



Light in Church design

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Abstract

The goal of this work basically represents the formation of a historical and practical basis on the basis of which it is possible to indicate specific approaches to the use of light design in different civilizational structures and certain periods of their creation. When it comes to the form of churches, a detailed presentation of their spatial structure has been updated: disposition, construction, materialization, acoustics, lighting. The phenomenon of light has been approached as a physical phenomenon that affects the comfort and practical use of space, and a symbolic phenomenon rich in social and religious meaning. Even today, the concept of good architectural practice is certainly not possible or achievable without a functionally designed lighting concept within a spatial unit and strategically designed units to achieve sufficient optimal amounts of daylight. In architecture in general, light is the starting point, it is not just an opening or a window, i.e. a dome, but an element that is thought about at the very beginning so that all the others make sense at the end.

The intangible and ubiquitous phenomenon of light builds architecture and fills its spaces, appealing to our emotions. Thus, both natural light and artificial lighting serve to get to know special places in the architecture, and then give those places a special character.

Keywords: Light, Christianity, churches, design

1. Introduction

The topic 'Light in Sacred Architecture' complements all the curricula of subjects taught by the Author at the Faculty of Architecture of the University of Sarajevo^[1]. In the university textbook "Architectural Physics", the author dealt with light from a purely physical aspect and the relationship between man and light, establishing 'the definitional area of human comfort from the aspect of vision conditions'^[2]. In the aforementioned book, the Author has only indicated many other dimensions of the human-light relationship: "In architecture, there is a frequent case of reflector lighting of an object for aesthetic reasons. At the same time, with the reflector light, in contrast with the dark background, the desired details of the construction can be highlighted, which is not really possible in the conditions of natural (day) lighting. In addition, the angle of incidence of the reflector light on the desired object, as well as the color of the light, should be appropriately selected"^[2].

In this paper, it will be precisely these 'other dimensions of the human-light relationship' that will be the main topic: philosophical, religious, psychological, aesthetic dimensions. Lighting plays a vital role in the way people perceive and understand architecture. Whether the buildings are lit naturally or artificially, lighting is a medium that allows us to see and appreciate the aesthetics of the buildings around us and the message of the 'illuminated building' that it emits in space^[3].

To illustrate the approach to the content of the work 'Light in Church Design', we present one concrete example of a sacred building, Notre Dame in Rouen, France. An 'objective' approach to the presentation of this sacred object implies the presentation of its spatial structure: disposition, construction, materialization, acoustics, lighting. The Primatial Cathedral of Our Lady of the Assumption of Rouen (French: Cathédrale primatiale Notre-Dame de l'Assomption de Rouen) is a Roman Catholic church (Figures 1, 2).

It is known for three towers, each in a different style. The cathedral, built and restored over a period of more than eight hundred years, has features from early Gothic to late Renaissance architecture. Christianity was established in Rouen around 260 by Saint Melonius, who was also the first bishop. It is believed that the first church was under or near the current cathedral. In 395, a large basilica with three naves was built on the same site. In 755, Archbishop Rémy (727-771), son of the Frankish statesman and general Charles Martel (688-741), founded the first chapter of the cathedral

and built several courtyards and buildings around the church, including a palace for the archbishop. The cathedral was enlarged by St. Owen in 650, and Charlemagne visited it in 769. However, starting in 841, a series of Viking raids seriously damaged the cathedral complex. The Viking leader Rollo (846-932) became the first duke of the Duchy of Normandy, and was baptized in the Carolingian cathedral in 915 and buried there in 932. His grandson, Richard I of Normandy (933-996), further expanded it.



Fig 1: Notre Dame Cathedral, Rouen, France

<https://www.mediastorehouse.com/granger-art-on-demand/plans-diagrams/floor-plan-13th-century-cathedral-notre-dame-10408262.html>

<https://www.pinterest.co.uk/pin/799600108813702736/>

<https://www.pinterest.com/pin/interior-of-cathedral-notre-dame-de-coutances-by-amyralston--460000549409059320/>

<https://www.dreamstime.com/stained-glass-window-cathedral-notre-dame-de-rouen-normandy-france-image234955415>

Accessed: 7.6.2022.



Fig 2: Rouen Cathedral. Photo in the evening (left) and at night (right)

<https://www.locationscout.net/france/14107-notre-dame-de-rouen>

Accessed: 7.6.2022.

The 'subjective' view of Notre Dame Cathedral in Rouen is much more complex. Here, light plays an extremely important role, both natural and artificial. During the day, during the year (seasons), the light flux of natural (daytime) lighting changes (from the aspect of physics: spectral composition, intensity), which affects the visual perception and 'experience' of the architectural object. At the same time, the 'experience' of the object will be different, from individual to individual. Between 1892 and 1893, Claude Monet (184-1926) painted a series of plane trees of Rouen's Notre Dame Cathedral. He took pictures from different positions and at different times of the day (Figure 3). The painter made as many as 30 plane trees with the cathedral as his motif. Claude Monet immortalized Rouen's Notre Dame Cathedral from three points of view. The first pictures were painted in

February 1892 and represent the cathedral seen from the Cour d'Albane. These canvases were the only ones made outdoors. Then he settled in the workshop, which changed twice. He was especially installed on the first floor of the Finance Office, now the Tourist Office in Rouen. He made 28 views of the western facade at different times of the day. The facade was painted between 1892 and 1893 during two different campaigns, and the pictures were published after 1894. Claude Monet painted up to 14 versions at a time, moving from one canvas to another depending on the changing light and time of day. It was only about 10 days before the end of the cathedral campaign that Monet entered the cathedral for the first time after spending two years in front of its facade. Twenty of these canvases were presented in 1895 to the merchant Durand-Ruel, where they won the admiration of

famous painters such as Degas, Cézanne, Pissarro and Renoir. Claude Monet and his cathedral campaign occupied a dominant position in the development and promotion of

Impressionism in France and throughout the world (Figure 3).



Fig 3: Claude Monet: Paintings of the facade of Rouen Cathedral in different years, seasons and times of day

From left to right, top to bottom: 1. Rouen Cathedral, West Façade, Sunlight, 1892 (National Gallery of Art Washington, D.C., USA), 2. Rouen Cathedral, Red, Sunlight, 1892 (National Gallery Museum of Serbia, Belgrade, Serbia), 3. Rouen Cathedral. Portal and tower of Saint-Romain, full of sun; blue and gold harmony, 1892-1893. (Musée d'Orsay, Paris), 4. Rouen Cathedral. Portal, morning sun; blue harmony, 1892-1893. (Musée d'Orsay, Paris), 5. Rouen Cathedral, facade (sunset), harmony in gold and blue, 1892-1894. (Musée Marmottan Monet, Paris), 6. Portal of Rouen Cathedral in the Morning Light, 1894 (J. Paul Getty Museum), 7. Portal of Rouen Cathedral in the Morning Sun, Harmony in Blue, 1893 (Musée d'Orsay, Paris), 8. Rouen Cathedral, facade (morning effect), 1892-1894. (Folkwang Museum Essen, Germany), 9. Rouen Cathedral, facade 1, 1892-1894. (Pola Museum of Art Hakone, Japan), 10. Rouen Cathedral, Facade in Sunlight, 1894 (Clark Art Institute Williamstown, USA), 11. Rouen Cathedral, West Front, 1894 (National Gallery of Art), 12. Rouen Cathedral, West Façade, Sunlight, 1894 (National Gallery of Art), 13. Rouen Cathedral - Setting Sun, (Symphony in Gray and Pink), 1894 (National Museum Cardiff, Great Britain), 14. Rouen Cathedral, facade and Tour d'Albane. Gray Weather, 1894 (Musée des Beaux-Arts de Rouen), 15. Rouen Cathedral. Portal and tower of Saint-Romain, morning effect; white

harmony, 1892-1893. (Musée d'Orsay, Paris), 16. Rouen Cathedral, facade and Tour d'AlbaneI, a dull day, 1892-1894. (Beyeler Museum Riehen, Switzerland), 17. Rouen Cathedral, West Portal, dull time, 1892 (Musée d'Orsay Paris).

[https://en.wikipedia.org/wiki/Rouen_Cathedral_\(Monet_series\)](https://en.wikipedia.org/wiki/Rouen_Cathedral_(Monet_series)), Accessed: 7/6/2022.

Every summer, from June to September, Rouen hosts a cathedral light show with a dazzling illumination of the facade of the building (Figure 4). When night falls, couples, families, groups, tourists and residents of Rouen and the surrounding area can meet at the Place de la Cathédrale to enjoy this emotional show. Founded in 911 by the Scandinavian chieftain Rollo, Normandy saw some dark times with Viking invasions in the ninth century. Joan of Arc, a legendary figure in France, tells her story on the facade of the highest cathedral in France. In its own way, Cosmo AV will transform the saga of Joan of Arc and the Treaty of Saint-Clair-sur-Epte, which ceded Normandy to the Vikings. From July 2 to September 19, 2021, the show will return. Every evening you will be able to see the free sound and light show of the Rouen Cathedral, composed of two creations: "Fiers & Conquérants" on the theme of William the Conqueror and "The New Worlds" on the theme of the great naval epics. The shows will be shown every evening, 50 minutes (2 times).



Fig 4: Rouen Cathedral illuminated and colored by a dramatic light show after dark
<https://en.rouentourisme.com/cathedral-of-light/>, Accessed: 8.3.2021.

2. Light

Light, generally speaking, is a tool that enables not only seeing, that is, gathering information from the environment, but also the mechanism of that seeing, as well as the quality of seeing. At the same time, man is a special system through which the objective dimensions of light are refracted, forming an image of reality, along with a series of subjective dimensions of each individual.

Physics, as a science, treats light as part of the spectrum of electromagnetic radiation (EM or EMR) that spreads through the Universe, carrying electromagnetic radiation energy. It includes radio waves, infrared radiation (invisible to humans, but which humans feel as heat), visible radiation (light, in the range of 280 nm to 780 nm), ultraviolet radiation (which is part of the spectrum of optical radiation, invisible to humans, but which affects him, darkening his skin, for example), X-rays and gamma rays.

Electromagnetic radiation (which physics treats through the quantum-wave theory) is caused by periodic changes in the electric or magnetic field. Depending on how this periodic change occurs and the power generated, different wavelengths of the electromagnetic spectrum are produced. In a vacuum, electromagnetic waves travel at the speed of light, usually denoted “ c ” ($c = 300,000$ km/s). The wavefront of electromagnetic waves emitted from a point source is a sphere. The position of an electromagnetic wave within the electromagnetic spectrum can be characterized either by its frequency of oscillation or by its wavelength. Electromagnetic waves of different frequencies are called by different names, because they have different sources and effects on matter. In order of increasing frequency and decreasing wavelength, these are: radio waves, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays (Figure 5).

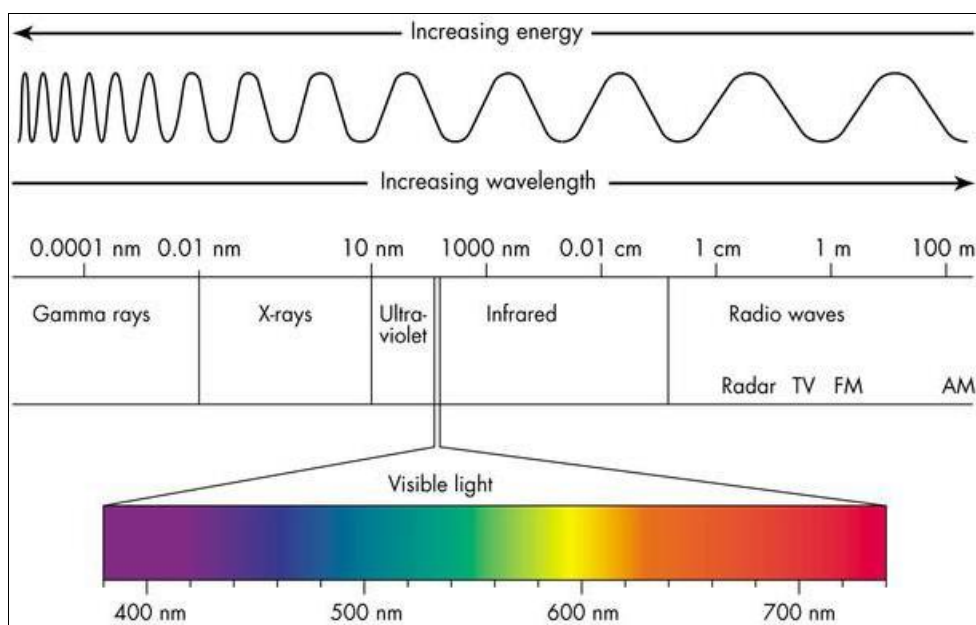


Fig 5: Electromagnetic spectrum with prominent visible light

<https://sites.google.com/a/coe.edu/principles-of-structural-chemistry/relationship-between-light-and-matter/electromagnetic-spectrum>
 Accessed: 7.6.2022.

The history of lighting is generally divided into four periods, each of which overlaps and which together illustrate the slowly changing lighting technology. First there was the Primitive, a period that encompasses the age of torches and lamps of prehistoric people - although in fact French peasants continued to use the same lighting methods shown in nearby cave paintings until the First World War. Two more recent phases are medieval - the development of metal lamps. The

latter began with the creation of glass lantern chimneys by Leonardo da Vinci (1452-1519) in 1490, and culminated in the first practical incandescent light bulb by Thomas Edison (1847-1931) - it continues today. Between the primitive phase and the medieval phase of lamps, was the world of ancient Greece and Rome, the classical stage, which marks the peak of illumination in antiquity. Earlier ancient civilizations, such as Egypt, belong to a primitive age in

lighting - before the relatively widespread adoption of the candle and vegetable oil as fuel.

As with the use of vegetable oils, the development of the candle dates back to ancient times, but the ancient use of candles became common (that is, among the wealthiest citizens) in Rome. In the use of animal fat, the candle seems to go back to an earlier stage, but the hardened candle tallow created a much more stable, relatively safer fuel than lamp oil.

Candles and lamps had in common a wick made of fibers that burned slowly. In a lamp, the wick draws in liquid fuel that becomes fuel as it burns, and the burning carbon at the end of the wick creates light. With a candle, the heat from the flame at the end of the wick liquefies the wax near the base of the wick. Capillary action pulls the liquid wax upwards, where the heat evaporates it, and the combustion of the steam produces light.

2.1 Light in Christianity

We also see the relation to light in the Bible, Genesis chapter 1:

1:1: In the beginning God created the heavens and the earth.
 1:2: The earth was still desolate and empty. Darkness lay over the abyss. The Spirit of God hovered over the waters.
 1:3: Then God said: "Let there be light!" And there was light.
 1:4: And God saw that the light was good. That's how God separated the light from the darkness.
 1.5: God called the light day, and the darkness he called night, it became evening, and it became morning - the first day^[3].
 For a long time (until the year 313) Christianity was illegal and there were no buildings where Christianity could be manifested with rituals. This religion suffered from the rigor of the Roman soldiers and had to survive hidden deep in the caves, in the catacombs. After 313, the Roman Empire (Constantine I, 272-337) legalized Christianity. Then Christians started building churches. Early Christians in Anatolia were attacked by Persian soldiers. They built their hidden churches by carving hills, especially in Cappadocia^[6]. The earliest churches were built in the form of a basilica, a Roman marketplace. The first churches had side aisles separated by a colonnade from the main gallery called the nave. At the end of the altar was a semicircular space called the apse. The priest led the prayer from the apse, in front of the faithful gathered in the nave. The worshipers in the ship needed reading light whose angle of incidence would not bother them. Therefore, the windows in this section are designed to create diffused lighting. These buildings are designed to reflect a mystical and mysterious ambience. This ambience is mostly created with the help of window arrangements and the orientation of the building. In Byzantine churches, light was used dramatically to emphasize the stories of faith and its most important annual and daily moments. The Hagia Sophia in Istanbul emphasizes daylight as an architectural element. Forty windows that perforate the bottom of the dome open up a perspective that dissolves into a floating light space. The windows of the dome resemble a necklace of light. The apse of Hagia Sophia is oriented towards the southeast so that the Christmas morning liturgy is celebrated with the participation of sunlight. Sunlight and moonlight create light illusions by forming crescents on the walls. In this way, the heavenly sphere is dramatized. On the half-dome of Hagia Sophia above the apse is an icon illuminated by focused beams of daylight achieved by the arrangement of windows on the half-

dome. After the late medieval period, Gothic churches appeared and their interiors were quite dark. As a rule, in Gothic churches, the maximum amount of light was where the maximum religious and intellectual content of the building was located.

This era is known for the stained glass used on church windows. The color used in the glass contributed to the creation of a stronger mystical ambience with daylight. Renaissance architects, beginning with Brunelleschi, clearly used light to reveal their forms. The source of light was never hidden. In the basilica of St. Peter in Rome, Michelangelo achieved lighting effects that were clearer and more direct. In the Baroque period, light was one of the elements of architecture that was manipulated for emotional effect. The most brilliant example of the symbolic use of light as a representational medium in architecture is in the Baroque period of the 16th and 17th centuries. The motivating factors were the worship of God and the aspirations of society. The symbolism and imagery of light and darkness was an ideal vehicle for expressing religious mysteries and was used to encourage devotion. Baroque architecture and art are characterized by movement, feelings, irrationality, spirituality, atmosphere and were all based on the dynamism and rules of nature. In the 19th century, the Industrial Revolution introduced new materials and construction techniques. They introduced lighter structures, and window spans became larger. Skeletal structures allowed architects to let more sunlight into buildings. In the 20th century, the Moderne movement brought aspirations to represent society's religious beliefs in architecture. Modern architecture brought with it a shift towards poetic, symbolic use of light in architecture. A more spiritual use of light in architecture can be seen in the later work of Le Corbusier. In his second period, Le Corbusier became increasingly interested in representing the spiritual motivations that lie at the root of the entire human experience. He saw natural forms capable of a divine and mystical character. In 1910, he visited Turkey, studied Hagia Sophia, several mosques and Cappadocia churches. He was inspired by the light effects of the buildings he saw, which he transposed into the design of the chapel in Ronchamp (1955). He was also influenced by the stained glass windows of Gothic cathedrals. In the chapel at Ronchamp, light was used not only as an integral part of the building or as a historical allusion, but as an uplifting and adoring environment. In the monastery of La Tourette (1957-1960), with its chapels, he uses extremely powerful light spoons and light tubes to introduce daylight into the interior space. It is likely that in the monastery of La Tourette Le Corbusier referred to the oculus of the Pantheon. Le Corbusier said that "architecture is a magnificent, masterful and correct play of volumes under light"^[7]. Metaphorical and mystical processing of light can be recognized in the works of contemporary architect Tadao Ando. In Church of the Light (1999) Ando designed a dramatic altar wall representing Christian symbols^[8]. He combined the symbolic meanings of the shape of the cross and daylight. These examples show that daylight continues to be used for spiritual influences more than for functional needs in the modern era. In these spaces, the harmony of daylight depends on the ambience to be achieved. Therefore, the spatial organization of the church is directly related to the lighting design. The Cathedral of Christ the Light, as a larger cathedral center, consists of a cathedral church, an office of the bishop's curia, a conference center, a parish office (priest's residence). The

Cathedral of Christ the Light was designed by architect Craig W. Hartman from the famous design firm Skidmore, Owings & Merrill (SOM). The cathedral was opened on September 25, 2008.

3. Churches

A church building, church house or simply church, is a building used for Christian worship and other Christian religious activities. The term is used to refer to the physical structures in which Christians worship God, and it also refers to the Christian community. It is sometimes used as an analogy for buildings of other religions. In traditional Christian architecture, the floor plan of the church often forms a cross. Towers or domes can evoke thoughts of the heavens. Modern churches have different architectural styles and layouts. Some buildings intended for other uses have been converted into churches, while many original church buildings have been repurposed. The word 'church' in Christian Science is used to describe the Christian religious community as a whole, or the body or assembly of Christian believers.

In the Greek language, the adjective 'κυριακόν' (Romanized: *kyriak-ós/-ē/-ón*) means 'belonging to Kyrios' ('Lord'), and the first usage was adopted by the early Christians of the Eastern Mediterranean regarding anything related to Jesus Christ. Thus, 'Κυριακος οίκος' (Romanized: *'Kyriakós oikos'*, meaning 'house of the Lord', church). 'Κυριακή' (Romanized: *'Kyriakē'*, meaning 'Lord's day', Sunday), *Κριακία προσευχή* (Romanized: *'Kyriakē proseukhē'*, meaning 'Lord's Prayer') are expressions derived from the term *κυριακον* - *kyriak-ós/-ē/-he*. *Cyrican* is an Old English word for churches and church property. In standard Greek usage, the older word *ἐκκλησία* (Romanized: *ecclesia*, meaning 'assembly', 'congregation' or place where such a gathering is held) was retained to denote both a particular building of Christian worship ('church'), and the whole community of believers. This usage has persisted in Latin and Latin-derived languages (French: *'église'*, Italian: *'chiesa'*, Spanish: *'iglesia'*, Portuguese: *'igreja'*, for example), as well as in Celtic languages (Welsh: *'eglwys'*, Irish: *'eaglais'*, Breton: *'iliz'*, for example) and in Turkish (*'kilise'*). In Germanic and some Slavic languages, the word *kyriak-ós/-ē/-ón* was adopted instead and derivatives were created from it. In Old English, the sequence of performance began as *'cirice'*, then Middle English *'churche'*. German *'kirche'*, Scottish *'kirk'*, Russian *'cerkov'* (Церковь), Serbian-Croatian-Bosnian *'crkva'* (crkva, Црква). All are derived in a similar way.

According to the New Testament, the first Christians did not build church buildings. Instead, they gathered in homes (Acts 17:5, 20:20, 1 Corinthians 16:19) ^[4] or in Jewish places of worship, such as the Second Temple or synagogues (Acts 2:46, 19:8) ^[4]. The oldest archaeologically identified Christian church is the house church (*domus ecclesiae*), the church of Dura-Europos, founded between 233 and 256 AD. In the second half of the 3rd century, the first purpose-built halls for Christian worship (*aula ecclesiae*) began to be built. Although many of them were destroyed at the beginning of the next century during Diocletian's persecution, during the reign of Emperor Constantine the Great (Latin: *Flavius Valerius Aurelius Constantinus Augustus*, 272 or 273-337) even larger and more complex church buildings began to appear. From the 11th to the 14th century, a wave of cathedral construction and construction of smaller parish churches took place in Western Europe. In addition to serving as a place of

worship, the cathedral or parish church was often used as a general gathering place in communities, and hosted events such as guild meetings, banquets, mystery shows and fairs. Churches and buildings were also used for threshing and grain storage ^[5]. Between 1000 and 1200, the Romanesque style became popular throughout Europe. While the term 'Romanesque' refers to the tradition of Roman architecture, the trend actually emerged throughout Western and Central Europe. The Romanesque style is defined by large and bulky buildings that usually consist of simple, compact, rarely decorated geometric structures. Common Romanesque church features include circular arches, round or octagonal towers, and pillow capitals. In the early Romanesque era, the coffered flat ceiling was fashionable, while later in the same era, the vault gained popularity. The interiors expanded, and the motifs of the sculptures took on more epic features and themes.

The Gothic style appeared around 1140 in Île-de-France and then spread throughout Europe. Gothic churches lost the compact qualities of the Romanesque era, and decorations often contained symbolic and allegorical features. The first pointed arches, vaults, ribs and buttresses began to appear. This allowed for an increase in window size, creating brighter interiors. The ceilings of the nave became higher, the columns and bell towers too. Many architects used this development to push the limits of structural possibilities, a tendency that resulted in the collapse of several towers that had designs that unwittingly crossed the limits of empiricism. In Germany, the Netherlands and Spain, it became popular to build halls, a style in which each vault would be built to the same height. Gothic cathedrals were lavishly designed. Some show unprecedented degrees of detail and complexity in decoration. Notre-Dame de Paris and Notre-Dame de Reims in France, as well as San Francesco d'Assisi in Palermo, and the Wool Cathedral and Church in Salisbury, England, and Santhome Church in Chennai, India, display the elaborate styles characteristic of cathedral Gothic. Some of the most famous Gothic churches remained unfinished for centuries, after the Gothic style lost its popularity. The construction of Cologne Cathedral, started in 1248, stopped in 1473 and continued only in 1842, is one such example.

In the 15th and 16th centuries, the change in ethics and society due to the Renaissance and Reformation also affected the construction of churches. The usual style was like Gothic, but in a simplified way. The basilica was no longer the most popular type of church, but halls were built instead. Typical features are columns and classical large capitals.

In Protestant churches, where God's words are of particular importance, the visitor's gaze is directed towards the pulpit. The Baroque style was first used in Italy around 1575. From there it spread to the rest of Europe and to European colonies. In the Baroque era, construction was greatly intensified. Buildings, even churches, were used as indicators of wealth, authority and influence. The use of forms known from the Renaissance was extremely exaggerated. The domes and capitals are decorated with mouldings, and the former stucco sculptures have been replaced by frescoes on the ceilings. For the first time, churches were seen as one connected work of art and consistent artistic concepts were developed. Instead of long buildings, more central plan buildings were created. The spacious decoration with floral ornaments and mythological motifs was erected around 1720 in the Rococo era.

Protestant parishes preferred side churches, where all visitors

could be as close as possible to the pulpit and the altar.

A common architecture for churches is a cross shape (a long central rectangle, with side rectangles and a rectangle in front for the altar space or sanctuary). These churches often have a dome or other large vaulted space inside that represents or draws attention to heaven. Other common shapes for churches are a circular floor plan, representing eternity, or an octagon or similar star shape, representing a church that brings light to the world. Another common feature is the steeple, a tall tower at the west end of the church or above the crossing. Another common feature of many Christian churches is the orientation of the front altar towards the east. Often the altar will not be oriented to the east, but in the direction of the rising sun. This tradition originated in Byzantium in the 4th century, and became popular in the West in the 8th to 9th centuries. The old Roman custom of having the altar at the west end and the entrance at the east was sometimes followed until the 11th century, even in the areas of northern Europe under Frankish rule, as seen in Petershausen (Constance), Bamberg Cathedral, Augsburg Cathedral, Regensburg and the cathedral in Hildesheim.

The Latin word basilica (derived from the Greek, Βασιλική Stoà, Royal Stoa) was originally used to describe a Roman public building (as in Greece, mostly a tribunal), usually located in the forum of a Roman city. After the Roman Empire officially became Christian (in 380), the term expanded to refer to a large and important church to which the Pope gave special ceremonial rights. Thus, today the word retains two meanings, one architectural and the other ecclesiastical.

A cathedral is a church, usually Catholic, Anglican or Oriental Orthodox (congregational church), in which the seat of the bishop (metropolitan, in Orthodoxy) is located. The word cathedral got its name from the cathedral, that is, the bishop's throne (in Latin: ecclesia cat Cathedralis). The term is sometimes (improperly) used for any large church. A church that functions as a cathedral is not necessarily a large building. It may be as small as Christ Church Cathedral in Oxford, England, Porvoo Cathedral in Porvoo, Finland, Sacred Heart Cathedral in Raleigh, USA, or Chur Cathedral in Switzerland. However, often the cathedral, along with some abbey churches, was the largest building in any region. A pilgrimage church is a church to which a regular pilgrimage is made, or a church along a pilgrimage route, often located at the tomb of saints or holding icons or relics attributed to miraculous properties, the place of apparitions of Mary, for example.

A monastery church (minster church) is the main church building in a Christian monastery (monastery) or abbey.

A collegiate church is a church in which the daily worship service is held by a canonical college, which may be presided over by a dean or provost. Collegiate churches were often supported by large lands held by the church or by tithe income from appropriated beneficiaries. They usually provide different spaces for communal worship and for the choir offices of their priestly community.

The architecture of evangelical places of worship is mainly characterized by its sobriety. The Latin cross is one of the only spiritual symbols that can usually be seen on an evangelical church building and that identifies belonging to that place. Some services take place in theaters, schools or

multi-purpose rooms, rented only for Sunday. Because of their understanding of the second of the Ten Commandments, evangelicals do not have religious material displays such as statues, icons, or pictures in their places of worship. Usually, there is a baptismal font (also called a sanctuary) on the stage of the auditorium or in a separate room for baptism by immersion. Old and unused church buildings can be considered an interesting proposition for developers as the architecture and location often provide attractive homes or entertainment venues in the city centre. On the other hand, many newer churches have decided to host public facilities such as schools, universities, cinemas or theaters. There has been an increase in partnerships between church management and private real estate companies to convert church property into mixed use. Although it has drawn criticism from some, the partnership offers an opportunity to increase income for the church community while preserving assets. The largest churches in the world will be presented below.

St. Peter's Basilica in Rome, Italy, was built in 1506–1626. year (Figure 6). The area of the main prayer area of 15,160 m² can accommodate 60,000 people. The Papal Basilica of Saint Peter in the Vatican (Italian: Basilica Papale di San Pietro in Vaticano), or simply the Basilica of Saint Peter (Latin: Basilica Sancti Petri), is a church built in the Renaissance style located in the Vatican City, a papal enclave located within the city Rome. It was designed mainly by Donato Bramante, Michelangelo, Carlo Maderno and Gian Lorenzo Bernini. The church is the most famous work of Renaissance architecture and the largest church in the world according to internal measurements. Although it is neither the mother of the Catholic Church nor the cathedral of the Diocese of Rome (these equivalent titles are held by the Cathedral Basilica of St. John Lateran in Rome), the Basilica of St. Peter is considered one of the largest Catholic sanctuaries. It is described as 'a church that has a unique position in the Christian world' and as 'the largest of all the churches of the Christian world'. Catholic tradition holds that the basilica is the burial place of St. Peter, the chief among Jesus' apostles and also the first Roman bishop (Pope). Saint Peter's grave is supposedly directly under the high altar of the basilica. This is why many popes are buried in the church of St. Peter from the early Christian period. The church has stood in this place since the time of the Roman emperor Constantine the Great (Constantine I, Latin: Flavius Valerius Constantinus, Greek: Κωνσταντῖνος, 272–337). The old basilica of St. Peter dates from the 4th century. The construction of today's basilica began on April 18, 1506, and was completed on November 18, 1626.

Basilica of St. Peter is known as a place of pilgrimage and for holding masses. The Pope presides over numerous masses throughout the year, both inside the basilica and on the neighboring Square of St. Peter. These masses attract audiences, from 15,000 to over 80,000 people. As a work of architecture, it is considered the largest building of its era. Basilica of St. Peter is one of the four churches in the world that have the status of a great basilica, and all four are in Rome. Dimensions of the base of the Basilica of St. Peter in Rome are: length 220 m, width 150 m; the height of the top of the dome of the basilica from the ground is 136.6 m, and its diameter is 42 m (external) and 41.5 m (internal).

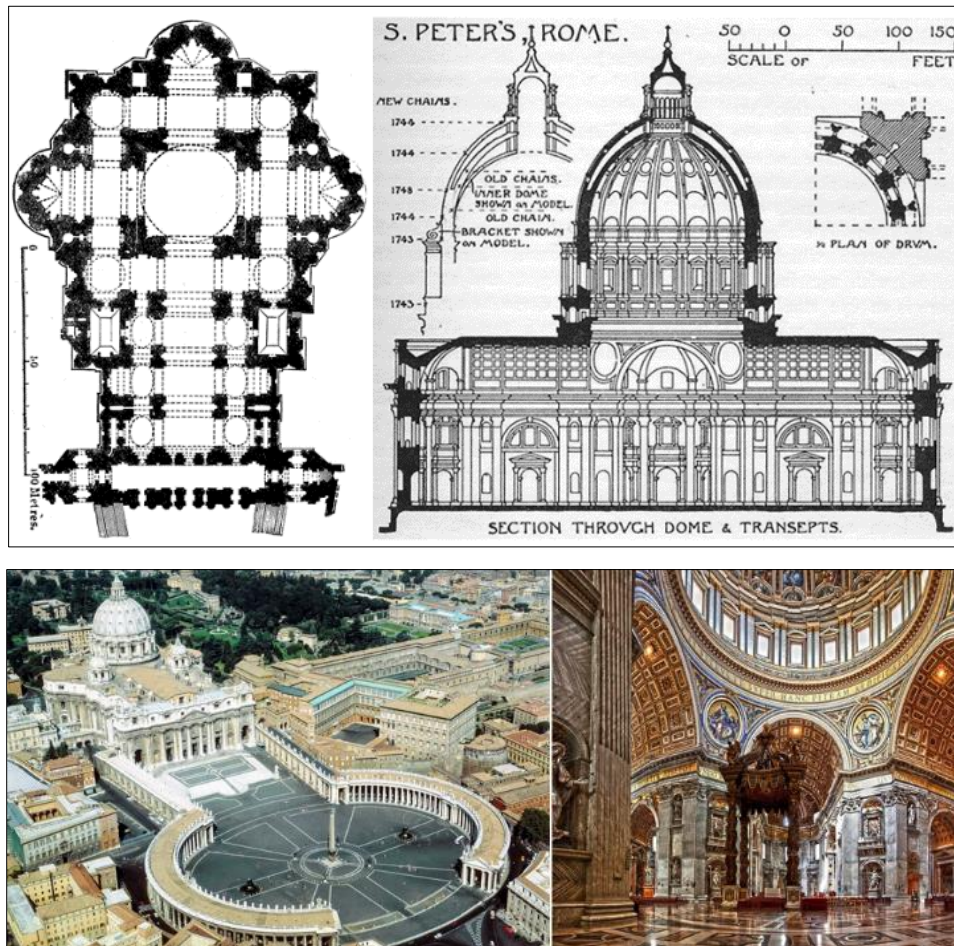


Fig 6: St. Peter's Basilica, Rome, Italy, 1506–1626
<https://www.pinterest.es/pin/367887863312870403/>
<https://www.pinterest.com/pin/526428643913457176/>
https://etc.usf.edu/clipart/73700/73703/73703_st_peters.htm
<https://www.pinterest.com/pin/196751077440696511/>
 Accessed: 4.10.2021.

Milan Cathedral, Milan, Italy, built 1386–1665, on the surface of the prayer space of 11,700 m² can accommodate 40,000 people in one visit. Milan Cathedral (Italian: Duomo di Milano) or Metropolitan Cathedral-Basilica of the Nativity of Saint Mary (Italian: Basilica cattedrale metropolitana di Santa Maria Nascente), is dedicated to the Nativity of St.

Mary (Santa Maria Nascente). It took almost six centuries to complete the cathedral: construction began in 1386, and the last details were completed in 1665. It is the largest church in Italy - the Basilica of St. Peter's Basilica in the Vatican City - the second largest in Europe and the third largest in the world (Figure 7).

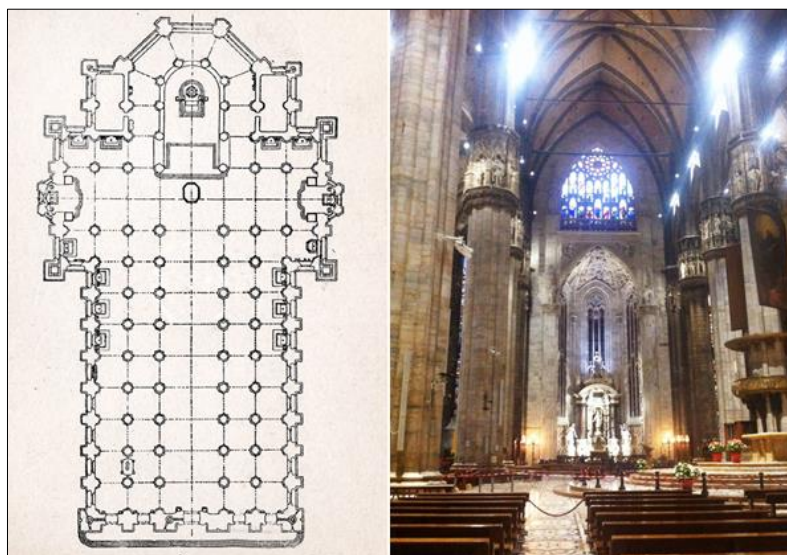




Fig 7: Milan Cathedral, Milan, Italy, 1386-1965 (area 11700 m², capacity 40000 people)

<https://thetowerinfo.com/milan-cathedral-facts/>

<https://www.pinterest.com/pin/306104105893099709/>

<https://commons.wikimedia.org/wiki/File:Plan-of-the-Milan-Cathedral.png>

<https://agnesashe.wordpress.com/2017/03/23/a-vast-interior-milan-cathedral/>

Accessed: 4.10.2021.

The Basilica of Our Lady of Licheń, Licheń Stary, Poland, has a prayer area of 10,090 m². The Basilica of Our Lady of Lichen is a Roman Catholic church located in the shrine of Our Lady of Sorrows, Queen of Poland, in the village of Licheń Stary near Konin in the Greater Poland Voivodeship, Poland (Figure 8). The church was designed by the architect Barbara Bielecka, and was built between 1994 and 2004. The construction was financed by donations from pilgrims. With a tower 141.5 meters high, it is one of the tallest and largest churches in the world. The history of the establishment of the church dates back to 1813, when Tomasz Kłossowski, a Polish soldier who fought under Napoleon near Leipzig, was seriously wounded. He called on the Virgin Mary, begging her not to let him die in a foreign land. According to legend, she appeared to him with a golden crown, a dark red dress, with a golden cloak, and in her right hand she holds a white

eagle. She comforted the soldier and promised that she would recover and return to Poland. Tomasz was instructed to make a picture of her and to place it in a public place. With a nave 120 meters long and 77 meters wide, with a central dome 98 meters high and a tower 141.5 meters high, it is the largest church in Poland and one of the largest church buildings in the world. It also has one of the highest domes in the world. The church is dedicated to Our Lady of Sorrows, Queen of Poland, whose icon, possibly from the 18th century, is displayed on the main altar of the basilica. It is one of the main pilgrimage sites in Poland. Between 2002 and 2007, the Polish organist Zych - based on the project of prof. Andrzej Chorościński - built an organ with 157 branches. It is the largest organ in Poland, the 4th in Europe and the 13th in the world. Pope John Paul II blessed the basilica in 1999.



Fig 8: Basilica of Our Lady of Licheń, Licheń Stary, Poland

<https://www.poznantours.com/offerview/lichen-sanctuary-tour/>

<https://www.thousandwonders.net/Basilica+of+Our+Lady+of+Liche%C5%84>

Accessed: 4.10.2021.

Church of the Most Holy Trinity, Fátima, Portugal, was built in 2004-2007. Its prayer area of 8700 m² can accommodate 9000 people (Figure 9). The Basilica of the Holy Trinity (Portuguese: Basílica da Santíssima Trindade) is a Roman Catholic church and minor basilica in the Sanctuary of Fátima (Marian Shrine of Our Lady of Fátima) in Cova da Iria, in the civil parish of Fátima, in the municipality of Ourém in

Portugal. In 2009, it received the award for outstanding construction from the International Association for Bridge and Structural Engineering (IABSE). The IABSE awards the most significant, innovative, creative or otherwise stimulating structure completed in the last few years. The church was designed by the Greek architect Alexandros Tombazis.





Fig 9: Church of the Most Holy Trinity, Fátima, Portugal

<https://www.dreamstime.com/cathedral-complex-basilica-church-fatima-aerial-view-cathedral-complex-minor-basilica-most-holy-trinity-church-image176761569>

<https://www.pinterest.com/pin/520095456941425964/>

<https://www.hellotravel.com/portugal/basilica-of-the-holy-trinity>

Accessed: 4.10.2021.

The Cathedral of National Salvation (Romanian: Catedrala Mântuirii Neamului), also known as the National Cathedral (Romanian: Catedrala Națională), is an Orthodox cathedral under construction in Bucharest that will serve as the patriarchal cathedral of the Romanian Orthodox Church (Figure 10). It is located in central Bucharest on Spirea Hill (Arsenal Square), facing the same courtyard as the Palace of

the Parliament. The Cathedral of the People's Salvation is 86.2 meters high and at 135 meters high (ground-cross) occupies a dominant position in the city landscape of Bucharest, visible from all approaches to the city. The area of the prayer area of the church is 6100 m², and it can accommodate 7000 visitors/believers. The cathedral was designed by architects from the design firm Vanel Exim SRL.



Fig 10: Cathedral of National Salvation (Romanian: Catedrala Mântuirii Neamului), Bucharest, Romania, 2010-2018 (Architects: Constantin Amaiei)

<https://playtech.ro/stiri/cum-arataacum-catedrala-mantuirii-neamuluicand-va-avea-loc-marea-inauguraredupa-finalizarea-completa-a-lucrarilor-70955>

https://www.realitatea.net/stiri/actual/catedrala-mantuiriiineamului_5dcc9272406af85273d75597

Accessed: 4.10.2021.

The Metropolitan Cathedral of Brasília (Portuguese: Catedral Metropolitana de Brasília) is a Roman Catholic cathedral that serves Brasília and serves as the seat of the Archdiocese of Brasília (Figure 11). It was designed by architect Oscar Niemeyer (1907-2012) in collaboration with civil engineer Joaquim Cardoza (1897-1978). It was completed and dedicated on May 31, 1970. The cathedral is a hyperboloid building built of 16 concrete columns, each weighing 90 tons. In the square approach to the cathedral there are four 3-meter high bronze sculptures representing the four evangelists created by the sculptor Dante Croce in 1968. The 20-meter-high bell tower has four large bells donated by the Spanish inhabitants of Brazil. At the entrance to the cathedral there is a column with passages from the life of Mary, the mother of Jesus, painted by Athos. A twelve meter wide and 40 centimeter deep reflecting pool surrounds the roof of the cathedral, helping to cool the cathedral. Visitors pass under this pool when entering the cathedral. The cathedral can accommodate up to 4,000 people. The baptistery is on the left

side of the entrance, and it can be entered from the cathedral or via the spiral staircase from the entrance square. The walls of the oval baptistery are covered with ceramic tiles painted by Athos Bulcão in 1977. The offices for the Archdiocese of Brasília were completed in 2007 next to the cathedral. The 3,000 m² building connects directly to the cathedral underground. Visitors enter the cathedral through a dark tunnel and exit into a bright space with a glass roof. The cathedral roof consists of sixteen sections of fiberglass, each 10 meters wide at the base and 30 meters long. The segments are inserted between the concrete segments of the hyperbolic paraboloid. Suspended below this is a 2,000 m² stained glass work originally created by Marianne Peretti in 1990 in shades of blue, green, white and brown. Inside the cathedral above the nave are sculptures of three angels suspended by steel cables. The shortest is 2.22 meters long and weighs 100 kilograms, the medium is 3.4 meters long and weighs 200 kilograms, and the largest is 4.25 meters long and weighs 300 kilograms. The sculptures were created by Alfredo Ceschiatti

in collaboration with Dante Croce in 1970. The altar was donated by Pope Paul VI, and the painting of the patron saint Our Lady of Aparecida is a replica of the original located in Aparecida - São Paulo. The Way of the Cross is the work of Di Cavalcanti. Below the main altar is a small chapel that can be accessed by stairs on both sides and behind the altar.

Brasilia Cathedral, officially the Metropolitan Cathedral of Our Lady of Aparecida (Catedral Metropolitana Nossa Senhora Aparecida), dedicated to the Blessed Virgin Mary under the title of Our Lady of Aparecida, who was proclaimed by the Church as Queen and Patroness of Brazil.



Fig 11: Cathedral of Brasília (Portuguese: Catedral Metropolitana Nossa Senhora Aparecida), 1970, Brasília, Brazil (Architect: Oscar Niemeyer)

<https://divisare.com/projects/306858-oscar-niemeyer-gonzalo-viramontecatedral-metropolitana-nossa-senhoraaparecida-1970>
Accessed: 4.10.2021.

The Roman Catholic Diocese of Orange has two architectural firms, Johnson Fain (focusing on the cathedral building itself) and Rios Clementi Hale Studios (focusing on the exterior), to create a design plan that meets the complex needs of the 1.3 million member diocese and the day-to-day needs of the cathedral. parishes with more than 10,000 members. In addition to addressing these urgent needs, the design committee was tasked with developing a multifaceted plan that not only addresses the complex design requirements of transforming Christ Cathedral into a space that is liturgically and quintessentially Catholic, but also addresses the various intricate engineering challenges of bringing the building and its grounds to the most modern construction sites in terms of technology and usability. Within the cathedral building itself,

the design ethic preserves and revitalizes the exquisite and inspiring architecture, transforming the space into one that supports the liturgical (mass) aspects of the Catholic faith and the central role of the Eucharist. Exterior design works on creating a structure and a theme proportional to the dynamism and beauty of the existing buildings. This new landscape and the new spaces that will be created respect the history of the site, its architecture and worshipers, while enabling its renewed life as a Roman Catholic cathedral. The design enhances the liturgical importance of the cathedral building in relation to its neighboring buildings and welcomes pilgrims to an experience of faith as they enter the campus and cathedral. The cathedral was designed by architect Philip Johnson (Figure 12).

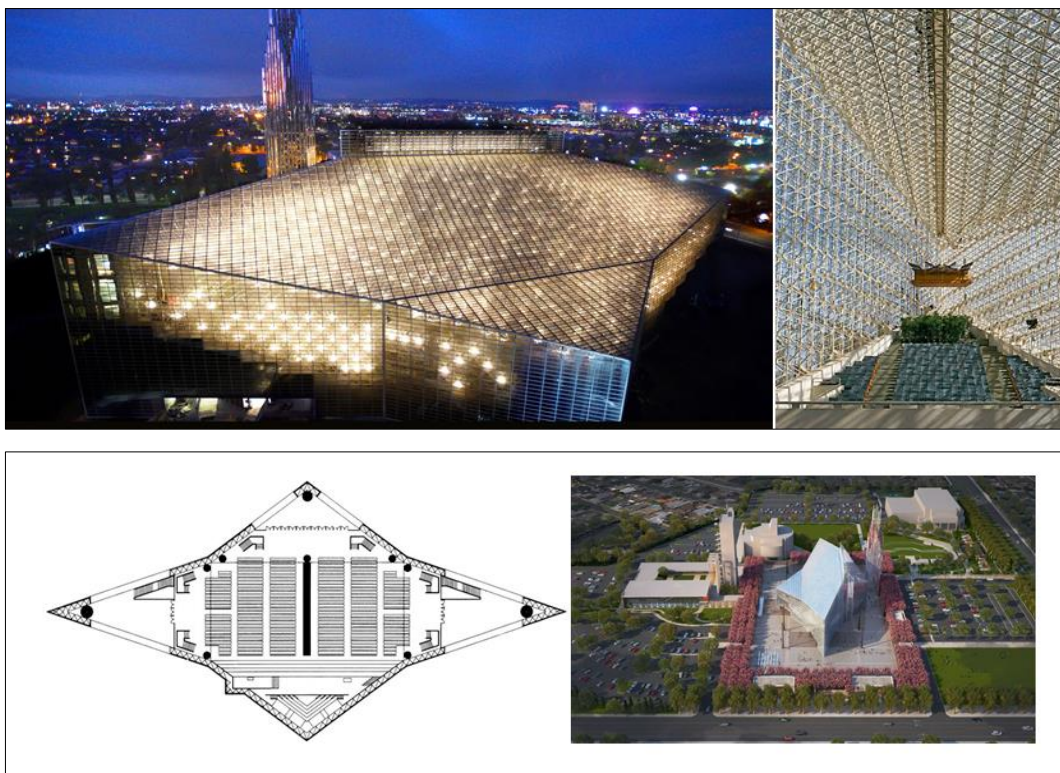


Fig 12: Crystal Cathedral, Garden Grove, California, 1980

<https://www.archdaily.com/445618/adclassics-the-crystal-cathedral-philipjohnson>, Accessed: 4.10.2021.

In Ibaraka (a suburb of Osaka), Japan, stands one of Tadao Ando's architectural works, the Church of Light. The Church of Light embraces Ando's philosophical framework between nature and architecture through the way light can define and create new spatial perceptions as much, if not more, than its concrete structures (Figure 13). Completed in 1989, the Church of Light was rebuilt in an existing Christian complex in Ibaraki. The new church was the first phase of a complete redesign of the site - later completed in 1999 - according to Ando's design aesthetic. For Tadao Ando, the Church of Light is an architecture of duality - the dual nature of existence - solid/void, light/dark, sharp/tranquil. The existing differences leave the church empty of any decoration, creating a clean, unorganized space. The intersection of light and solidity raises the traveler's awareness of the spiritual and worldly within himself. The use of simplified materials reinforces the duality of the space; the concrete construction removes any distinction between traditional Christian motifs and aesthetics. Apart from the crossed cross from the east-facing facade, the church is composed of a concrete shell; concrete adds to the darkness of the church by creating a more humble, meditative place of worship. As a testament to the minimalist architecture, the empty crosses on the east-facing wall are the only prominent religious symbols present in the church. Ando's Church of Light is formally minimalist and reduces the religious paraphernalia to a simple cross extrusion, which is often criticized as disturbingly empty and undefined. Although said to be nothing more than six walls and a roof, there is a whole level of design aesthetic that Ando and his

contractors are carrying out that the tenants misread and fail to recognize. As a modern, minimalist structure, the Church of Light exudes an architectural purity found in the details. There is no decoration in the reinforced concrete volume that is not part of the construction process. The seams and joints of the concrete were precisely and carefully constructed by Japanese carpenters, together with Ando, who worked to create an impeccably smooth surface and precisely aligned joints, so much so that the seams of the concrete form perfectly coincide with the extrusion of the crosses on the east side of the church. The concrete construction is a reinforcement of Ando's main goal of simplicity and minimalist aesthetics; however, the way the concrete is poured and shaped gives the concrete a luminous quality when exposed to natural light. Ando's decision to place the cross on the eastern facade allows light to pour into the space during the early morning and during the day, which has a dematerializing effect on the interior concrete walls, turning the dark volume into a lighted box. Ando's approach to light and concrete in the Church of Light, like his other projects, have a surreal effect that perceptually changes material into immaterial, dark into light, light into Space. "In all my works, light is an important controlling factor. I create closed spaces mainly using thick concrete walls. The primary reason is to create a place for the individual, a zone for himself within society. When the external factors of the urban environment require the wall to be without openings, the interior must be especially full and satisfactory" (Tadao Ando) ^[8].

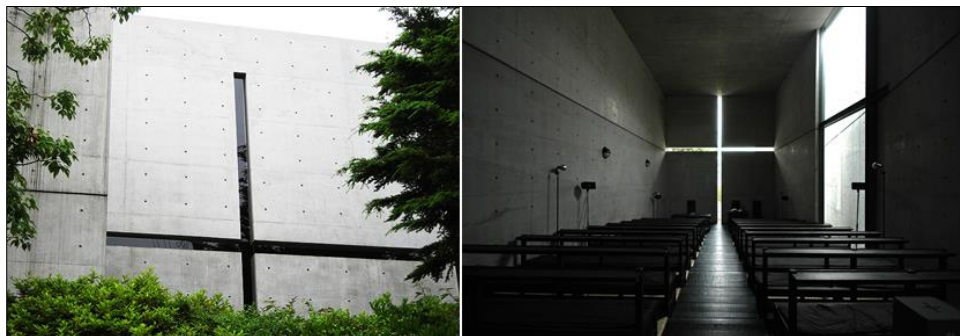


Fig 13: Church of Light, Ibaraki, Osaka, Japan, 1989

<https://www.archdaily.com/101260/adclassics-church-of-the-light-tadao-ando>, Accessed: 5.9.2021.

The Cathedral of Christ the Light, as a larger cathedral center, consists of a cathedral church, an office of the bishop's curia, a conference center, a parish office (priest's residence). The mausoleum contains twelve crypts reserved for Oakland bishops and grave sites available to members of the diocese at a comparable cost to other Catholic cemeteries in the diocese (Figure 14). The center of the cathedral also houses the City Lights cafe and cathedral shop, as well as a public square and garden. The Cathedral of Christ the Light was designed by architect Craig W. Hartman from the well-known design firm Skidmore, Owings & Merrill (SOM). The cathedral was opened on September 25, 2008. Located at 2121 Harrison Street in Oakland, the cathedral serves as the home church of approximately 530,000 Catholics in Alameda and Contra Costa counties. The Catholic Cathedral Corporation of the East Bay launched a design contest for the Cathedral of Christ the Light. Various designs were evaluated, and the corporation declared the work of architect Santiago Calatrava the winner. (Calatrava's design for the

Cathedral of Christ the Light was chosen before the site for the project was determined). By the time the site was chosen, a parking lot previously dedicated to the construction of Oakland's tallest building, Calatrava's design had fallen through, replaced by the runner-up design by Craig W. Hartman of Skidmore, Owings & Merrill's San Francisco office. Hartman designed an abstract 20th-century building from a family of styles developed by architects such as Ludwig Mies van der Rohe. Hartman's vision of the Cathedral of Christ the Light was compared to an image of a bishop's miter, fashioned from steel and filled with glass frit. The worship space in the Cathedral of Christ the Light is shaped like a vesica piscis ("fish bladder"), a shape formed by the intersection of two circles. The walls are composed of overlapping panels of wood and glass that rise towards the sky and form a vault, like a fish scale. The design is, among other motifs, inspired by the miracle of the bread and fish in the Christian tradition. The small garden on the grounds of the Cathedral of Christ the Light is intended to serve as a

place of healing for survivors of sexual abuse by clergy. In the garden there is a basalt sculpture and a plaque with the inscription "This healing garden, planned by survivors, is

dedicated to those innocents who were sexually abused by members of the clergy. We remember and affirm: never again" [9].

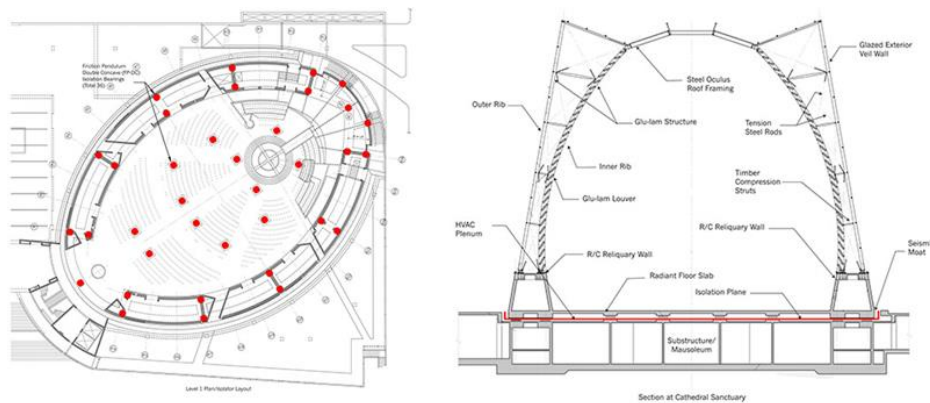


Fig 14: Cathedral of Christ the Light, Oakland, California, 2008
https://www.flickr.com/photos/ml_kap/36663553463, Accessed: 4.10.2021.
<https://www.pinterest.de/pin/542543086337298213/>, Accessed: 4.10.2021.

4. Artificial lighting in churches

Lighting (or lighting) describes the way the human eye (man) is exposed to natural or artificial light. Natural light comes from the Sun, stars or fire. The intensity of these sources will depend on the time of day and location. Buildings are often designed to optimize the capture of natural daylight. In contrast, artificial light is man-made and can come from sources including fire, candlelight, gaslight, electric lamps... Today, the term 'artificial lighting' generally refers to lighting generated by electric lamps. The term 'lamp' refers

specifically to a light source, which typically consists of a light element housed in an external container (bulb or tube) that emits radiation within the visible spectrum. Artificial light, in general, is easily manipulated to achieve the desired lighting result. Light can be increased or decreased, directed, focused and colored. This allows the lighting to create a series of effects according to the requirements of the space [1]. In recent years, there has been a major shift from traditional incandescent bulbs to energy-efficient alternatives. Incandescent lamps. A traditional light bulb with an

incandescent bulb, which was once often used in residential buildings. They are generally considered to be the least energy efficient choice of electric lights, but they are cheap, turn on instantly and come in a variety of sizes and shapes. Fluorescent lamps. Compact Fluorescent Lights (CFL) are available in a variety of sizes and fixtures and can be used in place of incandescent bulbs without changing fixtures. They are generally more energy efficient than incandescent bulbs. Some are dimmable and compatible with other lighting

controls. CFLs come in rod, spiral and reflector varieties. Light Emitting Diode (LED). LEDs are a rapidly developing lighting technology and are one of the most energy efficient lamps available. Compared to incandescent bulbs, they can use about 75% less energy and can last 25 times longer, but they are much more expensive. They are generally highly valued for their comparable or higher quality lighting effect compared to other types of lighting (Figure 15).



Fig 15: Light Emitting Diode (LED)

<https://www.lifewaychurchinteriors.com/retro-fit-lighting/>, Accessed: 7.19.2022.

<https://www.clarityslv.com/led-church-lighting/>, Accessed: 7.19.2022.

4.1. Types of artificial lighting

Ambient lighting. This is general artificial lighting and overall lighting in the room. It can provide an even spread of light to give most people a comfortable level of illumination and to be able to see reasonably well and move around the room safely. It can usually be delivered using pendants (on walls) or ceiling lights.

Task lighting. This light enables the execution of tasks such

as reading, studying, working on production machines, working on the production line... It is used where the level of light in the environment is insufficient to perform tasks.

Accent lighting. This type of lighting adds drama and character and allows you to highlight certain features that are considered interesting. The idea is to draw the viewer's attention to an illuminated 'point', on a wall, a decorative pool, an expensive vase - for example (Figure 16).



Fig 16: Accentuating details in the church with lighting

Left: Illuminated statue of St. Michael in the church of St. Michael and All Angels, Chiswick, London, England

Center and right: Statue in St Mary's Cathedral Church, Sheffield with and without spot lighting

<https://www.buildingconservation.com/articles/lighting-historic-churches/lighting-historic-churches.htm>, Accessed: 7.19.2022.

The necessity, justification, quality and type of artificial lighting are very important and current in contemporary sacred buildings. True, most of them use natural light as a tool of artistic highlighting or even as a work of art in itself that unites the regular sphere and visibility. Therefore, the interior does not require artificial light from outside, only functional and temporary lighting. On the other hand, another group of modern churches and sacred buildings generally uses artificial light already in the design phase as part of art

or as a tool for highlighting. Sacred buildings use artificial light not only as an artistic tool, but also as an indispensable instrument for highlighting the architectural form, the lack of which would make the interior space insignificant or even frightening. In the second group, artificially lit sacral objects, the color and intensity of the artificial light were chosen to emphasize the architectural design, and through this at the same time display artistic and decorative elements that have a functional role. Such portholes are generally arranged in or

around the direction in which natural light enters and their design closely follows the atmosphere of the interior of the sacred space. Their arrangement often follows the rhythm of doors and windows and the shape of individual structural elements of the building. Special attention should be paid to the fact that artificial light has an impact on our sense of time. The cyclical nature of time, the power of regeneration, can best be expressed consciously and artistically represented by the appropriate, dynamic use of natural light, while the subjective feeling of time can be characterized by the use of static artificial lighting.

4.2. Methods of lighting historical churches

The internal and external application of light in churches can have several interpretations. We are talking about the indirect use of light (whether it is natural or artificial light) which serves to emphasize an emphasized element of the interior (sculpture, painting, certain area...). The dimensions and arrangement of transparent panels with the aim of encouraging meditation and introversion are another example of the indirect use of lighting. Examples of direct use can primarily be found in communities that worship light or the Sun. There we find an extremely wide range of lighting techniques that use the annual shift in the direction of daylight intensity as well as the daily cycle of changing lighting conditions from sunrise to sunset. As a result of the further development or extinction of such cults, the latter type of sacred buildings no longer inspire their modern viewers with awe of the ancient deities, but often evoke respect only for the advanced state of natural sciences in such ancient communities of our ancestors. In the early days when Christian congregations were housed in houses, which were later converted into churches by enlarging the interior, the size and arrangement of transparencies (windows) were apparently the same as for other residential buildings. The typical early Christian 'catacomb atmosphere' left its mark on churches centuries later. The vaulted cave-like space, which was dimly lit but in some places brightly lit (later an artistic tool for emphasis), had the psychological effect of a cave or similar structure that serves to protect the primal instincts of people.

Gothic architecture introduced a fundamentally new and homogeneous system structure with the use and development of pointed arches and ribbed vaults. She used a skeleton of graceful girders that carry relatively light vaults wrapped in an orderly arrangement of large, tall spaces flooded with light. The openings were often extremely large and glazed in color (stained glass). Although the orientation of the church with respect to the compass, which became more and more strict in Gothic architecture, seemed to impose a limitation on the appearance of interior lighting. The use of a large number of structural as well as decorative elements helped to soften this strict system of light direction, creating a unique artistic lighting effect for each building.

During the Renaissance, fine art of a religious orientation appeared at first, to be in sharp contrast with the rational interior lighting and architectural arrangement of buildings. On the one hand, there is an obvious contrast between the mathematically precisely shaped incoming light and the work of fine art. Dealing with his subject and using colors with exceptional impulsiveness, on the other hand, is noticeable in the rational composition of these paintings - a striking sign of the artist's attempt to become independent in the face of the prevailing lighting of the church's interior. Light, which is

often the only applied element that allows relatively easy recognition of almost all forms of Mannerist art, is treated in a calculated and conscious way similar to the Renaissance in architecture and often serves as the only basis for accurately determining the real dimensions of space among the sumptuous spirals and labyrinth of mass and form. The painting was generally monotonous, unconventional and often shocking, with a bold choice of subjects, compositions and geometric shapes. The light represented Renaissance softness and lightly referred to the characteristics and extremely efficient lighting in the Baroque, which was from one direction and therefore immediately understandable.

In the artistic periods before the Baroque Enlightenment, the surrounding holy figures symbolizing God were represented in a way that can be called general and almost dogmatic. The Baroque led to a shift in the representation of fame: each artist illustrated differently, across regions and decades. Apart from the explicit and often colorful Byzantine circles, which are also reminiscent of the architecture of Ravenna, and the equally explicit paintings of the Renaissance, which already have softer contours and finer tones, three depictions of Baroque origin, almost exclusively typical of that era, became dominant. The usually golden glory of an irregular contour that radiates in all directions is particularly typical for sculptures, it is also present in paintings, and gave the effect of shining rays of the growing radiation of the Sun around the faces of the saints. Glory highlighted by tiny stars in a special circle, which reminds us of the starry sky of Ravenna, can also be found in sculpture and in painting. Finally, characters without explicit fame were often emphasized only by changing the tone and color of the sky in the background: the long and glowing colors of the Sun's disc were used to draw the eye.

Among countless variations, it is almost exclusively a frequent application of natural forms that will function as a kind of fame that can be said to be general.

The lighting of the classicist church shows - in accordance with the characteristics of that style - the basic features of ancient public buildings. However, since then, the natural lighting design of a single principle cannot be seen to be followed, as the individual has increasingly come to the fore in the field of art; the artist firmly demanded personal attention. The great variety in concepts, structural design and choice of materials no longer allow the statement on analysis of natural lighting to be widely applied. Considering the technical standard of the age, it necessarily brought the moment for the introduction of artificial lighting in sacred interiors, even if it can be said that it happened by chance, and this change resulted in a wide variety of different solutions.

4.3 An overview of selected examples of light treatment in church design

The Cathedral Church of Saint Peter (German: Kölner Dom, officially: Hohe Domkirche Sankt Petrus) is a Catholic cathedral in Cologne, North Rhine-Westphalia, Germany (Figure 17). It is the seat of the Archbishop of Cologne and the administration of the Archdiocese of Cologne. It is a famous monument of German Catholicism and Gothic architecture, and in 1996 it was declared a UNESCO World Heritage Site. It is the most visited landmark in Germany, attracting an average of 20,000 people a day. At 157 m, the cathedral is currently the tallest church with twin towers in the world, the second tallest church in Europe after the Ulm

Minster and the third tallest church in the world. It is the largest Gothic church in Northern Europe and has the second highest towers. Two huge towers give the cathedral the largest facade of any church in the world. The choir has the highest ratio of height to width, 3.6: 1, of any medieval church. The construction of the cathedral in Cologne began in 1248, but was stopped around 1560, unfinished. Work did not begin until the 1840s, and the building was completed according to its original medieval plan in 1880. Cologne's medieval builders planned a large building that would house

the reliquary of the Three Kings and that would correspond to its role as a place of worship for the Holy Roman Emperor. Despite remaining unfinished in the medieval period, the Cologne Cathedral has come together over time as a 'masterpiece of exceptional intrinsic value' and 'a powerful testimony to the strength and persistence of the Christian faith in medieval and modern Europe'. Only the telecommunications tower in Cologne is taller than the Cathedral.

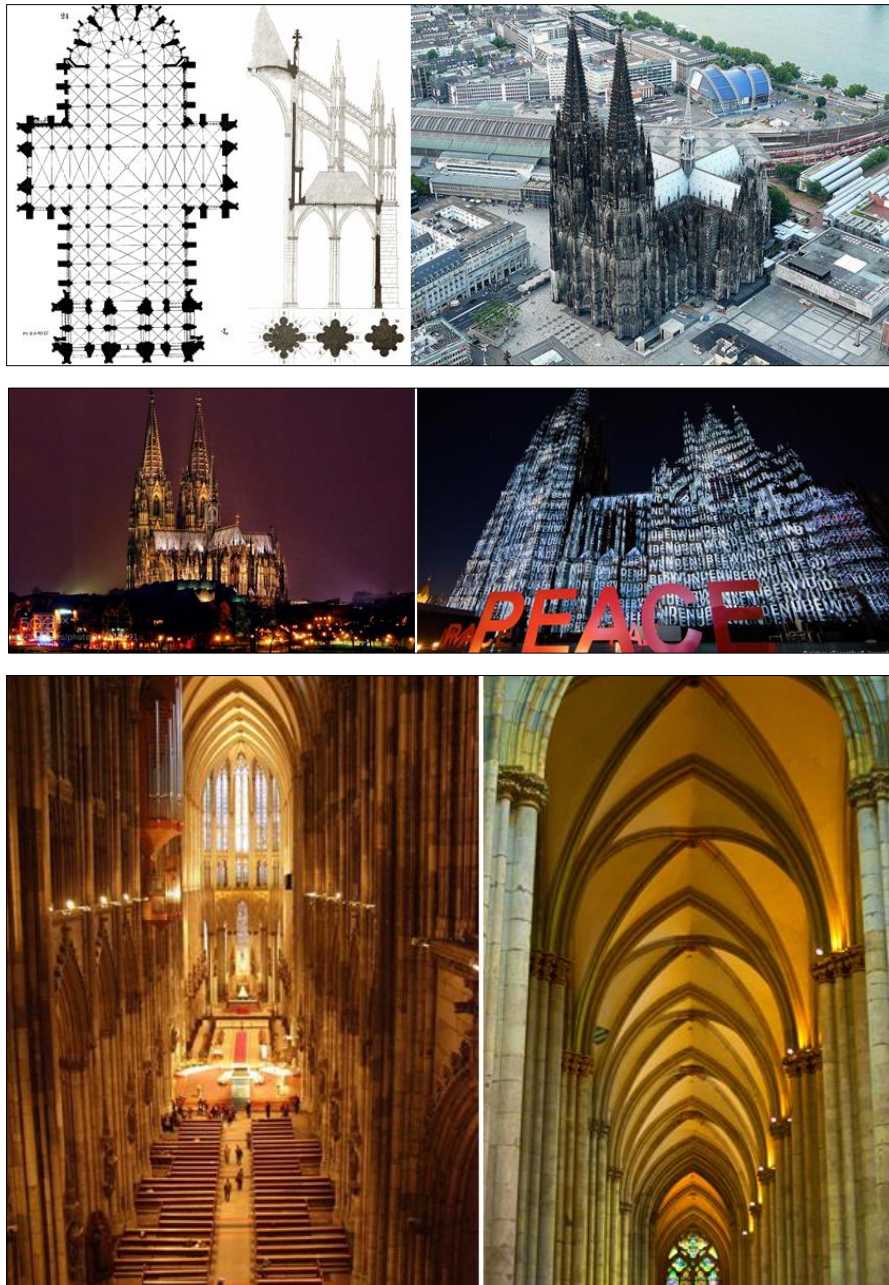


Figure 17. Cologne Cathedral (German: Kölner Dom, officially: Hohe Domkirche Sankt Petrus), Cologne, Germany, 1248-1880

<https://upload.wikimedia.org/wikipedia/commons/6/68/Cologne-Cathedralaerial-east.jpg>

<https://www.dw.com/en/rememberingworld-war-i-cologne-cathedralilluminated-for-peace/a-45648271>

<https://www.pinterest.dk/pin/586453182708570075/>

<https://www.pinterest.com/pin/158470480612383124/>

<https://www.pinterest.com/pin/558868635001167031/>

<https://www.wallpaperflare.com/germany-koln-cologne-cathedral-interiorgothic-windows-wallpaper-ewftk>

Accessed: 8.3.2021.

Daejun Holy Light Church, which opens to the city, is planned as a continuous corridor through the church square from the main avenue, across the corridor to the adjacent park facing the back of the church (Figure 18). The church was designed by the architects of the design firm Lee Eunseok + Atelier KOMA. The lobby is a closed outdoor square for the public and an open hall for children. The hall is open to the surroundings horizontally, so it is revitalized by the city, and the church gives the neighborhood a bright and open space. Since the modern church is a complex facility where many members will worship, socialize and have different gatherings, it is necessary to provide efficient spaces and a movement system in a situation where different spaces are stacked on narrow ground, and the underground space should be used as a place of worship. Therefore, the Church of the Holy Light, located in the city center of Dunsan City, Daejeon, consists of the following three parts: an outer square and soft facade, a pleasant and harmonious worship space, an inner hall square, and an educational space.

Daejun Holy Light Church has dedicated a block area on the front road entirely to an underground parking lot. The roof of the parking lot can be used as an outdoor parking lot in case of emergency, but it is usually used as an open multi-purpose space for people like the square in front of a church in Europe. The cross tower and the corridor are landmarks in the city, and the back of the church can be seen from the road. Together with the surrounding buildings, they limit and define at the same time. The recessed curved wall on the front of the church functions not only as a decorative feature but also as a wall that characterizes the entire interior and exterior of the church. It is the basic concept of the church, which

welcomes neighbors as if it encompasses the square and the city. The Church wanted it to be a metaphorical example of a mild Christian life. This facade is the first impression of the Church of the Holy Light and becomes a luminous body of colorful changing light, a reflection of the name of the church.

The underground place of worship contains the maximum number of seats in a given location. Also, planning a place of worship without balcony seats is intentional to create a space for community building. The underground place of worship is spacious and easily accessible from the outside from the sunken garden instead of through the lobby. The underground worship space is separated from the city noise, so it is quiet. Also, the underground lobby in the shape of a funnel became a pleasant and bright space from the light of the stained glass window. In addition, the semicircular floor plan of the main chapel and the pulpit lower than the stalls reduced the sense of religious authority. This layout also supports preaching and harmony among members.

The hall on the first floor is planned as a public space that citizens can easily access because its facade faces the outer square and the park that is next to the church at the back. There are rooms for education and administrative staff for infants and toddlers, and they also act as a cafe. Most of the educational space is mostly located on the upper level. This arrangement provides a bright and cool view that is open in all directions so as to create an effective educational environment for future generations. It's easy to get in and out, and youngsters can enjoy the multi-purpose hall and roof garden.

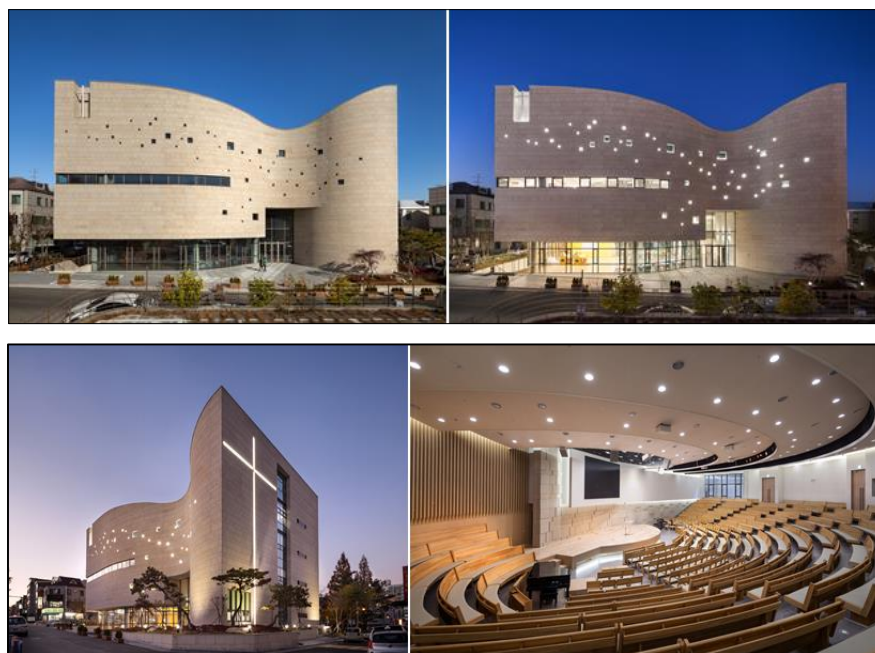


Fig 18: Daejun Holy Light Church, Dunsan, Daejeon, South Korea (Architects: Lee Eunseok + Atelier KOMA) <https://www.archdaily.com/895059/daejun-holy-light-church-lee-eunseokplus-atelier-koma>, Accessed: 8.2.2021.

Conclusion

In this paper, the phenomenology of light is approached as a physical phenomenon that affects the comfort and practical use of space, and a symbolic phenomenon rich in social and religious meaning. The goal of the author's analysis basically represents the formation of a historical and practical basis on the basis of which it is possible to indicate specific

approaches to the use of light design in different civilizational structures and certain periods of their creation. The viewpoints of many forms of creation and produced effects are analyzed through the historical conditioning of generating light sources, comparing and analyzing solutions, with appropriate classification. When it comes to the evaluation criteria that were applied in the research/presentation of the

complete material, in addition to the conditioning of the moment of creation, they mainly refer to the concept, function, forms, and different approaches within the mentioned forms of sacred objects, i.e. the diversity of spiritual identities is dynamized. This author's approach affirms the interculturality of the language of light, which represents a specific way of creating a place for a contemplative atmosphere of various forms of religious encounters within churches. The phenomenon of light is approached as a physical phenomenon that affects the comfort and practical use of space, as well as a symbolic phenomenon rich in social and religious meaning. In addition to artificial light sources, Sunlight/daylight is also analyzed, which also contributes to the formation, structure and symbolism of sacred architecture, and plays an important role in ancient mythologies and religions. It conditioned the orientation of the objects, their spaces and contributed to their physical and aesthetic entity. The earliest window cavities were unglazed openings in wall panels through which light and fresh air entered the premises of the building. Although the first glass panels, which had both a functional and decorative role, appeared in Rome around the year 65, glazing became widespread in sacral architecture only in the 13th century. The variety of styles of sacred buildings nevertheless testifies to the importance of windows in architectural aesthetics, and the design of glazed windows at all times depended on the development of the glass making process and its availability. In the work, among other things, it is possible to meet covered domes where the structure of the space is symmetrical and centralized, sometimes a lineta (arched window on the roof) is made in the center of the dome. This central skylight emphasized the space of the building's dome. The cross projection of sunlight caused part of the inner surface of the dome to become brighter than the rest. The lack of symmetrical illumination of the dome balanced the symmetrical organization of space and architectural elements under the dome. It is most likely due to these and similar effects that sacred architecture is referred to as 'writing with light'. Although spatial comfort can have some subjective parameters that determine it, it certainly includes some general parameters, and one of them is certainly daylight, while the intensity of daylight can play a big role in achieving subjective spatial comfort. Therefore, even today, the concept of good architectural practice is certainly not possible or achievable without a functionally designed lighting concept within a spatial unit and strategically designed units to achieve sufficient optimal amounts of daylight. In architecture in general, light is the starting point, it is not just an opening or a window, i.e. a dome, but an element that is thought about at the very beginning so that all the others make sense at the end. This work suggests the conclusion that the history of architecture is, in fact, a search for light. This is confirmed by the light that dematerializes the surface, becomes more present than the material itself, manipulates vision and ignites the imagination, depending on the transparency of the material, color, texture, orientation towards the light, quality and quantity of light, the overall arrangement of the space and the position of the observer in it. By manipulating natural and artificially generated light sources, architects over the centuries have made architecture more appropriate and reliable. This work also suggests the conclusion that light is what enables sacred objects to become architecture, a set of values and their relationships conditioned by the time of

creation and spiritual needs/identifications, relationships of existence and consciousness. Light is the anchor that additionally keeps us in the sphere of logical and critical thinking, understanding and reasoning, where not only new or old knowledge is systematized, it gives purpose and enables self-respect. Light understood in this way is – Credo, manifesto and constitution. It could be said that the motif of light in the sacred architecture of all times is an enigma that needs to be solved again and again.

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