International Journal of Arts Humanities and Social Sciences Studies
Volume 9 Issue 6 ǁ June 2024
ISSN: 2582-1601
www.ijahss.com

Hagia Sophia: The Epitome Of Sacred Lighting

Yueming Qi

Abstract : *In the capital of Turkey, Istanbul, stands a Byzantine architecture wonder that was created nearly 1500 years ago–Hagia Sophia, the Church of the Holy Wisdom. Completed in 537, the feature distinguishing Hagia Sophia from other architecture was its central dome, which produced a magnificent "floating" illusion. This engineering marvel, as well as the delicate play of esoteric light inside the church, struck Byzantine viewers with the utmost astonishment as they were sure this could only be the creation of God. This phenomenon provided an insight into Byzantine beliefs that was unique from the perspective of the pinnacle architecture of the era. The construction and methodology behind the creation of Hagia Sophia's dome lighting reflected Byzantine religion and culture as a synthesis; its beauty and value transcend time, giving internal enlightenment to viewers while influencing the architecture of Byzantium and beyond.*

Keywords: *Architecture, Art History, Byzantine Culture, Constantinople, Domes, Hagia Sophia, Natural Lighting, Orthodox Religion.*

I. INTRODUCTION

Constantinople, 540 CE. The day of a Christian pilgrim unfolds as the sun creeps up the sky; the Byzantine third-hour approaches. The Christian walks steadily into the church, and his surroundings slowly darken as he ventures further. The stone walls gradually engulf illumination from the sun. Something magical ahead and high above intrigues the Christian and leads him into the heart of the church. At that moment, the clock strikes the third hour. A beam of light falls from above and scatters gold upon the altar. The Christian goes down on his knees, his eyes wide open, sure that he is in the presence of God–the dome of the church appears to be resting in mid-air upon nothing but light at its base. How did the architects create this illusion? Hagia Sophia was commissioned by Byzantine Emperor Justinian on top of a previous church in 532, and he intentionally created this dome lighting to honor God. The dome of Hagia Sophia contained the latest architectural innovations of the time. It reached a diameter of 102 feet and remained the largest dome in the world until the Duomo in Florence, Italy, was built in the 15th century. The lighting miracle and elegant architectural design made Hagia Sophia one of the most beautiful constructions in the world.

The innovative dome lighting was not just a technological breakthrough made by its architects, Anthemius of Tralles and Isidorus of Miletus, but also a clear reflection of the Byzantine culture starting from late Roman influences. The Romans passed down the expansion of Christianity after Constantine's conversion from paganism in 312. To honor the divine, Emperor Constantine built scores of religious buildings: 58 churches and two monasteries, including the original church on Hagia Sophia's site, *Megale Ekklesia* [1]. This desire to construct religious buildings spread rapidly like wildfire after the decline of the Western Roman Empire and continued to bloom through the Byzantine era. Churches became centers of daily life for intellectual enlightenment and communal business, and they even led to a prosperous economy, as markets were linked with church celebrations [2]. Hagia Sophia was especially celebrated, for its dome appeared to float on a ring of light due to the visual illusions created by its shape and reflections of light. Viewers' fascination with the dome was documented by the prominent Byzantine historian Procopius, who wrote several books covering subjects of war, architecture, and society in Justinian's time. He recorded his observations of Hagia Sophia's dome in 537 as "though it were suspended from heaven by fabled golden chains [3]." Byzantines viewed this as the blessing of God and believed that under such a dome, they would receive insights from God's blinding light [4]. This enshrined Hagia Sophia in the history of classical architecture, and it also connected citizenry with religion in a distinct manner. Churches were key to comprehending the Byzantine civilization, and Hagia Sophia provided a revolutionary interpretation of religion, architecture, and culture tied closely together.

Since the Byzantine Empire's beginning in 330, the vigorous pursuit of religion was paramount. Religious studies professor Derek Krueger at the University of North Carolina writes: "Scholars increasingly understand religions not simply as the asset to a series of intellectual propositions but rather as richly embodied

cultural systems [2].” Krueger argues that religion intertwines with the culture of an era, and historically, architecture has always been a reflection of culture. The Byzantine Empire was no exception, using its affluence to embed cultural–and therefore spiritual–beliefs in its architectural tradition [5]. In churches, architecture provided space for people to worship the divine, thus becoming an even further place of cultural merging. Hagia Sophia was the pinnacle of construction for cultural representation and hence became the classic of the Byzantine style. As arguably one of the most important churches in this era, evaluating Hagia Sophia will present a thorough understanding of the Empire. Hagia Sophia’s beauty transcends time, influencing future churches and mosques from different civilizations as a model in presenting the abstract divine in physical matters. This essay will examine in detail how natural light effects in Hagia Sophia showcased elements of the Byzantine religion and culture.

II. HISTORY OF HAGIA SOPHIA

The original church built on the site of Hagia Sophia was issued by Emperor Constantine. He commissioned it to be built in Constantinople, the capital of Rome, in 325. The first church had a timber wood structure common in Roman architecture, but it was a failed choice of material, as it burnt down during riots following the second banish of St. John Chrysostom in 404 [6]. Emperor Theodosius II constructed the second church on the site, and it lasted over a century before its demise in fire again [6]. This led the Byzantine Emperor Justinian to fully transform it into the architectural wonder that influenced the Empire’s history. Justinian issued the project to Anthemius of Tralles and Isidorus of Miletus, two talented architects renowned in mathematics and engineering. With their skill, they invented particular structures for Hagia Sophia that made it unparalleled. The remarkable church was completed in 537 after just six years of construction, bringing the initial creation of Constantine to an unsurpassable level [3]. Through inventiveness and sheer scale, Justinian brought some of Old Rome’s glory back into New Rome, welcoming the Byzantine Empire’s first golden age.

Upon Hagia Sophia’s first construction, historians have not ceased their praise of the seemingly impossible dome. Procopius wrote in his tribute, *The Buildings*, that the “radiance [of the dome] is generated within, so great an abundance of light bathes this shrine all around [3].” Courtier and poet Paul the Silentiary wrote in his most praised work, an *ekphrasis* on Hagia Sophia, that the dome was a “firmament which rests on air” and the illumination was produced internally, which “strikes men’s eyes with irresistible force [7].” In these descriptions, the authors were impressed by the lighting and connected their findings with religious features–Procopius imagined heavenly chains lifting the dome. The dome lighting was sacred, meaning it deserved veneration, as the light was dedicated to God. This was significant because Justinian’s command of an impressive dome enhanced the belief in God as divine light filtered from above. He understood the power of architecture, which was to allow one to feel the strength of the Almighty. Justinian left a spectacular mark in the history of Hagia Sophia and subsequently in the course of Byzantium.

Justinian’s Hagia Sophia design became the model of Byzantine architecture. Hagia Sophia’s main centralized building could be visualized as a colossal dome sitting upon a cube with two other semi-domes extending on opposite sides. Every inch of Hagia Sophia spoke to viewers in a religious tone. The interior was covered with rich mosaic depictions upon a gold background with no bare visible wall. In scale, Hagia Sophia was “formidable for any structure not made of steel [3].” It reached about 270 feet long and 240 feet wide. The central dome reached 108 feet in diameter and was 180 feet above the ground [3]. With these dimensions, Hagia Sophia was the largest church in the world until the Seville Cathedral was completed in 1520. The complexity of the dome truly exemplified the architect's brilliance in engineering. The central dome had 40 windows opened at its base, allowing light inside to produce the famous illusion of a dome “floating” on light. Originally, a mosaic portrait of Jesus was situated in the center of the dome, and the golden mosaic rays coincided with pouring sunlight [8]. This system of church design from Justinian was essential because it created a dematerialized space to honor God and made worshippers feel spiritually inspired.

Unfortunately, the original dome of Hagia Sophia collapsed in an earthquake just 20 years after its completion. The dome’s incredible shallowness could not withstand the fact that Constantinople was in an earthquake zone. Paul the Silentiary recorded the collapse of the dome as follows: “Part of it lay on the floor, and part–a wonder to behold–hung in mid-air as if unsupported [9].” Even with the destruction, the poet nonetheless considered the dome astonishing. The dome still appeared floating–just not held with heavenly chains, but rather with a delicate balance of forces. Isidorus’s nephew, Isidorus the Younger, rebuilt the dome seen today, as both original architects passed before the collapse. Greek poet Agathias documented Isidorus’s observations of the “nature and faults” of the fallen dome and said they created a “narrower and steeper [dome that] did not strike spectators with as much amazement as before, but it was far more securely set up [9].” Indeed, the current dome was much more stable and only required small renovations in the following centuries, triggered mainly by constant earthquakes. The price was the illusion of a floating dome was lost forever, leaving only a few lucky observers with a spectacle they took to their graves; its exterior views were furthermore altered as years passed.

Hagia Sophia's purpose as a church changed as historic events followed. During the Fourth Crusade in 1204, Hagia Sophia was looted and turned into a Roman Catholic church. In 1453, Constantinople and the Byzantine Empire fell to the Ottomans, and Hagia Sophia was transformed into a mosque [6]. The Turks did not destroy the building; they recognized that former mosques did not encompass the "slightest reminiscence of harmonious space" seen in Hagia Sophia [10]. This was pivotal because Islamic rulers came to a consensus with Byzantine emperors that Hagia Sophia was a structure capable of communicating with gods through lighting. Though Hagia Sophia was only transformed into a mosque with additional constructions, such as minarets, future mosques started to follow the Great Church's floor plan because of its beauty and influence. Nevertheless, it became a symbol of authority and empirical power to the Ottomans. Writing in his chapter of *Hagia Sophia and the Great Imperial Mosques*, scholar Martin Charles states that the six other mosques in Constantinople built by sultans "can be satisfactorily accounted for by the direct inspiration of Hagia Sophia itself and seem to be little influenced by the older tradition of mosque building [10]." Charles's observation concluded that the beauty and cultural representation of light in Hagia Sophia was appreciated in a multi-cultural dimension.

The acknowledgment of Hagia Sophia's importance extended to modern times. During the rise of historical preservation, Hagia Sophia became a museum open to the public in 1934 and was further recognized as a UNESCO World Heritage site in 1985 [6]. Thousands of tourists each year were able to marvel at the lavish interior and wisdom of the Byzantines. However, in 2020, Hagia Sophia was turned into a mosque again. Though it is still open for visitors, the light of this Byzantine architecture is slightly dimmed from the perspective of Christians. To them, the current state of Hagia Sophia somewhat deviates from its initial intent. Yet, light will continue to shine through the many windows of the dome and enlighten anyone beneath its crown, Muslims and Christians alike.

III. RELIGIOUS SYMBOLISM OF LIGHT

Prior to Hagia Sophia, the belief that light was a manifestation of the divine had existed in civilizations for centuries. The sun is an object that radiates light; it brings warmth to the earth and is essential to human survival. Thus early humans deified and worshiped the sun for its immense powers in different periods. Sun gods such as the Egyptian Ra and the Greek Apollo were seen as the most influential and revered deities in their respective cultures, and they were bequeathed with names like the "creator of the world" or the "ideal human [11]." This was essential because through viewing the sun as the dominant object in the world, the idea of an "Almighty" controlling the earth and represented by blazing light emerged. It was a regular activity for people to pray to the Sun for well-wishes in living and to put their faith in supernatural beings [11].

The nature of these rituals led to the construction of temples and other architecture related to religion and spirituality. Temples, in particular, needed to exhibit specific effects as a sign of honor and proof that the presiding deity exists. Professor and archaeo-astronomer Giulio Magli states that "the project of designing temples [are] explicit manifestations of the sacred obtained through the use of natural light by means of suitable astronomical alignments [11]." Magli points out that even in the earliest civilizations, people used light to symbolize deities and create light phenomena that inhibit meaning. So far back as the Egyptians, the temple of Abu Simbel was oriented to let sunlight shine on a set of cult statues biannually; ancient Greek temples were skillfully planned to allow light to illuminate the interiors on deity birthdays and equinoxes; the Pantheon in Rome had the "arch of light" produced by its oculus to celebrate the birth of Rome [11]. This long history of light in religious architecture was crucial because it proved that illumination had been associated with the presence of the divine dating centuries before. With Hagia Sophia and its successors, this tradition stayed consistent in the Byzantine Empire across another important religion.

With Emperor Constantine's introduction of Christianity to Rome, the religion became an integral aspect of the Byzantine Empire's culture. In 324, Constantine separated Rome into western and eastern sections and moved the capital of East Rome to Constantinople (current Istanbul, Turkey), marking the beginning of Byzantium [2]. West Rome soon declined under warfare, while Eastern Rome flourished in the form of the Byzantine Empire. Constantine was baptized on his deathbed, making the religion legal across the empire and amplifying its spread. This set the fundamentals of European culture for centuries after. According to religion professor Gregory Armstrong at Sweet Briar College, Constantine declared that "...honor for the divine law [is] civic virtue to be inoculated in the subjects of the empire with the help of Christianity…[1]" Professor Armstrong insists that Christianity forever became an inextricable part of the government after Constantine and even more so in Byzantine culture, as under Constantine's decree, his citizens must also honor God. Constantine's successors passed down his legacy through the religion.

Christianity's supremacy and dominance were brought to a climax by Emperor Justinian. He proclaimed the Orthodox Christian Doctrine as the only legal religion, following Constantine and Theodosius II, who each contributed to Christianity's spreading with legislation [3]. Justinian's devotion to Christianity and the empire led to his construction of numerous religious buildings. Just before the creation of Hagia Sophia and other churches, Justinian had triumphed over Rome's long-fought enemy: the Persian Empire [12]. With

stabilized frontiers, Justinian chose to focus on the connection between the state and the Greek Orthodox church, which became inseparable in politics and society. The profits and land that the Empire won from the war supplied his vision. He built so many churches in Constantinople that, according to Procopius, it was "impossible to write about them in detail [5]." As art historian Jaś Elsner states from a religious standpoint, "Justinian's building of churches demonstrates his piety [5]." While on a governmental and military level, "the construction of fortresses shows the emperor's zeal in preserving the empire [5]." Elsner believes Justinian wanted constructions that represented both his passion for retaining the empire's strength and his loyalty toward God. The creation of these churches was pivotal because it shows Justinian's determination to preach to his citizens about the religion. The teaching was done by providing lighting effects–spectacles that could only be explained as the doings of God.

The building of Hagia Sophia was Justinian's way of honoring the divine with light. Justinian himself contributed much to the design and the effect, as he was "inspired by God [5]." The two architects, Anthemius and Isidorus, executed the Emperor's ideas faithfully and brilliantly. As a result, Hagia Sophia was a building whose scale and phenomena were never seen before, which illustrated Justinian's will to make the construction "something different and grander than the past [5]." Justinian was trying to make history, to accomplish greatness that was never seen before in the realms of architecture and religion through Hagia Sophia. The discussion of Byzantine religion cannot be held in the absence of natural light. Thus Hagia Sophia, under Justinian's persistence, illustrated a connection to the divine with light in two ways: its orientation and its dome.

Before entering into the detailed conversation of Hagia Sophia's characteristics, it is essential to first understand the symbolism of light in Byzantine. Symbolism plays a vital role in religious architecture, as its purpose is to use physical (or real-life) mediums to exemplify beliefs connected to the host of the construction. The Orthodox religion states that light is the closest materialization of Jesus on Earth, which extends from the belief that Jesus holds the "real light," or the truth and justice of the world [4]. This meant the faithful needed to find ways to access His knowledge and to see the world from God's perspective. This belief was vital because it illustrated the purpose of churches: to provide spaces for worshippers to seek "enlightenment" and communication with God. In her article for the *International Space Syntax Symposium*, religion scholar Theodora Antonakaki writes that in the Orthodox religion, "a symbolic character was given to the structural materials, forms, and light [4]." The essence of Antonakaki's argument is that natural light is used to strengthen the religious characteristics of Byzantine churches. Indeed, light is the most important consideration in Byzantine architecture, as all structures collaborate to create multiple phenomena that demonstrate holiness. Hagia Sophia's direct English translation is the Church of the Holy Wisdom. The name states its purpose of presenting God's insight through light to humankind and further explains its reasons for providing such profound lighting.

Hagia Sophia showcased the symbolism of light, starting with its carefully calculated orientation. In Hagia Sophia, light was the medium used to represent the blessings of God. Hagia Sophia was placed at a delicate angle of 33.5° southeast, coinciding with the angle of the rising Sun on the winter solstice [13]. The subtle rays of morning light also produced a faint sense of religion, as the Sun's angle was low, making light designs inside the church occur quicker. More notably, the time that the morning sun hits Hagia Sophia's consecrated grounds was connected to an essential practice in Christianity: Mass.

Mass, the central act of worship in Greek Orthodox, occurred during the Byzantine third hour, and this time roughly aligned with today's 9:00 am. The axis of Byzantine churches differed, mainly oriented toward a church's dedication date [14]. However, frequently used churches, like Hagia Sophia, point to the third hour of equinoxes or solstices [14]. During Mass on the winter solstice, the first ray of sunlight would penetrate the apse and shine on the priest and gifts on the altar. It would create a scene of shimmering gold. This distinct beam of light symbolized the Holy Spirit, as according to Byzantine historian Iakovos Potamianos, the "highly directional light beam…bears a distinct similarity to the depictions of light of the Holy Spirit in frescoes and mosaics [14]." As people at the time believed, the Spirit would turn gifts into holy presents with His blinding light and take the faithful givers to a higher intellectual level, making them understand more of God's wisdom. This was significant because the light beam's planning showcased the two architect's determination to make every aspect of the building referenceable in a religious manner. They even considered using the light provided by the orientation as a divine performance of the Holy Spirit. The whole construction of Hagia Sophia was centered around visualizing God's wisdom and presenting that to the faithful using light.

The interior of Hagia Sophia also provided natural lighting on a practical note associated with religion. The Roman architect Vitruvius wrote in his celebrated series *De Architectura* that illumination was necessary to consider when constructing religious buildings [13]. Anthemius and Isidorus had certainly taken Vitruvius's point into account. They lined the sacred building to the rising Sun but also built apses to allow ample light inside at all times. Four fenestrated semi-domes opened to the center, admitting light. Senior research scientist Nadine Schibille compliments the ample interior lighting that provides "religious elevation and… guarantees the greatest possible exploitation of natural daylight throughout the day and the seasons [13]." Schibille continues to

illustrate that in the morning, eastern semi-domes receive the rising sun's light while the south ones take over the job in the afternoon. The additions of these semi-domes were crucial because the church would be blessed with the first ray of sunshine until the last golden beam ventured down the horizon.

Hagia Sophia's orientation did not only consider lighting in one day. In fact, the church made illumination focus on different aspects throughout the year. The lighting levels also differed by season as the angle of light changed with the sun, which illuminated different mosaics on the wall according to seasonal themes [13]. This was crucial because while making natural lighting practical in use, at the same time, the architects used it to add to the mystifying effect of the church. The orientation and structures of the building allowed an abundance of light inside at all times. This fulfills the requirement of illumination and, more importantly, the purpose of the church as a spiritual enlightenment device since the truth of God shines on Hagia Sophia every second of the day.

Hagia Sophia's central dome acted as a lighthouse guiding Byzantine worshippers to venture into the heart of the church. Windows were placed in zones, creating a dimming effect as people walked inside. Antonakaki explains this system of lighting further as she writes, "stained glasses are often used in the windows to color the daylight and strengthen the mystical atmosphere [4]." There are about 200 stained glass windows in Hagia Sophia, working with the light zones to add a sense of unearthly nature to the environment. As Byzantine worshippers walked inside the church, leaving the bright daylight outside, they would feel a sense of solemness as interior brightness decreased. This darkness was important because this environment allowed worshippers to focus and find light sources to indicate where to go. They would then see the lit rim of the central dome, guiding them further from the semi-darkness to embrace God's light. This process symbolized God leading His faithful believers into His wisdom, letting them feel His presence and intellectually preaching to them. The creation of the dome lighting in a semi-dark environment illustrated God's purpose in architectural language.

The dome was also visually connected with Jesus's image. In the center of the central dome, a mosaic painting of Christ was depicted. This way, the light shining through windows would coincide with the golden mosaic rays depicted around the portrait of Jesus, enhancing a holy effect. The Pantocrator was not illuminated by direct lighting from the outside. Instead, the subtle illumination created by reflective surfaces gave the effect that Jesus himself was emitting light [15]. The dark environment and bright dome caught the viewer's attention, which was significant because it further showcased that Jesus was the holder of the "true light" in the world. This phenomenon happened throughout the day, allowing worshippers to view the illuminated Jesus.

The combination of Hagia Sophia's orientation, dome, and planned lighting serve to symbolize God. Though all these carefully built structures contributed to the church's success, the remarkable phenomenon of the floating dome made Hagia Sophia a legend. The mechanism and thought behind the central dome were a true demonstration of Byzantine wisdom in architecture.

IV. THE DOME DESIGN FOR LIGHTING

Hagia Sophia's dome, in concept, differs from all lighting phenomena created in the past, including the designs of the Egyptians and Greeks. Once a year on the summer solstice, looking in front of the Sphinx, the Giza Pyramids create a hieroglyph called Akhet, meaning horizon, with the sun [11]. The Greek temple for Apollo at Bassae had a fixed doorway that allowed morning light to shine on the young god's statue in spring, symbolizing the god's return from northern lands [16]. These lighting effects, though fantastic in execution, only occur once or twice a year. They were the products of carefully calculated orientations associated with the Earth and Sun's orbit and depended less on architectural structures to support the effects. Although Hagia Sophia, too, exhibited the phenomenon of the Holy Spirit during Mass once a year, Justinian and his architects made a bold move with unprecedented architectural decisions. They decided to create a constant lighting miracle visible daily any time there was sunshine–hence, the floating dome. The floating dome was not just math combined with astronomy but a revolutionary artificial structure that allowed men to manipulate sunshine at will. The floating dome was made possible by Hagia Sophia's central structure and the various reflective surfaces on the dome.

The Byzantines derived much architectural knowledge from their predecessors, but eventually, new structures were needed. At the start of Byzantium, churches were primarily built on the bases of Roman basilicas, which were usually cubes or rectangles [1]. Because of its religious need to symbolize the circular heavens, a hemispherical dome was placed on top. This involves the knowledge of putting a "circle" on top of a "square." This was a significant idea because even their Roman ancestors built circular domes solely on cylinders; thus, the methods of creating a dome on a square were of Byzantine wisdom alone. Hagia Sophia was the first monument to acquire this new structure at such a large scale; its dome's diameter stretched 102 feet. Procopius complimented the discovery using the word "mechaniko," meaning it had "prepared in advance designs of future constructions [17]." The essence of Procopius's observation pointed to the novelty of this centralized structure and dome design, and he believed that they were extremely beneficial formats that opened

new architectural potentials. Indeed, the "circular dome on top of square base" became the most prominent characteristic of Byzantine churches.

The mechanism used in Hagia Sophia is the pendentive system. Essentially, it is placing the real dome on top of a much larger dome that falls into a square at the bottom. The sides of the larger dome open to form four semi-circles. The endpoints of the semicircles fall into columns supporting the structure. So the larger dome is combined with the cubed space below, and the four semi-circles and the rectangle below them are turned into walls for the central part of Hagia Sophia. The smaller dome is placed on the large dome, and the space between the two domes forms four curved triangles called pendentives [3]. Art history professor Anthony Cutler concluded that the purpose of the pendentives is to "effect a palpable transition between the circular plan of the dome and the square formed by the four central piers [17]." Professor Cutler illustrates that the pendentive transition is yet another approach to presenting Byzantine aesthetics. The smooth progression from ceiling to wall allows the eye to gaze over uninterrupted surfaces, taking in the union beauty of the dome, wall, and glittering mosaics. This is essential because the pendentive system works as a connective tissue, tying Hagia Sophia's elements together and creating long-lasting effects.

This innovation in Hagia Sophia opened unique possibilities to Byzantine architecture. The pendentive system contributed to the floating dome illusion of Hagia Sophia itself. There was no support directly under it, and the ring of light around the dome's rim would further conceal connecting walls [3]. Because no person had seen the dome built in such a revolutionary way, it enhanced their awe of the suspended dome. Viewing the effect of the system with modern eyes, Anthemius and Isidorus succeeded in producing something truly unprecedented that influenced the whole of Byzantium. As stated by art historian Fred Kleiner, pendentives combined two formerly "independent and seemingly mutually exclusive architectural traditions," which were the central-plan architecture and longitudinal basilica [3]. The basilican plan had been successful and used for centuries; the central plan (round, polygonal, or cruciform) had only recently come to light under Christian influences. By uniting traditional and new designs, Hagia Sophia became the pioneer for a standard form of Byzantine architecture.

Moreover, this design allowed room for religious purposes. When Mass occurred, singing choirs, chanting priests, and onlooking clergy filled the nave and space under the dome. The jeweled presents, the golden bind of books, and the precious cross would gleam and illuminate under the dome's blazing stare. Only the emperor and patriarch (the equivalent of a pope) were allowed into the sanctuary during the ceremony. Under the holy dome and spectacles, the emperor and patriarch would be equally sprinkled with God's blessed light. This was pivotal because the synchronized standing of the two political and religious leaders symbolized the union of the church and state. Kleiner agrees when he writes, "standing at the pulpit beneath the great dome, his rule was again sanctified, and his person exalted [3]." Kleiner expresses that Justinian has succeeded in his grand vision for Hagia Sophia. The floating dome became a symbol of welfare, and as Justinian, the individual who made it possible, stood under it, he secured his empire and combined his rule with the church.

The former dome designs in ancient Rome had significant flaws in the eyes of Byzantine architects. The Romans were the first to conjure up hemispherical domes and apply them to buildings using their knowledge of concrete. The Pantheon holds the largest and most famous concrete dome in history. The entire building has only one light source: the oculus (round opening) that is in the center of the dome [14]. Undoubtedly, the oculus allowed a bright circular light disk inside and had various phenomena occur with this light, such as the "arch of light" produced on Rome's birthday, April 21st [18]. However, the interior of the Pantheon dome was dark at all times. If this were put into a Byzantine church, this would mean that the frescoes and mosaics on the dome itself would be hidden from light. Especially, the portrait of Jesus depicted on the central domes would also be dark. The light of God in the dome would then be tempered, a clear violation of the Lord's holiness. Light was the representative body of God, and a place where He was worshiped could not be overcast by shadows.

Additional problems arose with the absence of abundant illumination in pre-Byzantine domes. Potamianos notes as he writes, "all the aesthetic qualities, which could possibly give rise to a whole range of symbolic qualities, would remain inactive without light [14]." He emphasized the need for abundant light in Byzantine churches to illuminate Jesus and act as a medium to power all devices inside. This was noteworthy because light held priority in Byzantium; therefore, lighting inside domes was simply required. To resolve the withstanding problem, a dangerous but popular thought was to open windows at the base of domes. This would create a ring of openings around the rim, allowing light to flow inside [14]. Though the discovery of concrete could support such an idea without the dome collapsing, the windows would only allow light to go down into the vast space below, not up to where the Pantocrater and various mosaics were depicted. Something was needed to manipulate the passage of light, and the architects of Hagia Sophia solved this problem by using astounding wit.

Anthemius, in particular, was interested in a field of engineering called "catoptrics," where he derived ingenious ideas to light Hagia Sophia. Catoptrics is the study of reflecting light through mirrors. During

Anthemius' study of mathematics, he created sketches of reflectors that could be used in domes to reflect light inside. In their comparative study, Dr. Jabi and Potamianos concluded that Anthemius "was an expert in the handling of light, being able to direct, focus, and stabilize it [15]." They were pointing towards Anthemius' famous reflector, which allowed light to concentrate on one specific spot. This invention of Anthemius later played an important role in Hagia Sophia, though no direct evidence stated that he intended these designs specifically for the church [14]. Hagia Sophia exhibited two crucial systems of dome reflectors that made the illusion of the floating dome possible. Adaptations of Anthemius' reflector designs were essential because they were the geometric solution to lighting Hagia Sophia, and the designs influenced the planning of Byzantine churches after.

The first challenge was to let daylight shine on one specific area of the dome at all times, regardless of the sun's position. The most important part of the dome was the apex, the center where Jesus' portrait would be portrayed. The apex would be the church's highest point, symbolizing God's supremacy as it guided viewers closer to the center. Anthemius stated that "it is required to cause a ray of the Sun to fall in a given position, without moving away, at any hour or season," posing a high standard of construction for himself [15]. This was where his reflectors came into play. To achieve the architect's desired phenomena, reflectors, shaped like eggshells, were placed on the windowsills of the 40 windows at Hagia Sophia's dome base [14]. Each reflector was placed at a different angle concerning the window's relationship with the Sun and dome center so the "eggshells" could successfully reflect light to the center. As the sun rose and light poured through the windows, the light reflected off the eggshell reflectors and bounced up into the dome, illuminating the apex precisely. This design was remarkable because the apex would become the brightest part of the dome, drawing attention to Jesus' visage and echoing the golden aura surrounding His head.

Lighting the dome apex alone, however, was insufficient for Justinian and the architects, for the rest of the dome would still remain in shadow. Thus a dual system of reflectors was needed to light the dome completely. The original dome of Hagia Sophia was turned into a gigantic reflector itself, as it was incredibly shallow. This shape severely endangered its stability in order to allow enough light inside to illuminate the dome entirely [9]. The combination of Anthemius' two reflecting systems was critical because the illusion of the floating dome could be presented only with their collaboration. Sunlight would be filtered inside through the 40 windows, then bounced off from the carefully placed windowsill reflectors straight to the apex, creating a bright aura. The light aura dispersed as light beams were reflected inside the dome, lighting up the space entirely. In theory, the dome's light would not descend to the main church but would stay high up, creating no shadows [14]. This enhanced the lighting phenomena, as the bright dome separated from the rest of the building, which appeared dimmer.

Direct observations of the completed dome confirmed it had conveyed its message of divinity to onlookers. Procopius expressed his examination of the dome as follows: "For I am convinced that it rises above the whole earth; and the structure is discontinued every little while, purposely omitted at enough intervals that the places to which the gaps in the structure correspond give admittance to adequate light [9]." His phrase "adequate light" was noteworthy because this demonstrated the success of Anthemius. Even the first-time witness Procopius had noticed the unusual brightness of the dome and the light it encompassed. He took note of the unearthly light that seemed to be generated solely within the dome. The dome seemed a part of heaven, with mysterious illumination that differed from the mortal world below.

A quick search of Hagia Sophia's dome online, however, showed otherwise. The current pictures exhibit none of the astounding lighting described by Procopius and Paul the Silentiary. Today, the dome seemed almost ordinary; the only fantastic element was probably the immense size and space the dome encompassed. Where was the lighting phenomenon, the incredible floating dome? As explained before, twenty years after Hagia Sophia's initial construction, an earthquake collapsed the delicate dome, and Isidorus the Younger took on his uncle's job of restoration [9].

Isidorus the Younger had good reasons to re-evaluate the initial design. The original one pushed both the diameter and shallowness of a dome to an extreme [9]. It had a diameter of 102 feet, unheard of in the East. The dome was so shallow that it almost coincided with the larger dome, the pendentive system under it that held it in place. After the 557 earthquake, Historian Agathais gave a first-hand account of the dome's rebuilding. He reported that Isidorus the Younger's team had made the dome "more even and well-curved, conforming altogether to the [correct geometrical] figure [9]." Agathais implied that the former architects' bold moves on the dome had made it far too delicate geometrically to stand for centuries. Isidorus the Younger's new dome was twenty feet higher than the first, granting essential stability to Hagia Sophia as it was built in an earthquake zone. Even with these new measures in place, the dome partially collapsed a few more times in the centuries after the rebuild, and, in the 1200s, four buttresses were added to the west side to increase its strength [10].

However, could the dome be praised so highly if it only survived for two decades? After the original dome's collapse, no Byzantine church, not even Hagia Sophia, attempted the subtle curve and design of the dome again. Although readers may object that Hagia Sophia does not deserve its reputation with an illusion that

failed to survive the course of history, it is important to address Anthemius and Isidorus' daring nature in producing an unprecedented creation. The architects used the latest techniques of the time to create the dome to convey the presence of God. They accomplished their goal. It was their tenacity of architectural innovation that made Hagia Sophia so celebrated. It is crucial that the floating dome once stood on Earth because greatness is not defined by time but by the creativity and endeavor behind it. The gift of Hagia Sophia influenced the development of Byzantine architecture as they all strived to produce a similar effect to the long-lost dome but never reached or surpassed it.

Today, the subtlety the dome once had can still be imagined. Sunlight pours through its 40 windows at the base as always and is reflected inside, illuminating the golden tesserae that are slowly fading and peeling away as time passes. The tall ceilings and great space tell the tale of the Byzantine Empire's glorious past; its culture is embedded in every inch of Hagia Sophia.

V. CULTURAL SYNTHESIS

An important concept in Hagia Sophia was the synthesis of cultural elements. Synthesizing was the combination of ideas that form one unified structure or system, and it was a major focus in the creation of Hagia Sophia [19]. Architecturally, the Great Church incorporated the period-typical layout design, enchanting reflective surfaces, and a fragile floating dome. Regarding religion, the ample lighting inside and planned illumination brought a sense of divinity and holiness. While Hagia Sophia was a political center, its aesthetics also became a classic. These different aspects, engineering, religion, government, and art, were all represented in Hagia Sophia. The church created a union, a synthesis, of Byzantine culture. The blend of these various features was essential because this combination made Hagia Sophia commemorated. Hagia Sophia's synthesized cultural features offer a unique chance to understand the Byzantine Empire's beliefs by studying one construction.

Hagia Sophia was the product of cultural fusion between Old Rome and New Rome. The legacy of Christianity that Constantine left developed and merged into Byzantine society. Additionally, the influences of Early Christian and Roman architecture were showcased in Byzantine art and constructions. In his book, The *Byzantine Republic: People and Power in New Rome*, classics professor Anthony Kaldellis at the University of Chicago maintains that "...ancient Rome, whose direct descendent Byzantium was in an unbroken line of political and ideological continuity [20]." Professor Kaldellis confirms that Byzantium, or New Rome, inherited many cultural aspects directly from the end of Old Rome. With a rich heritage, Byzantium was able to develop its own styles and traditions. The symbolism of religion in the Great Church was discussed in detail in previous sections; hence the focus now turns to the political and aesthetic aspects of Hagia Sophia.

Byzantine architecture successfully continued late Rome's political government. They maintained the legacy of Constantine's promotion of Christianity, and in this time, the church and state became highly united in a theocracy. The Byzantine emperor was not only the leader of the empire but also the head of the church [20]. Byzantine theocracy joined church and state, with both parties viewed as pivotal aspects in ruling the empire. Theocracy cast its shadows in Hagia Sophia's design, as Constantinian policies and architectural designs strongly influenced the church in ancient Rome [1]. Hagia Sophia contained many architectural features from Old Rome, including its dome, arch, and, most importantly, its particular layout.

The combined layout of a basilican plan and central plan in Hagia Sophia has its roots in ancient Rome. In ancient Rome, basilicas functioned like modern-day townhouses and were used to hold courts of justice and assemble people in the city. A basilica was viewed as a public governmental forum that held administrative duties [1]. It was not a coincidence that Hagia Sophia, a Byzantine church, chose the design of a Roman forum. In fact, this choice emphasized the significance of Hagia Sophia's purpose. Constantine originally envisioned a church as a place where religion and administration were joined together. While encouraging the spreading of Christianity, former Roman basilicas were transformed into churches with additions, and the Byzantines obtained this style due to its efficiency. Constantine gave all bishops juridical roles, which made the church a beneficial communal space [1]. Professor Armstrong illustrated the practicality of churches by stating, "such a basilica was highly functional in terms of the Christian community's needs as a worshiping congregation and in terms of its new official status in the empire [1]." Churches had taken over the function of ancient Roman basilicas as they adapted to the Byzantine culture. This was noteworthy because, as one of the first to use the basilican design, Hagia Sophia's importance in the empire was showcased bureaucratically. The unique basilican layout of Hagia Sophia illustrated that it was an innovation in both architectural and political fields. The layout's combined meaning demonstrates the union of different aspects of culture inside Hagia Sophia.

Shifting perspective into Hagia Sophia's interior, it appears that its walls and floors encompassed cultural meanings. Hagia Sophia's walls were covered with rich mosaic depictions upon a gold background with no bare visible wall. Mosaics were another significant reflection of Byzantine beliefs. Characters in mosaics were distorted in places like the head and body, but these seemingly odd depictions have their merits. The intentional disfiguration was to show that they are not of human nature but of the divine [1]. Kleiner explains

the golden mosaic background as "artists…seeking a means to conjure a spiritual world before the eyes of the faithful, not to represent the everyday world outside the sacred place of the church [3]." Kleiner believes the expensive golden color symbolizes an unearthly environment worshippers are trying to enter, thus fitting the church's spiritual purposes. This system of mosaics was essential because it visually presented Byzantine culture to viewers inside the church. Mosaic depictions were a direct way to convey cultural beliefs and [1]meanings to worshippers as they were easily referenceable to the Bible; other cultural aspects in Hagia Sophia are sensory-based, but they coincide with the golden mosaics to present an impression of holiness.

The floors of Hagia Sophia were made of gray Proconnesian marble, which was associated with water. Proconnesian marble was supplied from an island in the Sea of Marmara close to Constantinople. The white marble was grained and had blue veins, which contributed to the illusion of water. The marbles were rendered with continuing patterns that created a wave-like effect when light swept across them that were meant to incite imagination so viewers could interpret the marble as an ocean. Four lines of green stone represented the rivers of heaven dividing the marble waters [19]. Marbles, reflective in nature, enhanced the light bouncing inside Hagia Sophia. Light was the essential material in Hagia Sophia, and its architects referred to it repeatedly to iterate its effect. Art history professor Bissera Pentcheva stated in her study of Hagia Sophia aesthetics that the fluid golden rays inside "liquefies the ceiling as its shimmer bounces off the faces of the faithful [19]." Professor Pentcheva argued that light connected the architecture with its worshippers inside. Light was reflected off the golden mosaics down to the marble floors below, tricking the eye into viewing it as flowing water, then subsequently illuminating the faces of people, linking the building and people into one aesthetic experience.

While the concept of synthesis made Hagia Sophia rich in cultural integrations, light was the medium that strung all elements together, creating a unified presentation. Hence, the importance of light spoke for itself. Professor Pentcheva notes that the gold illumination linked the walls, floor, and viewers together, turning these different elements into "one transmuting visual entity [19]." Pentcheva agrees that Hagia Sophia's static cultural representations are made active by the flow of light. Light guides the viewer's perception first to the illumination of the dome; then, their gaze follows the reflected glow to the golden mosaics, where people can decipher the meanings of the images. Light inhibited a golden glare from the mosaic walls, and they fell to the marble floors below, changing the solids into water. The designed pathway of light was crucial because it allowed observers to study the entirety of Hagia Sophia from the top of its dome to the vast space beneath. Viewers could take in the beauty of Hagia Sophia from its spectacular engineering and aesthetics and, simultaneously, other parts of Byzantine culture.

Future Byzantine churches followed the lavish exterior and interior designs of Hagia Sophia. Many incorporated a similar square or rectangular basilica layout with a central dome. Usually, the dome had openings at the base but did not exhibit a distinct lighting effect, as Hagia Sophia had specially designed features for light reflection. Moreover, the interiors of Byzantine churches were covered with stunning mosaics. Important churches had surfaces filled with gold to represent heaven, while all had depictions of Biblical stories [4]. These similarities are of note because they directly point to the vast influence of Hagia Sophia, and although all Byzantine churches have their uniqueness, none surpasses The Great Church. Other churches failed to create similar sensory effects to Hagia Sophia because they did not understand the essence of synthesis: a union, not just an assembly of elements. While Hagia Sophia incorporated various seemingly disconnected elements of culture, the church was linked as one by manipulating light. The mere compiling of thoughts and ideas does not make a church noticeable; they must be integrated to produce one entity. Hagia Sophia was the first church that accomplished this level of cultural fusion, and thus it was a forerunner of the Byzantine style that became a classic model for future constructions.

VI. CONCULSION

The architectural periods after Byzantine, Romanesque and Gothic, continued Hagia Sophia's heritage. Christianity spread throughout Europe rapidly, and its worshippers quickly increased in numbers. With a larger crowd to host, many churches developed the "pilgrimage" floor plan shaped like a crucifix. Several others, such as St. Peter's Basilica, referenced Hagia Sophia's central layout and construction techniques for their crossing and apse design [21]. The concept of representing God as holy light extended into Romanesque and Gothic periods though diverging from Hagia Sophia's method of using dome lighting. Stained glass was characterized in the Gothic period, and their depictions of Biblical stories on glass were likely inspired by Hagia Sophia's mosaic walls [3]. Here, glass became the medium to manipulate natural light into different forms and colors to visualize God for onlookers. Hagia Sophia's vast influence in church design surpassed the Byzantine Empire and greatly shaped religious architecture for centuries after. The Church of the Holy Wisdom influenced the construction of churches afterward as its descendants developed into various styles in regions; it was indeed a pioneer that opened a new architectural system.

There have been countless other churches and mosques built during and after the Byzantine Empire, and the history of humankind incorporating natural light in architecture dates back to the ancient Egyptians.

Hagia Sophia was not the first to consider lighting in large spaces, yet, its beauty and importance emerged from all these spectacles in human history. Therein lies value and meaning in Hagia Sophia's legacy. Like any other famous architectural structure, Hagia Sophia should be commemorated for its enormous scale and technical skill that represented the world's greatest engineering minds at the time. Hagia Sophia surpassed the simple compilation of elements and new structures. Its architects primarily created a conversation between faithful worshippers and God, but the greatness of its lighting surpassed making divinity tangible. The Great Church went beyond materiality and religion itself; it is a manifestation of human wisdom, a brightness in humanity. A single structure had never before so thoroughly fused the culture and religion of different societies together, nor was it ever done again. Hagia Sophia has justly become a synthesis of antiquity and humanity through its encompassment of multisensory aesthetics across civilizations.

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