Astronomical Clocks and the Evolution of Ancient Cosmology in Gothic Architecture
Julia Wetzel, University of North Texas

Abstract

This paper offers a review of the location and imagery of astronomical clocks. The zodiacs are highlighted as religious symbols taken from antiquity and transferred into the Middle Ages. The clocks contain imagery similar to other religious spaces such as cathedrals and Books of Hours, which imbues them with meaning while linking them to sacred spaces. The Ancient Lares created a sacred space outside temples. A comparison of them to the astronomical clocks suggests that the clocks also create a sacred space based on location and iconography. This paper will argue that astronomical clocks extended the religious sphere through their placement in public spaces.

Keywords

Astronomical Clock; Cathedral; Book of Hours; Zodiac; Time

Introduction

Among the stories associated with the great Olympians of Greek mythology are interwoven constellation myths that explain how the gatherings of stars were placed in the heavens. These zodiac constellations included Aries, whose golden fleece is central to the story of Jason and the Argonauts, or Leo, the Nemean lion slain by great Hercules, and their stories were entwined within a greater mythology. To the Greeks, constellation mythology was one way to explain the creation of the heavens, while astronomy mapped the coordinates of such constellations. The stars became ways to tell time, predict the seasons and weather, and plan the religious calendar. These time-telling mechanisms were acculturated into medieval society in similar ways. As the religious calendar was taken over by and incorporated into Christianity, so too were the laws of the stars. Astronomical clocks were originally created to accurately portray the placement and movement of
the planets and stars to reflect real time, but their evolution into the late medieval era saw the loss of astronomical accuracy. They became decorations placed in town squares and on cathedrals starting in the 1300s with their new purpose reflecting their former glory within their cosmic imagery. This chapter seeks to examine the zodiacs as the main symbolic imagery on the astronomical clocks and highlight their religious significance as markers of time through their transition into the medieval era. Evidence of the religious nature of the constellations can be seen in their inclusion in medieval Books of Hours and cathedral iconography. The shared cosmic imagery links the sacred spaces, allowing for the astronomical clocks to retain a portion of their original purpose. Once the religious symbolism of the clocks are noted, this chapter will compare the astronomical clocks with ancient *Lares*, who were gods and protectors of domestic spheres. A comparison with the role of the *Lares* will highlight how the location of the astronomical clocks outside cathedrals extended the religious sphere into the public domain. The paper will conclude that astronomical clocks retained some of their former function hidden within their iconography and when connected to other religious spaces like cathedrals, created a new purpose for the clocks.

**The Cosmos: The Shift from Ancient to Medieval Cosmology**

The essential aim of cosmology, like mythology, is to explain the way a group of people saw the world. The zodiac signs were a part of Greek mythology, just like the twelve Olympian gods, and they explained how the stars became a part of the heavens. Eratosthenes tells us that Aries, the golden-fleeced ram, was carrying Phrixos and Helle across a sea strait when Helle fell off into the sea and was taken by Poseidon (Epitome 19). Phrixos landed with the ram in the land of Aietes where the ram’s golden fleece was removed and given to Aietes as a gift. Upon the acquisition of the fleece, the ram became a constellation for its sacrifice. The golden fleece appears again in Apollodorus’ version of ‘Jason and the Argonauts,’ in which the golden fleece became a prize (1.9.16). In a similar fashion, Leo, the lion, was placed in the stars by Zeus to commemorate Heracles’ first labor. The lion was killed by Heracles without weapons, which was
a source of much pride for Heracles (2.5.1). Apollodorus tells us that killing the lion was no easy feat for Heracles, who pounded the lion with arrows and a club to no avail (2.5.1). The lion took refuge in a cave before Heracles found a back entrance and eventually managed to strangle the beast. Heracles was eventually himself placed among the stars for his twelve labors.

Philosophy offered another means by which the Ancient Greeks and Romans could explain the celestial world. The ideas of influential writers such as Pliny the Elder and Plato were carried into the medieval era. Their views formed the basis for the medieval picture of the cosmos. Astronomy consists not only of calculations, but also of observation. Ancient philosophy demonstrates how the Greeks and Romans developed these ideas, which paved the way for mathematical astronomy. Pliny the Elder’s *Natural History* contains ten books of observational science, the second of which explains how the Greco-Romans viewed the heavens and used the stars to predict such things as the seasons and the harvest. Pliny explains that there are 1600 stars that are divided into 72 constellations. These include the Pleiades from the Taurus constellation, which mark the beginning of summer on May 10, and Sirius, the dog star, which signals the hottest part of the summer when “the sun is entering the first degree of Leo,” otherwise known as July 17 (2.47). The rising of Sirius follows the weather phenomenon Pliny calls the “North-east winds,” which precede the annual or Elesian winds. He goes on to explain that the setting of the Pleiades marks the beginning of winter, on November 11. Pliny argues that the sun controls “the year’s seasons” while each star has a “force of its own that creates effects corresponding to its own particular nature” (2.39). Natural phenomena such as thunder and lightning, waves, and whirlpools are some of the effects created by the stars (2.40, 43). Pliny’s observations form the basis and hypothesis for mathematical astronomy. Pliny’s work suggests that anyone who frequently looked up at the sky could map patterns and notice changes, and the observation of the stars allowed for practical applications such as time telling, weather predictions, and when the harvest should occur.
Ancient minds knew the Earth’s path around the sun also follows a “broad band of constellations” or the zodiacs constellations which allow for patterns to form (Evans, 1998, p. 55). The inclusion of the zodiacs in the Earth’s annual path around the sun, allows them to be present at specific times of the year and correspond with seasons. Particular stars that make up the zodiacs and other constellations were markers for seasons and harvests. As Pliny describes, the most well-known of the seasonal stars were the Pleiades, which comprise the Taurus constellation. In Greek mythology, the Pleiades were the daughters of Atlas, and the morning rising of these stars signaled the beginning of winter and “the time to sow grain” (Evans, 1998, p. 43). Arcturus, part of the Bootes constellation but not a zodiac, was one of the most famous stars, signaling the beginning of Autumn and harvest. Sirius, Procyon, Antares, Canopus, Aix, Lyra, and Aetos are also examples of seasonal stars. Sirius, the dog star, is an example of how the stars were used to decipher weather patterns. As Pliny states, when Sirius was high in the sky the Ancient Greeks knew to expect the hottest part of the summer, hence the modern saying “the dog days of summer.” The zodiac constellations also became a tool for navigation and a way to tell time at night.

When we look up at the sky today, it may seem daunting to believe ancient and medieval minds could find practical applications for specific stars and constellations. David H. Levy, the amateur astronomer known as the Comet Hunter and the author of Observing Variable Stars, offers some perspective to the modern stargazer. His book teaches the novice observer how to find each star and constellation with the naked eye, binoculars, or a telescope. Levy first explains that to find individual stars without aids, one must first orient oneself to the stars by observing them nightly. After a time, the viewer begins to memorize the sky and can quickly find certain stars. He clarifies that “seeing is an art to be developed” and that, by training your eyes, you orient your senses to the sky and its changes (Levy, 1998, p. 14). When discussing constellations, Levy begins with Ursa Minor and Ursa Major because they are the easiest constellations to find. From Ursa Major, one can begin looking for more specific constellations. He demonstrates that off the “handle” of Ursa
Major, the observer can find Arcturus, the “bright yellow-orange star,” which is one of the most important stars mentioned earlier (Levy, 1998, p. 3). Ursa Major and Ursa Minor are the keys to finding constellations in spring, and the “Summer Triangle,” comprising the stars Vega, Deneb, and Altair, allows viewers to locate constellations in the summer (Levy, 1998, p. 25). Levy’s work offers a simplified perspective on ancient and medieval stargazing and demonstrates how, after time and practice, even modern viewers can observe the stars.

This perspective makes it easier to envision how an observer could mark time using the stars. Time told at night consisted of twelve seasonal hours, divided between the time after sunset and before sunrise. Utilizing this form of time telling requires knowledge of the changes in daylight throughout the seasons. Each night can be divided into six parts of two hours each, based on six zodiac constellations; this allows the navigator to count the hours based on the position of those stars (Evans, 1998, p. 95). The zodiac constellations, as well as many other stars in the sky, thus had many practical applications.

Observing the stars creates a sense of curiosity about who created the heavens. In addition to mythology, philosophy attempted to answer and explain these questions. Plato’s *Timaeus* demonstrates the ancient origins of medieval cosmology and philosophy. In a dialogue between Socrates, Timeaus, and Critias, Plato emphasized the importance of researching the heavens and its creator by expressing the view that our world is made from reason and intelligence (29b). The creator made everything in his image, giving it a soul and intelligence, so that “the nature of the universe [may] surpass all other products in beauty and perfection” (30b). According to Plato, everything possesses an invisible soul, and material world was created inside it. When the creator was finished, he made the exterior sphere of the world. The interior and exterior spheres work together in a harmonious movement as “eternity,” or what we call “time” (36d–37e). These spheres were called the heavenly bodies and are divine like the stars. Furthermore, Plato continues by positing that all matter is made up of four elements: fire, water, air, and earth. Moreover, celestial bodies contain depth and the ancients visualized the cosmos through rectangles and triangles.
Understanding the makeup of triangles and rectangles enabled humans to understand the heavens, and this led the way for mathematical astronomy. Plato’s understanding of the stars through geometry and trigonometry fed into medieval conceptions of cosmology and astronomy. In fact, medieval scholars endlessly labored over how to reconcile Plato’s and Pliny’s ideology with their religion and faith to create the medieval view of the cosmos.

Astronomy was understood as comprising philosophy, as in Plato’s *Timaeus*, and mathematical astronomy, as in Ptolemy’s *Almagest*. Plato and Aristotle’s divine creator was altered to “meet the demands of biblical interpretations” and came to be associated with God (Lindberg, 2007, p. 259). Along with Aristotle and Plato, other ancient ideas were incorporated into medieval cosmology. Isidore of Seville (c. 560–636), for instance, built his philosophical understanding of the universe on ancient conceptions to create a cohesive medieval philosophy. He explains that astronomy was “the law of the stars” made to compose the relation and placement of the heavenly bodies to Earth (Isidore, 2006, paragraph xxiv). Ancient ideas were adjusted to fit the medieval image of heaven. It is my contention here that this ideology of the medieval cosmos is based off ancient ideas and was realized in the architecture and ornamentation of the Gothic cathedral.

**The Cathedral: A Manifestation of Ideology**

Gothic architecture was prevalent in Europe from the mid-twelfth to the sixteenth centuries; it was characterized by buttresses, vaulted ceilings, and flamboyant ornamentation like stained glass windows. Through these stylistic components, cathedrals were able to create heaven on earth for their believers. Through gothic cathedrals, medieval cosmology was transferred from words to physical ideological elements that became part of the building process. Religious figures wanted their sacred spaces to reflect their beliefs, which allowed cathedrals to demonstrate not only medieval philosophy but also its grounding in ancient history. Ancient Greco-Roman architecture was based on the idea of historical memory. Temples, triumphal arches, and other important monuments each contained iconography that projected how
the ancients wanted themselves to be viewed. These monuments manipulated how future generations remembered history. Robert A. Scott, author of *The Gothic Enterprise*, translates this idea into a gothic perspective. He explains how the Greeks used mnemonic devices to store and remember information. Scott demonstrates the use of architectural metaphors to master “the art of memory.” Students of architecture were instructed to create a building within their mind in which to store memories (Scott, 2011, p. 171) and to create “icons” or symbols that could be used to recall memories. “Much attention was given to learning the rules for creating icons,” which were separated into two categories: forms and words (Scott, 2011, p. 174). The more unique an icon, the easier it was to remember; this idea was subsumed into later religious traditions.

Rather than using mental notes and architectural metaphors, medieval clergy also created icons in their sermons, thereby bringing mnemonic devices to life. The clergy believed that memory came from “creative eloquence” where preachers would create something worth remembering, in this case an icon (Scott, 2011, p. 177). Meditation and oral recitation also enabled monks to find grace and share it with the community. Their methods for remembering scripture and rituals functioned like ancient monuments and affected how people viewed the Church. The icons the clergy used in sermons reflected the way people remembered their speech and eventually became symbols that the masses would recognize. These imaginary architectural metaphors would create a shared image of the city of God, which everyone aspired to enter upon their deaths. In turn, these iconic images of a heavenly city of God shaped how the clergy perceived the gothic cathedral. Cathedrals began to mirror the clergy’s vision of heaven. The geometric vaults, light falling through stained glass windows, and the iconography of the medieval cathedral would reflect this image.

Abbot Suger’s *On What was Done in His Administration* expounds that the Basilica of Saint Denis was constructed in the twelfth century with “divine inspiration,” and the cathedral was covered with lavish ornamentation to mimic heaven (Suger, 1997, paragraph xxiv). No expense was spared in covering the church with beautiful ornaments.
Gold, multicolored gemstones, and expensive paintings were among the luxurious decorations. The front doors were created by sculptors and metal casters, and the tympanum was covered with mosaics. Other items, such as the cross and altar, also featured the same lavish adornments and materials as the rest of the church. Suger believed that the beauty of the abbey with its multitude of colorful adornments would transport the masses “from material to immaterial things” and elevate them to a higher understanding of heaven (Suger, 1997, paragraph xxxii). Although Suger’s abbey sparked the gothic revolution from the somber and less ornamented Romanesque style, it does compare to the flamboyance of later cathedrals. Still, he does demonstrate how early gothic cathedrals created heaven on earth.

A gothic cathedral was created so that humans could experience a “taste of heaven” by reflecting the medieval idea of the cosmos (Scott, 2011, p. 121). Isidore combines the divine mover of ancient philosophy with God and makes him the creator of the heavenly bodies such as the sun, moon, and stars. In his *Etymologies*, Isidore reiterates the medieval and ancient understanding of how the heavenly spheres worked and moved. Much like architectural vaults on earth, the heavens are supported by “vaults,” which created the curvature of the skies (Isidore, 2006, paragraph xxxix). Isidore’s words took on literal meaning in the building of gothic cathedrals created by series of vaults that were seen to hold up the “heavens.” God was viewed as sunlight and was materialized through objects such as stained-glass windows to reveal his magnificence. Plato’s idea of the geometric composition of all matter revealed the divine order of the cosmos with the divine creator at its center. Understanding the rationality of geometry allowed humans to comprehend and revere the divine order. Geometry was a way to reveal divine and “perfect proportions,” a necessary and aesthetical inclusion in gothic cathedrals (Scott, 2011, p. 124). Cathedral vaults came to represent a mathematically precise functional make-up of the cosmos. In addition, vaults allowed for the cathedral to add more stained-glass windows and were another part of the cathedral’s cosmic representation.
Stained glass windows also held a cosmic importance and contributed to the overall iconography of a cathedral. Although not a decoration specifically, the sun’s natural rays became an element of the gothic cathedral’s symbolism, much like the zodiacs. The sun’s light and the darkness surrounding the moon represented good and evil in Christian mythology. Stained glass windows were thus used to emphasize the symbolic importance of light in cathedrals. Stephen Hendrix’s *Architecture as Cosmology* states that “finite matter can only be a product of the infinite multiplication of the infinite,” meaning that light is an infinite source and becomes finite when seen through a colored glass window (Hendrix, 2011, p. 98). Geometry and mathematics are combined in planning for more windows to create more visible light. Hendrix demonstrates how *lumen* and *lux* each have a special religious connotation in Christianity in general and the cathedral in particular. The *lux* is the direct sunlight from God and is sacred, whereas *lumen* is reflected light that becomes a part of “the material world [and] is known through perception” of the refracted light (Hendrix, 2011, p. 98). Therefore, stained glass windows allowed the viewer to perceive the light of God. Hendrix argues that cathedrals represented the interaction between the known and the unknown, bridging the gap between reason and faith. Stained glass windows thus became more than just a beautiful adornment and embodied God’s light. Hendrix offers as examples in support of this argument the Dean’s Eye and the Bishop’s Eye windows in Lincoln Cathedral. The Dean’s Eye is a beautiful stained-glass window at the north end of the cathedral’s transept, and the Bishop’s Eye lies at the southern end. The Dean’s Eye is intended to protect the cathedral from the devil, whereas the Bishop’s Eye invites the Holy Spirit into the cathedral through the stained-glass window. Both windows take advantage of the symbolism of light. Hendrix’s analysis demonstrates how the cathedral was a manifestation of medieval cosmology and each part of the structure communicated this message.

Vaults, geometry, light, and colorful adornments are thus examples of how cathedrals manifest medieval and ancient cosmology. Each element possesses an individual role while simultaneously functioning as part of the larger macrocosm. Like stained glass windows and the self-
supporting arches of the vaults, the zodiac constellations represent their own symbolism while playing a part in the larger cosmic representation of the cathedral. Because cathedrals reflect the ideas and imagery of the cosmos, the addition of the zodiac constellations further supports the celestial symbolism of the cathedral. Having established the context of the zodiacs, we can now look more closely at their individual symbolism and representation. Drawing on ancient traditions and transitioning the constellations into medieval society highlights the zodiacs as symbols of time.

*The Symbolic Role of Time in Christianity*

Whereas mythology explains how the stars got to the heavens, astronomy maps their placement and gives them a purpose. The ancient Greeks told time based on the coordinates and positioning of the zodiacs and other constellations. The sun, moon, and stars were consistently reoccurring ways in which to tell time based on observation, as well as on calculated astronomy. Someone who paid attention to the sun would notice regular and seasonal markers of time. As we move towards the summer the days get longer, so that the longest day of the year falls in the middle of summer and the shortest day in midwinter. The sun’s movement could also be traced through its shadow, which is the concept behind sundials. Tracking the changes in sunrise and sunset also enables one to tell the seasons. These three indicators of time are dependent on place and the knowledge of one’s location but are also sufficiently noticeable without the use of mathematics and astronomy. Stephen McCluskey explains that in most cultures the “turning of the seasons typify sacred times” and sanctified the beginning of the seasons (McCluskey, 200, p. 6). The official calendar was also based on solar observations and phenomena.

The modern yearly calendar is an adapted form of the Julian calendar, created by Julius Caesar in 45 B.C.E and finalized in 8 C.E. As a solar–lunar calendar, the Julian calendar was based on the yearly solar cycle, which tracks the earth’s annual revolution around the sun, whereas the lunar cycle tracks the moon’s path around the Earth. The calendar year contains 365.25 days with a leap year every fourth year.
The calendar followed the seasons, the new moon, and the lunar cycle, which took 29.5 days (Evans, 1998, p. 163). Calendar months fluctuated between 30 and 31 days, and despite not being in sync with the actual lunar cycle, still became a way to measure months and years. This calendar was used until 1582 when Pope Gregory modified the Julian calendar.

The pontifices under Julius Caesar miscalculated the intercalation that inserted days in the calendar to make up the odd number of days in the year. The miscalculation was not seen immediately but became noticeable when calculating the date of Easter. Easter celebrates the resurrection of Christ and is dependent on the dating of the crucifixion and associated events. Traditionally, Easter falls just after the full moon and “just after the vernal equinox,” which has a fixed date of March 21 (Evans, 1998, p. 167). However, this observance follows not the physical lunar cycle of 29.5 days but rather the calendar tradition of 30 or 31 days. Without correcting the Gregorian calendar, the lack of inserted days over time pushed Easter closer to the summer than spring. Pope Gregory XIII issued a papal bull in 1582 that adjusted the luni-solar calendar and restored Easter to its correct time, agreeing with the true moon and omitting ten days from the calendar.

Time is important to religious tradition both for the observance of festivals and monastic prayer. Originally, astronomy was observational and undertaken for the sole purpose of telling time, which was especially important to the “mandatory, daily monastic ritual of prayers and other communal activities” (Lindberg, 2007, p. 196). Prayer time was performed based on the position of the sun during the day and the stars at night. The necessity of keeping time is evidenced by importance of the Book of Hours to everyday life. A Book of Hours was a prayer book for the laity, or average worker, to ritually imitate the clergy’s relationship with God. The book contained a calendar, four gospel lessons, hours of the virgin, hours of the cross and holy spirit, Psalms and litany, an office of the dead, and suffrages that allowed the masses to mimic the clergy’s intimacy with God and have a direct relationship with him. These books contained images created by some of the most talented artists of the time. The books were dedicated to the Cult of the Virgin, as were the
various Notre Dame cathedrals. Roger Wieck calls the Book of Hours a handheld “Notre Dame,” whereby the cathedrals mimic the imagery and purpose of the books (Wieck, 1988, p. 27). These books were expensive, as indeed were cathedrals, and were personalized so that they could be passed down the generations. Each book contained a different set of contents along with a different set of images, but each prayer and text had an established tradition of images. One of the most significant set of images was contained in the calendar section of the Book of Hours. The individual months of the calendar were adorned with images of seasonal work such as the different phases of planting and harvesting. The agricultural labors functioned as a medieval “perception of the changing seasons” (Wieck, 1988, p. 36). Interestingly, some of the earlier books contained Ancient Roman calendars but this practice was abandoned in the early Renaissance.

The calendars contained within Books of Hours also often included images of the zodiac alongside images of the labors of the month because both were closely associated with seasonality. The symbols of the zodiac came to represent the heavens, whereas the agricultural labors represented the Earth. Together the images represented the cosmos as created by God. As these symbols came to represent the cosmos, they also came to represent the role of man within it. The agricultural labors “reinforced the viewer’s part in this grand picture, whether as a humble laborer in a field or working under a heavenly sign” (Hourihane, 2007, p. liii). The images brought the viewer closer to the church by demonstrating their microcosmic role within the macrocosm. As seen in the Book of Hours of Isabel of Castile (Figure 1), the agricultural labor is seen on the left and the zodiac, Leo, is on the right. The image represents the month of August, which is associated both with Zodiac Leo and with the seasonal task of harvesting. In another Book of Hours, the Les très riches Heures du duc de Berry, shown in Figure 2, the image shows at the top a blue half circle of a calendar and zodiac signs. Rather than being directly adjacent to the zodiac, the agricultural labor is depicted underneath. The half circle shows Capricorn and Virgo as the zodiac constellations that represent the month of January. It should also be noted that the half circle looks very similar to an astronomical clock.
Together, the zodiac and the labors became representations of time seen in the Books of Hours and other forms of Christian art, including paintings, sculpture, and even cathedrals.

The importance of time to the ecclesiastical tradition can also be seen through the iconography of cathedrals. As Wieck noted, cathedrals became architectural representations of the books. Just as specific Books of Hours were focused on the Cult of the Virgin, so too were specific cathedrals found all over France. Cathedrals dedicated to the Cult of the Virgin Mary were denoted “Notre Dame.” Although the zodiacs are famously portrayed on Notre Dame cathedrals, they are by no means limited to them. Frequency could be attributed to the cathedrals’ location in major cities and the patronage that accompanies that privilege.

The Connection between Cathedrals and Astronomical Clocks

The collection of images in Time in the Medieval World features multiple examples of symbols of time, the labors of the month, the zodiac, and personifications of the months found in cathedrals and Books of Hours. The collection provides a small sample of some of the best examples of zodiacs within cathedrals. There are nine cathedrals mentioned in this collection, only two of which are dedicated to the Virgin Mary. Notre Dame de Chartres and de Amiens contain fifteen or more images of the established symbol of time, all though contained in portal or window panel, whereas the other cathedrals discussed contain only approximately five or fewer. Given that only two of the cathedrals in the sample are Notre Dames, it can be assumed that the zodiacs are not specific to a patron saint. The Abbey of St. Denis contains six zodiacs, and the Cathedral of Saint Lazare contains three zodiacs, the next largest number. Brauweiler Abbey and Burnham Deepdale Cathedral are the two outliers, the former of which is found in Germany and the latter in England, but they still each contain only one or two images of a single zodiac. A larger sample would be more conclusive but, based on this small sample, the use of zodiac symbols does not seem to conform to any established patterns within cathedrals. It is also important to place these images into the larger context of the cathedral. Chartres Cathedral contains the greatest number of zodiac images of the samples presented.
in the book. The cathedral contains 176 stained glass windows, each of which has its own theme and imagery. The windows contain images of kings, saints, important biblical stories, and defenders of the faith. However, of the 176 windows, only one is a zodiac window, complete with all twelve signs and their respective labors. The window should be read top to bottom with the zodiacs on the right side and the labors on the left. The Roman god, Janus, shares the first middle quatrefoil with Aquarius at the bottom, where the zodiacs begin. The final quatrefoil shows Jesus enthroned at the top as the “chronocator” sitting between two candles and the Greek letters alpha and omega (Miller, 1997, p. 72). The 176 stained glass windows of Chartres Cathedral demonstrate that the zodiacs comprise one set of symbols within a large network of biblical imagery used by the Catholic Church. However, the zodiacs are still equal in status to the likes of Charlemagne, the saints, and other important figures depicted in other windows. The small sample from Princeton’s collection and published by Pennsylvania State University lays the groundwork for future study while also providing a good overview of the use of the zodiacs in cathedrals. This study supports the idea that Books of Hours were handheld versions of cathedrals that imitated their iconography as well as their purpose of worship. The portrayal of zodiacs in cathedrals also validates the idea that the zodiacs could be found in places other than Books of Hours without being taken out of context. The two religious mediums demonstrate the common notion that the zodiacs were understood by the masses to be markers of time. The representation of the zodiacs within both cathedrals and Books of Hours reflects the religious imagery of the astronomical clocks.

The earliest astronomical clocks must be assessed in any analysis of the symbology of these clocks. The first clock was created by Richard of Wallingford in the fourteenth century, but it was lost after Henry VIII’s dissolution of the Catholic monasteries. It was made of iron and showed the planetary movements through plates, including the movements of the moon and tides. The iron clock stood “2 or 3 meters across” and sat on the wall of the “southern transept of the abbey church” (North, 2010, p. 263). John North notes that the clock was a “moving replica of the universe,” and was “inspired [by] astronomical practice, even down to
the method of calculating gear ratios” (North, 2010, p. 263). Although North explains that the façade of the first clock is different from that found in the later astronomical clock tradition, it influenced other astronomical clocks. For instance, in 1344 Giovanni De Dondi, son of an astronomer-physician, designed an astronomical clock in Padua, Italy. His clock contained a seven-sided frame with a dial for each planet, the sun, and the moon. However, Dondi’s clock failed to represent the universe as a whole and is not the same as the modern clock seen today. Wallingford’s clock did “extend the ancient tradition of anaphoric astronomical clocks of antiquity” into the medieval area with the influence of the Padua astronomical clock (North, 2010, p. 263). Most early churches did not have a clock but, as astronomy became more popular, astronomical clocks became much more prevalent. Henry King explains that owing to the poor accuracy of the first astronomical clocks, their purpose transitioned from one of noting literal time to one of decoration; as decorative objects, they grew in popularity over the course of the fifteenth century. Few still retained their time-telling function, but most were “objects of great novelty” (King, 1978, p. 32). Unlike the popularized astronomical clocks, Dondi’s clock featured religious symbolism, which might have influenced the design of universalized astronomical clocks.

**Astronomical Clocks**

Although not an astronomical clock, Wallingford’s clock certainly influenced the design of their facades. Astronomical clocks were functioning clocks that contained a wide variety of cosmic symbolism and, like cathedrals, they contained images of the sun, moon, and stars. Astronomical clocks were placed in town squares, as well as in cathedrals. Three examples demonstrate not only the variety of clock facades, but also how they used the solar, lunar, and zodiac cycles (much like the Books of Hours and cathedrals) to represent symbols of time and God’s creation of the universe. The first example is the Prague Orloj or the Prague Astronomical clock, located in the town’s square (Figure 5). The Prague clock contains two circular facades and is flanked by many other figures and virtues. The top circle is the astronomical clock, which
indicates the phases of the moon, sunrise, and sunset, as well as the positions of the zodiac. The bottom façade contains the seasonal twelve labors with their representative zodiac, just as in the Books of Hours. As was the case for many medieval manuscripts, the bottom calendar clock is illuminated to also represent time and mimic the Books of Hours. The bottom façade of the clock also contains the calendar dates with their saint and feast day on the outer rim. The Prague clock contains multiple ways to tell the time and features symbolism from both astronomy and the Books of Hours.

The next clock to consider is the Torre dell’Orologio in St. Marco’s Square in Venice, Italy (Figure 6). The Venice astronomical clock is far less lavishly adorned but it reflects symbols of time in a very similar way to the semi-circle shown in Figure 2. The Venice clock is painted dark midnight blue to reflect the night sky, while the outer rim features the Roman numerals to reflect the current time, and a middle ring features gold illuminated zodiac images. The negative space in the middle contains illustrative non-specific stars to further reflect the heavens.

Returning to the Notre Dame de Chartres Cathedral, the structure also contains an astronomical clock in addition to the iconographic zodiacs in its design. Chartres has two astronomical clocks but focus here is the clock on the external side of choir (Figure 7). The Chartres choir clock also has multiple rings that indicate sunset and sunrise, the phases of the moon, and the seasonal zodiac. Like the previous examples, the outer ring shows the hours of the day, the middle ring indicates the phases of the moon, and the circle in the center points to the seasonal zodiac. Each clock may look different, but they all share the same symbology of time. Because astronomical clocks reflect the same symbols of time as the calendars in the Books of Hours and in cathedrals, it can be assumed that the clocks are closely connected with the architecture of gothic cathedrals, although more analysis on their surrounding structures and location is required to draw definitive conclusions.

Despite having similar iconography, it is important to include the date of each clock here. Torre dell’Orologio in St. Marco’s Square was created in the 1490s, whereas the Prague Orloj was installed in 1410.
The most recent clock is the astronomical clock on the choir wall of Chartres Cathedral, which was built in 1526. These dates are important because gothic architecture spans the twelfth to fourteenth centuries (and in some areas lasted well into the sixteenth century). Therefore, the clocks discussed here were created after the traditional end of the gothic era.

Location is also an important consideration when assessing the clocks. Whereas the Prague and Venice clocks are found in town squares, the third clock is located within Chartres Cathedral. The clocks reflect the same zodiac constellations that were seen as symbols of time in antiquity. These symbols would be recognizable from their previous locations in religious spaces. Astronomical clocks were previously believed to serve only as decorations but sharing the same images as other religious objects and spaces also allowed the clocks to reflect their wider purpose. After all, the Books of Hours and cathedrals connected the masses to God and to holy rituals through iconography and ritual participation. The zodiac constellations allowed the clocks to partake in that imagery, as well as to share that religious space. In light of this, one question now presents itself: what purpose did the clocks serve? A comparison with ancient Lares may offer a viable solution.

**Lares and Astronomical Clocks: A Comparison of Sacred Space**

A lar, or in the plural lares, were “familiar and characterized deities” of the Roman household (Flower, 2017, p. 10). Lares were small figures typically depicted in a tunic with a horn, who became the gods of location in the Roman Republic. These happy and youthful beings were associated with the festival activities of eating and drinking. Their association with everyday activities allowed them to be worshiped in domestic spaces such the kitchen and hearth, but lares were also worshiped as ancestors of the family and protectors of spaces such as farms, fields, and borders. As such, they were worshipped both in the household, much like the Books of Hours, or at crossroads. Such associations led the lares to become “gods of place” rather than gods of myth, like the traditional Roman deities (Flowers, 2017, p. 21). It is the
lares’ role as protectors of place and their association with the domestic sphere that allows for a comparison of them with clocks.

The zodiac constellations link astronomical clocks with the ecclesiastical church and Catholic tradition. The iconography of the clocks echo God’s role as protector of the cosmos, which included the place where the clock resides. It is a visual reminder of not only religious tradition but also God’s omnipotent power. Like the Lares, the clocks also carry reminders of religious ritual associated with everyday activities. Like the Books of Hours, their presence in public spheres serves as a reminder of religious observances. Reflecting similar placement and associations to the Lares allows astronomical clocks to mirror their purpose. Their placement in the public domain also acts as a constant reminder of God’s power and protection. A comparison to the ancient lares opens up a new perspective concerning astronomical clocks as an extension of and connection to another ancient tradition.

Like the lares, astronomical clocks may have served a dual purpose for organized state religion. Sheri William’s thesis “Public Order and Social Control Through Religion in the Roman Republic” suggests that lares were a part of institutionalized religious control over the masses. Williams argues that the ritualization of religious institutions allowed the masses to be controlled by their piety. She explains that “ritual and routine were more important than the deities themselves” because ritualized worship was the public’s way of participating in Rome’s salvation (Williams, 2020, p. 11). Partaking in religious acts allowed communities to be invested in the safety of the republic because the gods rewarded their piety with the wellbeing of the state. This allowed the state to “bond with the smaller communities,” and thereby convince the population that their piety was for the greater good (Williams, 2020, p. 18). The state then controlled the religious calendar, which was important for social control and religious observance because the calendar dictated when rituals and festivals should be observed. Lares participated in this social control as the “guardians of the Roman community as a whole” and created a sacred space where they were placed in public spheres and in the home (Williams, 2020, p. 19). William’s argument can easily be applied to all organized religion
including Christianity to draw a new parallel for astronomical clocks. Whether protectors or reminders of God’s grace and omnipotence, the clocks participated in extending the influence of the religious hierarchy into the public sphere. Just like Roman religion, the Catholic church controlled the religious calendar and the observance of time. Books of Hours helped to regulate hourly prayer while allowing the masses to be connected to God. The calendars in these books also helped to regulate the observance of festivals and religious holidays, just as had been the case for the Roman State. The ancient tradition of organized religion moved into the medieval era under a new title and figurehead, allowing for the astronomical clocks to partake in the formation of social control, much like the lares. William’s argument and the comparison of the lares to the clocks indicates a different purpose for the astronomical clocks as extensions of ancient tradition, and this ancient iconography was perpetuated in multiple ways into the medieval era.

Because astronomical clocks follow the symbolic function of cathedrals and Books of Hours, it can be assumed that they too serve a similar religious function. Of the examples of clocks provided in this essay, one sits on a cathedral wall and the others are found in town squares. Based on the symbolism presented, astronomical clocks can be confidently interpreted as objects that mirrored the function of the lares. Cathedrals function as a house of God, much in the same way a Roman residence, but they also served a communal function as a meeting place for worship. The addition of an astronomical clock to a cathedral extends the iconography of the cathedral to include more symbolic representations of heaven. Even when placed in town squares, astronomical clocks include imagery that would have been seen and understood in cathedrals, allowing for them to extend their religious ideology and function to the town square to create sacred spaces, much in the same way as the lares did. I have argued here that the clocks go beyond the function of the lares and that their cosmological symbolism makes them special to medieval iconography. The comparison to the lares offers an alternative function for the astronomical clocks while connecting them to the realm and ideology of the medieval cathedral.
Conclusion

Astronomical clocks perpetuate the ancient astronomical tradition into Christian art while mirroring religious iconography both in cathedrals and more widely in town squares. The zodiac constellations allow astronomical clocks to retain their religious function, which transforms them into religious artifacts. Their iconography comes from a long-standing ancient tradition that was transformed and transitioned into medieval cosmology. Cathedrals manifested this ideology as a physical representation of medieval cosmology and the heavens. Books of Hours shared a similar function to cathedral iconography, namely to normalize the zodica as religious symbols of time. While Books of Hours and cathedrals have a clear purpose, the clocks are often assumed to be mere decoration, despite their religious imagery and their occasional placement with churches. A comparison to the ancient lares proposes a possible solution as regards the purpose of the clocks. The zodiac constellations connect the astronomical clocks back to religious spheres like the presence of lares to temples, for instance, thereby allowing the clocks to mimic their purpose. Lares were protectors of place and extended the religious space into the public domain. As the clocks mirror symbolism, they can also mimic purpose. These astronomical clocks thus contain a purpose and a specific religious imagery, and they should be considered part of the greater sphere of Roman cosmology in Christian art.
**Figures**

Figure 1: The calendar month of August with Leo on the right and a man harvesting grain on the left. University of North Texas Willis Library. UNT Special Collections, Facsimile, BX2080.A35 I83 1991.

Figure 2: The calendar month of January with a half circle at the top showing Capricorn descending and Virgo rising. The seasonal labor is shown at the bottom. University of North Texas Willis Library. UNT Special Collections, Facsimile, ND3363.B52 P6 1950.

Figure 4: Sign of Aries, Zodiac Panel, Stain Glass, Chartres Cathedral, Chartres France, 
https://digital.library.pitt.edu/islandora/object/pitt%3AFCW028A P1101
Figure 5: Astronomical Clock, Prague, Czech Republic, Astronomical Clock,

Figure 6: Astronomical Clock, St. Marco’s Square, Venice, Italy, Astronomical Clock
https://upload.wikimedia.org/wikipedia/commons/2/26/St_Marks_Venice_Clock.jpg
Figure 7: Astronomical Clock, Chartres Cathedral, Choir side, Chartres, France, Astronomical Clock, https://en.wikipedia.org/wiki/Choir_wall_of_Chartres_Cathedral#/media/File:Chartres_-_Horloge_astro_03.jpg

Figure 6
References


