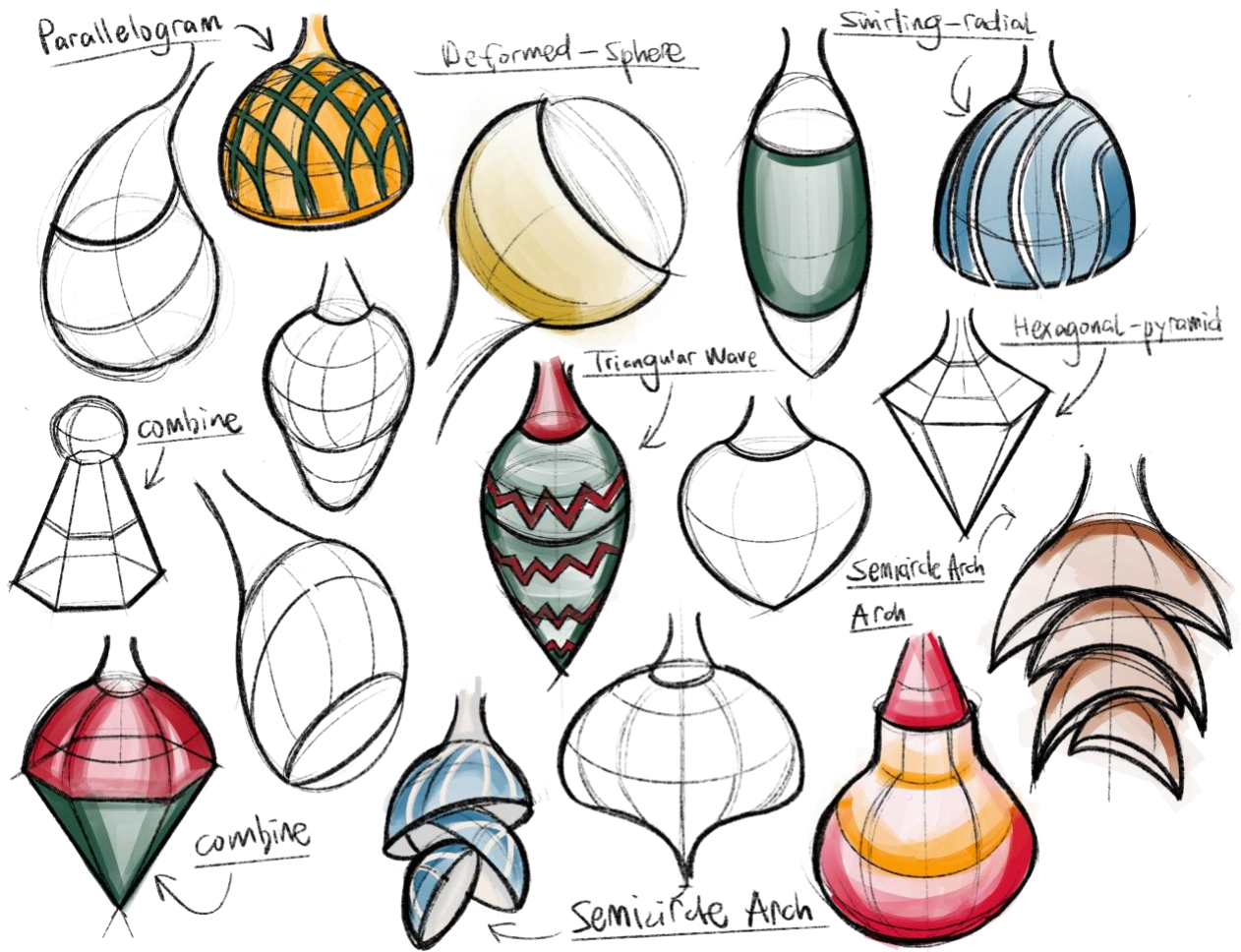
Figure 4.11 Design development sketches

Figure 4.12 Design development concept

The final design concept is to use plywood as the material for the lamp's internal structure. The elements are deformed sphere, triangular wave, parallelogram, arch, and radiation (see Figure 4.13). Cardstock is used as material for the exterior lampshade. Different patterns can be applied on the cardstock lampshade.

Figure 4.13 Final design concept

4.5 Model Making

4.5.1 Mockup

Use foam core first to determine size and scale (Figure 4.14). Figure 4.15 and Figure 4.16 are two different sizes and scales. This is how they look when puting light on them.

Figure 4.14 Foam core mockup

Figure 4.15 Foam core mockup in light

Figure 4.16 Foam core mockup in light

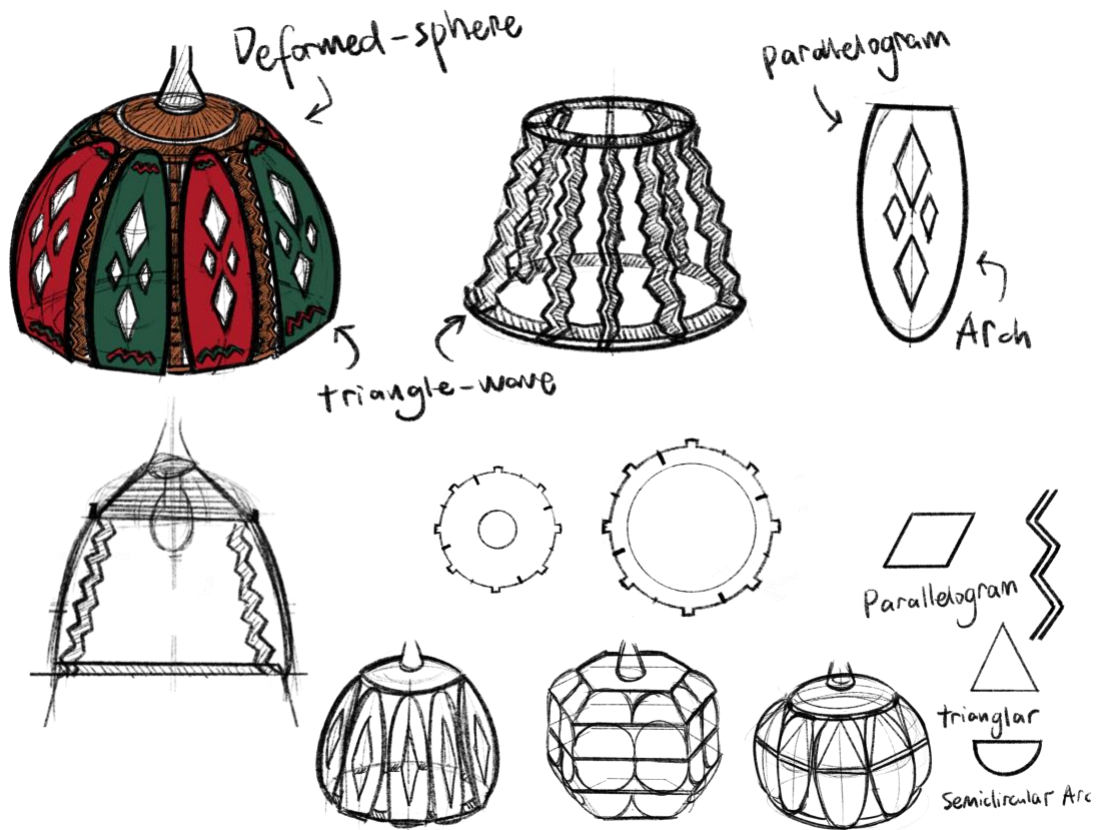### 4.5.2 Final Model

Plywood is the material for the lamp's internal structure. Cardstock is used as material for the exterior lampshade. The laser cutting technology was used here. Use Illustrator to make laser-cut file. Figure 4.17 and Figure 4.18 is the layout of the laser-cut file. Figure 4.19 is final model parts. Figure 4.20 is final model of the lamp. Figure 4.21 is the lamp with light. Figure 4.22 is the details of the lamp.

Final model descriptions

Triangular waves are applied in the internal structure. Arch and parallelogram are applied in the lampshade. The application of triangular waves, arch and parallelogram are reflected in the form. Deformed sphere and radiation are applied to the whole lamp. Their application is reflected in the proportions. Two colors are applied in the cardstock lampshade, which is reflected in color (See Figure 4.23).
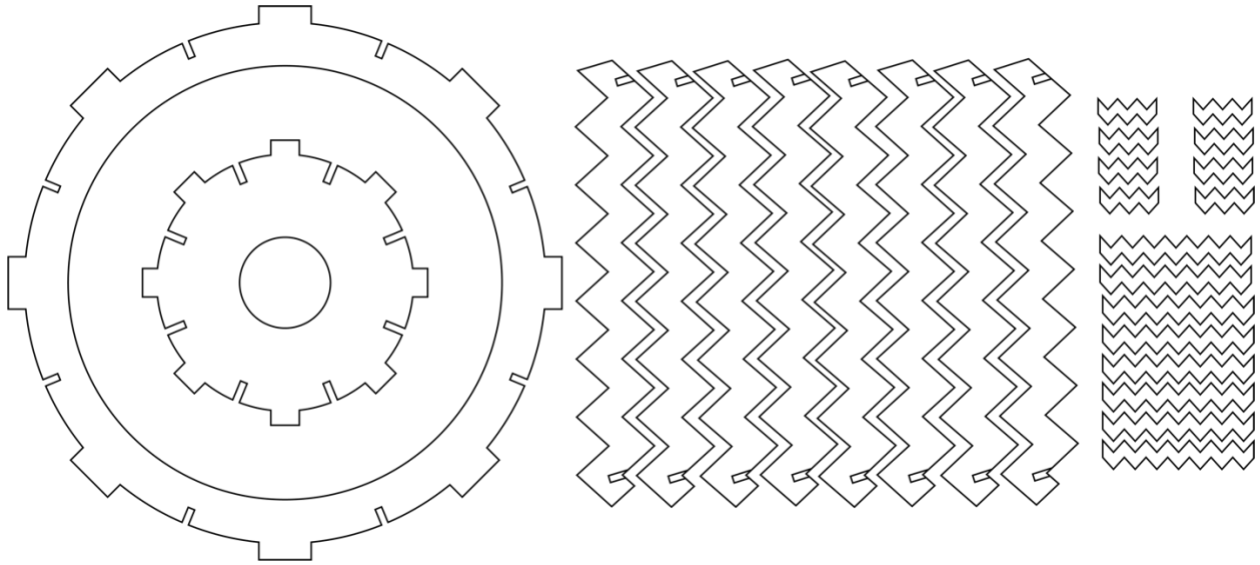
Figure 4.17 layout of the laser-cut file- structure
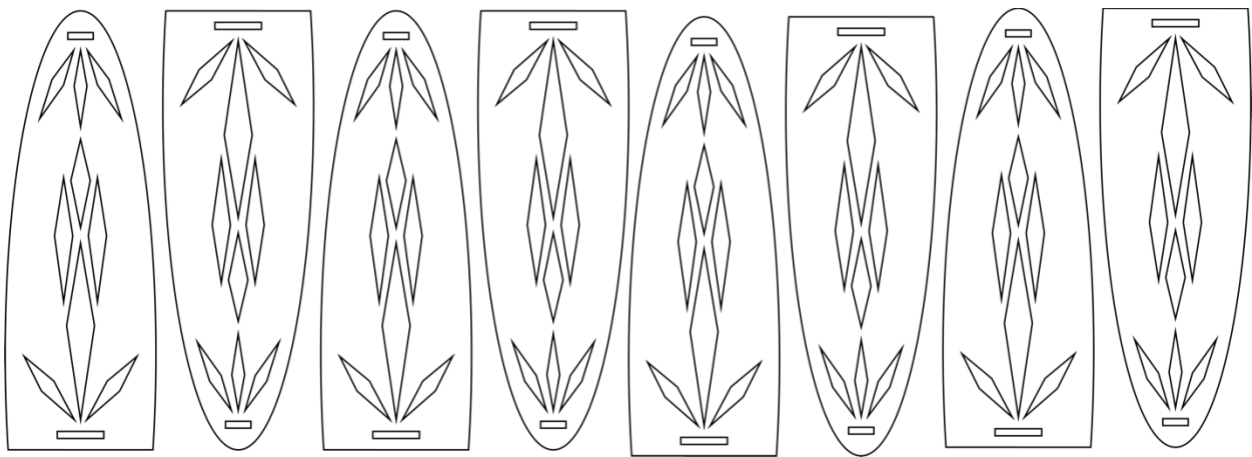
Figure 4.18 layout of the laser-cut file- lampshade

Figure 4.19 Final model parts

Figure 4.20 Final model

Figure 4.21 Lamp with light

Figure 4.22 Details of the lamp
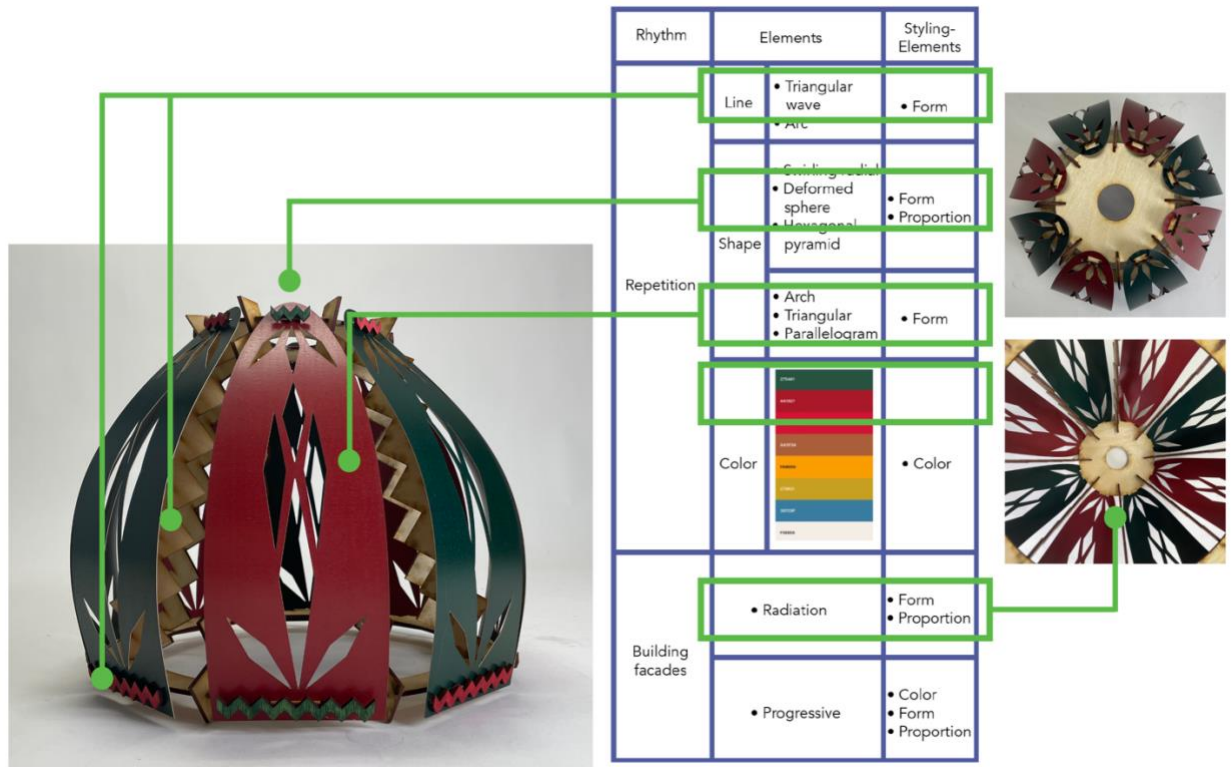
Figure 4.23 Final Model Descriptions

4.6 Summary

This lamp is successfully following the design guidelines in this thesis. The lamp has a strong relationship with the architecture which is St. Basil's Cathedral from western culture and is created by applying the analysis of aesthetic and texture features in Chapter 3. The designed lamp shows exploration of the design guideline.

CHAPTER 5 CONCLUSION AND FUTURE STUDY

5.1 Conclusion

The objective of this thesis is about applying local architectural features in luminaire design to achieve the purpose of cultural inheritance and improve product value. The results of the study of literature review chapter shows that culture can be a resource for design innovation and inspiration and can play a role in the intuitive use of products. Furthermore, architecture has an important cultural background in human history and has different features in different regional culture. Therefore, it is appropriate choice to use architecture as design inspiration. Luminaires also play an important role in the architecture and can affect people's perception of space. Design inspiration comes from the rhythm and construction texture of architecture. Rhythm includes pattern's repetition (line, size, shape, color) and building facades (regular, flowing, progressive, radiation, gradation). Construction texture includes rough, smooth, and both rough and smooth. After analyzing the rhythm, designers will analyze the styling, which is a visual expression including color, form, proportions. Construction material and texture can be a reference to design luminaire as well. The common light bulbs and materials of luminaire industry are studied and analyzed, and designers can choose among them according to different situations.

To create luminaire with characteristics of architecture, the sample work is to demonstrate the application of the design guidelines. In design guidelines application chapter, the Russian architecture, St. Basil's Cathedral from western culture, was chosen as an example to explain the design guidelines. These design guidelines help the author to create a lamp with St. Basil's Cathedral's features.

5.2 FUTURE STUDY

More aspects can be further investigated in the next phase. These design guidelines can be changed with the development of manufacturing technique and society, and feedback from users. In the previous chapter, Saint Basil's Cathedral from Russia was chosen to demonstrate the design guidelines in the design guidelines application chapter. Other architectures are recommended for future study. Furthermore, four traditional architectures are analyzed as examples. In fact, not only traditional architectures, but also modern architectures with local cultural characteristics can be analyzed in the future study.

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