**Roman Architecture**

# An Analysis of Hadrian's Pantheon and its Floor Pattern through the Identification of Palladian Shape Grammars

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**Abstract**: An analysis on the structural interpretation of the Roman Pantheon, incorporating its structure's subsymmetrical interior. Through this subsymmetry analysis, the application of shape grammars – specifically Palladian grammars – helps prove the unification of the Pantheon's floor pattern to the structure's orthogonal symmetry by exemplifying the floor's diagonal subsymmetry within an orthogonal grid. This theory, based off a centralized Cartesian coordinate, may provide insight into correlating works of hemicycle ornament executed within Trajan's Market, precedent structural designs implemented in Nero's Domus Aurea, and similar symbolic geometries within Beijing's Temple of Heaven.

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## I. Background History

The Pantheon is an ancient structure globally recognized for its all-encompassing architectural design, derived from Roman design principles. Completed in AD 121 under the authority of Roman Emperor Hadrian, the Pantheon we see today is in actuality the third remodel of its original structure.

Marcus Agrippa, best friend to Augustus and husband to Augustus' sister Octavia, completed the first Pantheon circa 26 BC. Articulated in Dio Cassius' passage:

> *"[Agrippa] completed the building called the Pantheon. It has this name perhaps because it received among the images which decorate it the statues of many gods, including Mars and Venus; but in my opinion the name derives because the vaulted roof resembles the heavens. Agrippa, for his part, wished to place a statue of Augustus there also and to bestow upon him the honor of having the structure named after him; but when the emperor would accept neither honor, he placed in the temple itself a statue of the former Caesar [i.e. Julius Caesar] and in the porch statues of Augustus and himself"* (Jones, 2000, 179).

Dio's passage and description of idol placements rectify Hellenistic ideals, where divine images were disposed around that of reigning sovereigns. While overt worship of the living Augustus was out of the question, a dynastic celebration of the proto-emperor was displayed in Agrippa's Pantheon with relation to the gods connected to the Julian family for the people of Rome to embrace. This idea can further be justified, knowing that Agrippa's initial Pantheon was built along the axis from the Baths of Agrippa to the Mausoleum of Augustus – the resting place of the Julian family to which Agrippa was related to by marriage.


Figure 1: *Google Maps Aerial View of Rome*

The unique orientation of Agrippa's Pantheon reflects that of the Mausoleum of Augustus, the former oriented north and the latter oriented south, with both structures facing the Campus Martius. Legend had it that Romulus, one of the two founding fathers of Rome, transformed into the god Quirinus and ascended into the heavens above the *Palus Caprae*. This was the name of the marshy area around the site of the Pantheon. By making a formal link between Agrippa's Pantheon and the Mausoleum of Augustus, the Pantheon promoted

Augustus as a new Romulus – the founder of a new Rome (Jones, 2000, 180). However, as time prolonged, Agrippa's wooden Pantheon was destroyed in a fire dated back to AD 80. Emperor Domitian replaced Agrippa's temple with his own. Holding as the second Pantheon until AD 118, Emperor Hadrian replaced Domitian's with that of his own, the third and final Pantheon still seen today by millions each year.

Hadrian's Pantheon, a masterpiece of technical, aesthetic, and spatial experience, spoke of a universal cosmology that represented the celestial home of the gods. The rotunda, an incomparable dome to anything before its time, is the chief novelty of Hadrian's Pantheon. Number symbolism made some contribution to the message of the rotunda. The articulation of the ground plan per a sixteen-part geometry recalls, as does Vitruvius' radial city plan of the sixteen-part Etruscan sky, placing the Pantheon implicitly at the center of a celestial scheme. Meanwhile, the coffering of the cupola is divided into 28 parts, the same number as that of the columns and pilasters belonging to the main order. The number 28 was considered "perfect," one of very limited sets of numbers that equal the sum of their factors. In correlation, the twenty-eight days in the lunar cycle invoke cosmic iconography as well. It has been concluded by Jones that the Pantheon encompasses all seven elements of the solar system known to be at the time of the Ancient Romans. These elements include the 28 vertical divisions representing the moon, the oculus representing the sun, the five horizontal rows of coffering representing the remaining five planets, and the seven exedrae (including the apse on the main axis) to represent one of the seven associated deities to the Roman culture (Jones, 2000, 183). The Pantheon truly reinforced the symbolism incorporated with the *templum mundi* ideal, a celebration of the Roman world with Rome and the emperor at its center.

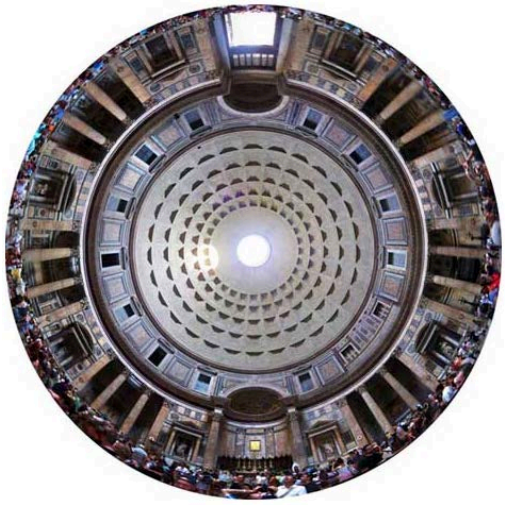


Figure 2: *The Pantheon's Rotunda - Crystalinks*

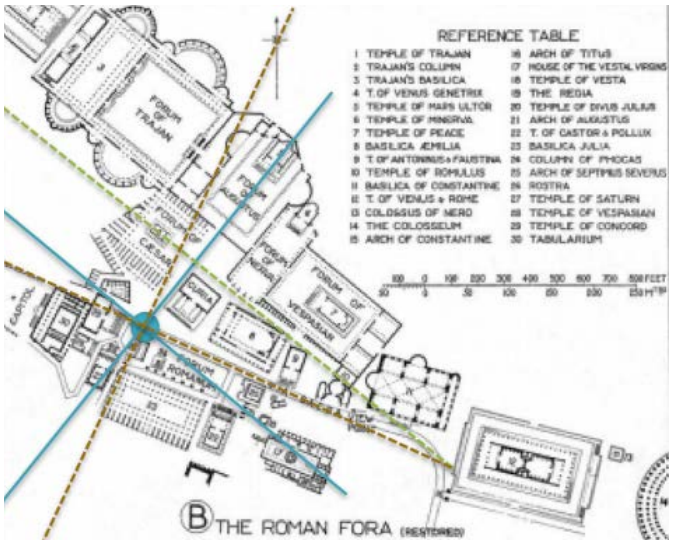
## II. The Roman Town Foundation

Roman colonies and towns were founded on Vitruvius' radial city plan of the sixteen-part Etruscan sky. Derived from the Etruscan deities, cities were symbolic in the sense of unifying the sky with the earth through cardinal directions. This unification was done so the affairs of human beings would be aligned with the affairs of the gods. To the Romans, the foundation of town building embodied the inexorable forces of nature – of which all life depended on. Roman colonies and towns originated from a centralized point known as the *Axis Mundi.* The Axis Mundi of each town formed the major North-South roadway known as the Cardo, and the East-West minor roadway known as the Decumanus. Expanding from a centralized point (the mundus) into four primary divisions, the Roman town was thus divided

by the Cardo and Decumanus. Similarly, Vitruvius' radial city plan integrated this principle to divide each primary division into four equal subdivisions, making a total of sixteen divisions. From this, the houses of the gods were transferred or diagramed into a regularized map of the four primary divisions of the cardinal directions. The unseen gods of the infernal regions and of the sky were categorized in the Pars Postica division, literally meaning "behind me" from the Italian derivation of Posteriori. The gods of the earth, harvest, and forest were defined under the Pars Antica division, literally meaning "front of me" from the Italian derivation of Anteriori (Allen, 2016). Through the unification of the northern half with that of the southern half along the East-West axis, Vitruvius' radial city embodies all deities of Roman culture from both a celestial and terrestrial realm. The city of Rome, however, was not organically grown from a North-South-East-West orientation.

FIG. 2.11 Piacenza liver, schematic representation.
(M. Pallottino, *The Etruscans*, p. 165)

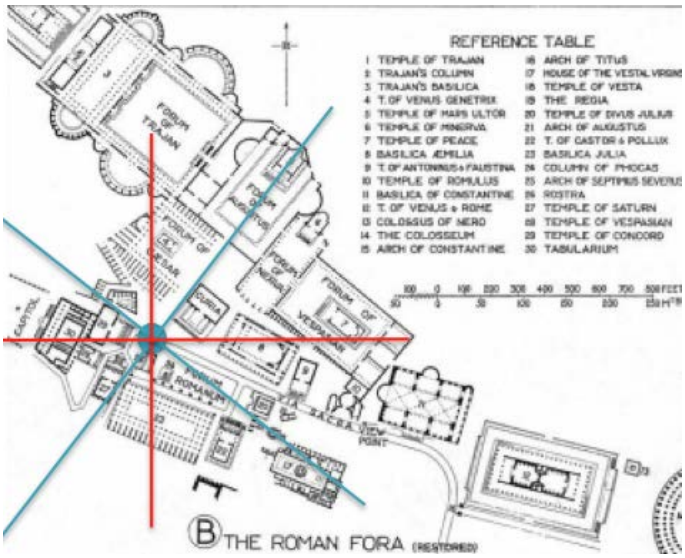
Figure 3: *The Orientation of the Umbilicus Urbis*




The *Umbilicus Urbis* was rumored to be the external part of the subterranean "mundus" that which Rome was founded on. This centralized point is in theory the center of the Roman world, where all roads leading to the imperial city directly led. From the Roman Forum, the Umbilicus Urbis runs parallel to the Via Sacra. However, there is no minor roadway that runs perpendicular to the Via Sacra. The Forum of Augustus' centralized apse directly overlooks the Umbilicus Urbis. Comparatively, the Forum of Augustus runs perpendicular to the Forum of Caesar. In correlation to the Mausoleum of Augustus with the Julian family, the unification of both forums produces a 45-degree angular diagonality to the Umbilicus Urbis, recreating a centralization of the Roman world through the two men who redefined the Republic through sovereign rule.

The naval of the Capital, the Umbilicus Urbis, did not grow the city of Rome out from its cardinal directions. From an angular growth, the Roman forum centralized the empire's capital from a different angular expanse - unsymmetrical to the traditional Vitruvian growth of Ancient Roman towns. However, if one creates a vanishing point from the centralized location within the Forum of Augustus to the Umbilicus Urbis

Figure 4: *The Adjusted Orientation of the Umbilicus Urbis*




as well as a centralized vanishing point from the Forum of Caesar, the two vanishing points run perpendicular to each other in correlation to the Roman mundus. When in comparison to the cardinal directions, the diagonality of the newly oriented mundus creates two evenly distributed divisions of such cardinal directions to divide into eight separate parts. These eight divisions, a factor of Vitruvius' sixteen-part city plan, can thus be correlated to the interior plan of Hadrian's Pantheon – the seven exedrae of the interior and the symmetrical entrance of the structure to produce eight niches within it. Relating such evenly distributed divisions from a centralized point on the Pantheon's floor, the surrounding structure and its boundaries helps viewers interpret the complex symmetries involved with the Pantheon's circular design.

## III. The Pantheon's Interior Complexities

The Pantheon is a building with a circular plan that integrates its terrestrial correlation to the celestial emphasis of Hadrian's structure. This induces the idea that the uncentered expanse of the floor, being identified to earth's limitless horizon, and the rotunda, with perfect imperial order, bound and shape the space within the Pantheon (Jones, 2000, 182). Contrary to Renaissance and Neoclassical wisdom, there is nothing arbitrary about the resolution of the floor, the main order, the attic and the cupola; each contributes quite definitely to the same theme. The aim of the model space is to implement an intended asymmetrical form to avoid uniform radial treatment of the circular plan, the chosen solution made to ensure the central field of each coffer is visible from all parts of the plan (Jones, 2000, 193-194). The absence of a radial system to the floor akin to the cupola puts most emphasis on the cardinal axes with some on the diagonal axis. Combining the floor pattern to that of the main columns and the coffering summate on the major axes and cancel each other out elsewhere. With this integration and dispersion of uniformity, Hadrian's Pantheon conferred emphasis on the main axis, the cross-axis, and the diagonal axes in different ways. The entrance (North-South) axis creates an emphasis on the apse and the positioning of sentinel capitals on either side with an alignment of the floor

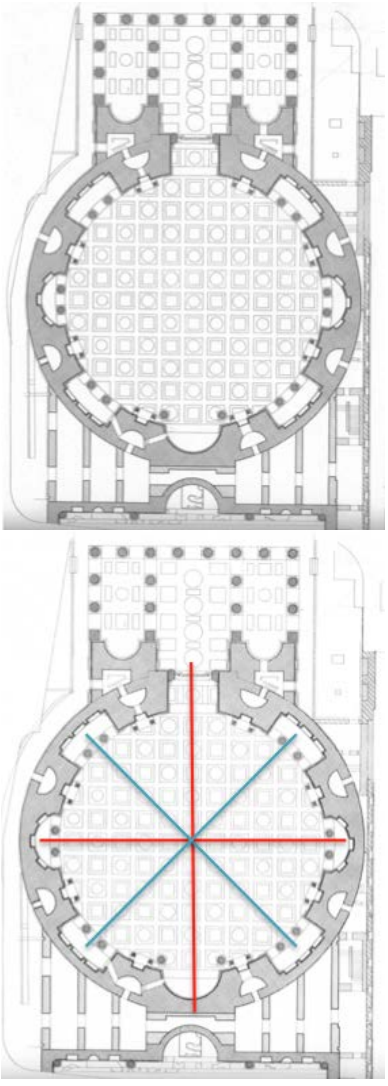


Figure 5.1: *Above - Long Section of the Pantheon- Jones, 178*
Figure 5.2: *Below - Subsymmetry Analysis*

pattern with a linear run of squares. The cross-axis (East-West) encompasses semicircular lateral exedrae with an alignment of the floor pattern with a linear run of squares. Two types of aedicule's, those with triangular pediments and those with round-headed pediments, divide the main axis from that of the cross-axis. The former stand on either side of the main axis while the latter stand on either side of the cross-axis. The diagonal axes align to the trapezoidal exedrae with an alignment of the floor pattern from corner to corner of successive squares. Since there is no symmetry for the diagonal axes, the sequencing of varying aedicule forms reduce emphasis for these axes, so that the eye naturally migrates back to the privileged points of the compass (Jones, 2000, 194-195).

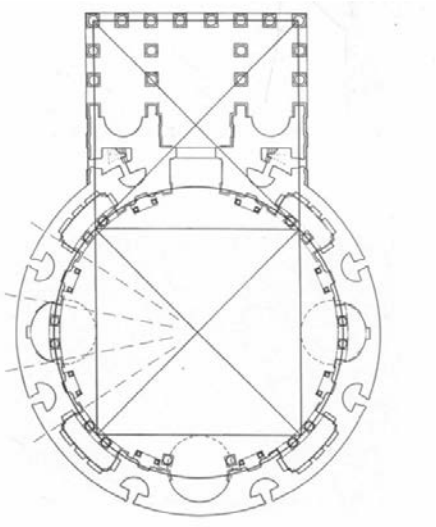


Figure 6: *Plan of the Pantheon with geometrical interpretation overlaid – Jones, 184*

## IV. Subsymmetry Analysis of the Pantheon

The architectural design of the Pantheon has been analyzed over the course of centuries in varying professions within the realm of academia to justify and rationalize its unique integrations of symmetry and shape, which manipulate the space it encounters. The Pantheon exemplifies varying methods of subsymmetry analysis, a foundational theory in different geometries that integrate formal and spatial compositions together with a structure's architectural details (Park, 1999, 123).

As Park explains, "the ground plan of the principle space [within the Pantheon] is seen to be a simple centralized design." Proven to be a structure influenced by various subsymmetries in the dihedral $D_{16}$ group, Park derives the octagonal substructure of the Pantheon's detailed floor plan from its 16-gon-based rotunda in order to relate the Pantheon's spatial relation to two orthogonal reflective axes. The floor design of the Pantheon involves a play on platonic and Euclidean relationships: doubling the square, and a comparison of a square with its inscribed circle. The alternating pattern of a square and circle induces a strong visual diagonality on the otherwise orthogonal scheme (Park, 1999, 134). How these alternating floor patterns of the Pantheon were produced to create such strong visual diagonality to its orthogonal scheme is what this essay will attempt to justify.

The dihedral groups of the Pantheon's structure can be analyzed in Park's subsymmetry figure below. Starting from a 32-gon base, the Pantheon's 16-gon dihedral group has been thoroughly derived by Park to show the structure's subsymmetry analysis integrates with the diagonal floor pattern and color scheme.

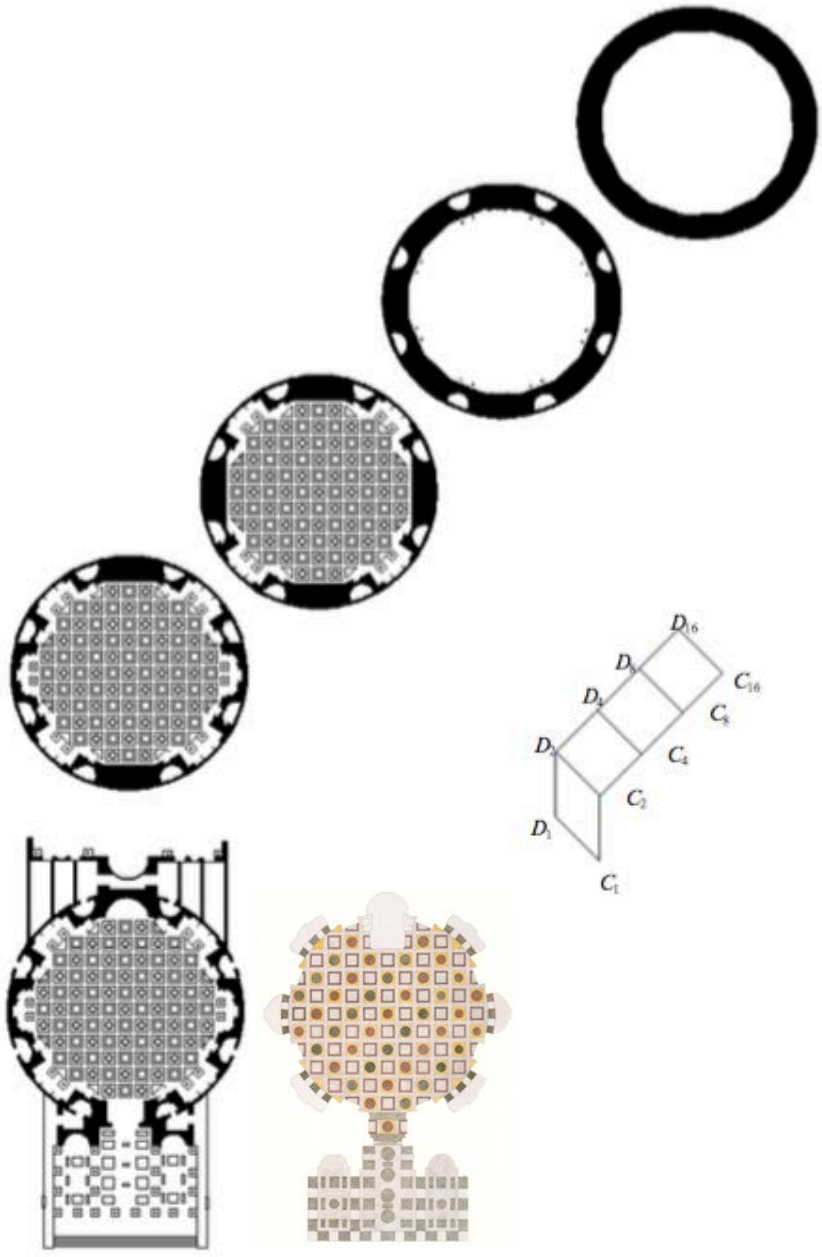
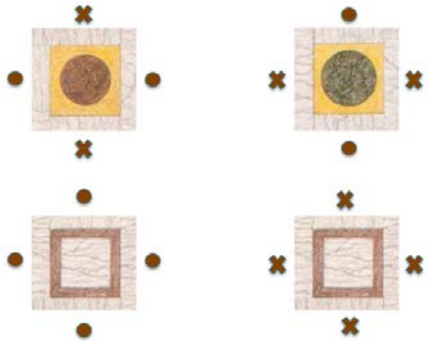



Figure 7: *Subsymmetry analysis of Rome's Pantheon (March, 1998) in comparison to its marble flooring, illustrated by Michael Imber*

## V. The Laced Grammar

Palladian grammars are defined as a parametric shape grammar that generates a ground plan emphasizing the Palladian style. Influenced by Palladian grammar, the Pantheon's floor pattern can be described by a grid definition. Starting under an initial shape from which the floor pattern originates, unique color schemed patterns define the floor design. The Pantheon's floor tiles follow a two dimensional growth of expansion based on a Cartesian coordinate with respect to the north-south axis of

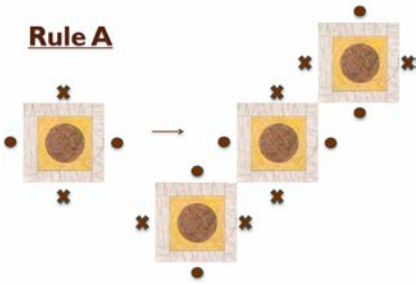
this system. Following the Palladian principle of bilateral symmetry relative to the north-south axis of the coordinate system, the Pantheon's woven floor pattern plan can be described by using six simple rules with two different geometries and three different color schemes. The two different geometries are identified as an inscribed circle within a square and a hollowed square, both of which share a similar outer ribbon-like boundary. The color schemes of the former's geometry include red and green, whereas the latter's geometry has a color scheme of red. To appropriately distribute the Pantheon's floor plan in Palladian terms, these three similar but different shapes are labeled four different ways to give an identity to the shapes when integrated together in the floor pattern.



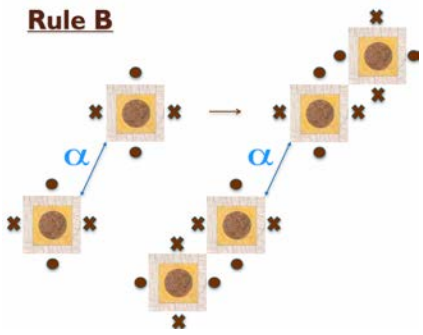
To the left is a figure showing the different labeled identifiers for the similar geometries found on the floor of the Pantheon. By identifying these two geometries in four separate markings, rules can be applied to easily integrate the two geometries with three separate color schemes together in a unified way. Six major rules are used to create the Pantheon's floor pattern through these four identified shapes.

Through the application of different shape identifications, more precise rules can be applied to constrain these shapes to the boundaries of shape similarities. These major rules, six in total, utilize shape similarity to grow the floor plan's orthogonal grid structure through a diagonal expansion. These Rules – Rule A, B, C, D, E, and F – are categorized below to describe the intricacies behind the similarly designed shapes that have unique identifiers.

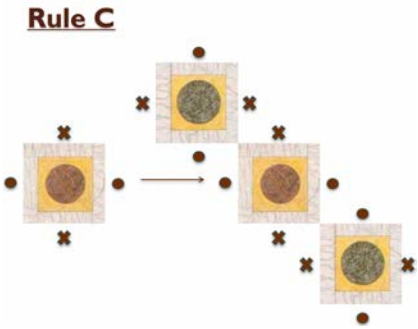
Rule A describes the case that if there is a red circle inscribed within a square, then another red circle inscribed within a square is to be added through bilateral symmetry to either the upper right-hand corner or lower left-hand corner of its original shape. These added shapes could further be constrained to the original shape by matching their outlying identifiers of the dots and x's together.



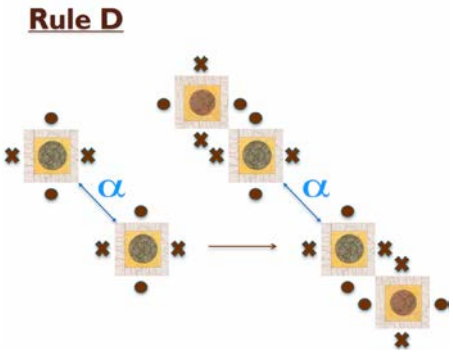

Rule B shows the case that there are two similar red circles inscribed within a square that separated by a similar distance alpha. By applying the similarity rule with that of bilateral symmetry, another red circle inscribed within a square is added to the upper right-hand corner of the original higher shape and the lower left-hand corner of the original lower shape separated by distance alpha. These added shapes could further be constrained to the original shape by matching their outlying identifiers of the dots and x's together.



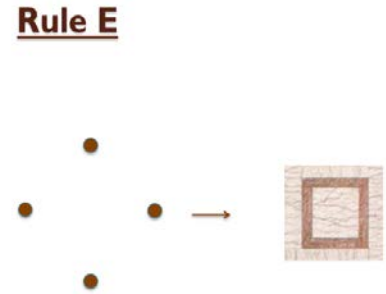
Rule C follows the similar rule schemata as Rule A. However, when there is a red circle inscribed within a square, then a green circle inscribed within a square is to be added through bilateral symmetry to either the upper left-hand corner or lower right-hand corner of its original shape. These added shapes could further be constrained to the original shape by matching their outlying identifiers of the dots and x's together.

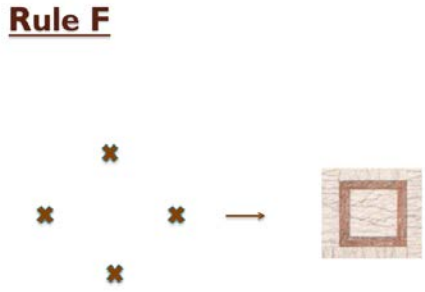



Rule D also follows similar rule schemata to that of Rule B. Here, there are two similar green circles inscribed within a square that are separated by a similar distance alpha. By applying the similarity rule with that of bilateral symmetry, a red circle inscribed within a square is added to the upper left-hand corner of the original higher shape and the lower right-hand corner of the original lower shape separated by distance alpha. These added shapes could further be constrained to the original shape by matching their outlying identifiers of the dots and x's together.




Whenever there is an enclosed empty space filled with the outlying identifiers of dots and x's, then a hollowed square of similar proportions can be produced for either outlying identifier as seen in Rules E and F.




The use of Palladian Grammars, in conjunction with bilateral and similar symmetries, allows for diagonal growth and pattern making to occur through the applications of Rules A, B, C and D. Rules E and F convert the diagonality of these former four rules into an alternating linear-to-diagonal form through the application of static placements of hallowed squares. By alternating the diagonal floor pattern with that of an orthogonal one, viewers are brought back to the major axes emphasis of the structure, the cardinal directions. By applying the orthogonal pattern, the diagonality of the interior loses its emphasis and brings viewers back on a centralized perspective, which aligns to the cupola's coffering, thus bringing back an interior emphasis of the Pantheon's cupola. As mentioned before, the cupola represents the celestial realm of the Roman universe. The floor pattern represents the terrestrial realm of the Roman universe, a diagonal pattern diminished due to its orthogonal applications to recreate an emphasis on the cupola and celestial world from its cardinal directions.

Through the application of sixteen unique steps that integrate these six rules onto the Pantheon's floor pattern, one can speculate the array of rule applications possible with the given structure's orthogonal boundaries. To correlate the structure's floor plan to Vitruvius' sixteen-part town plan in sixteen steps, a representation of these rule applications is seen in a boustrophedon manner below.

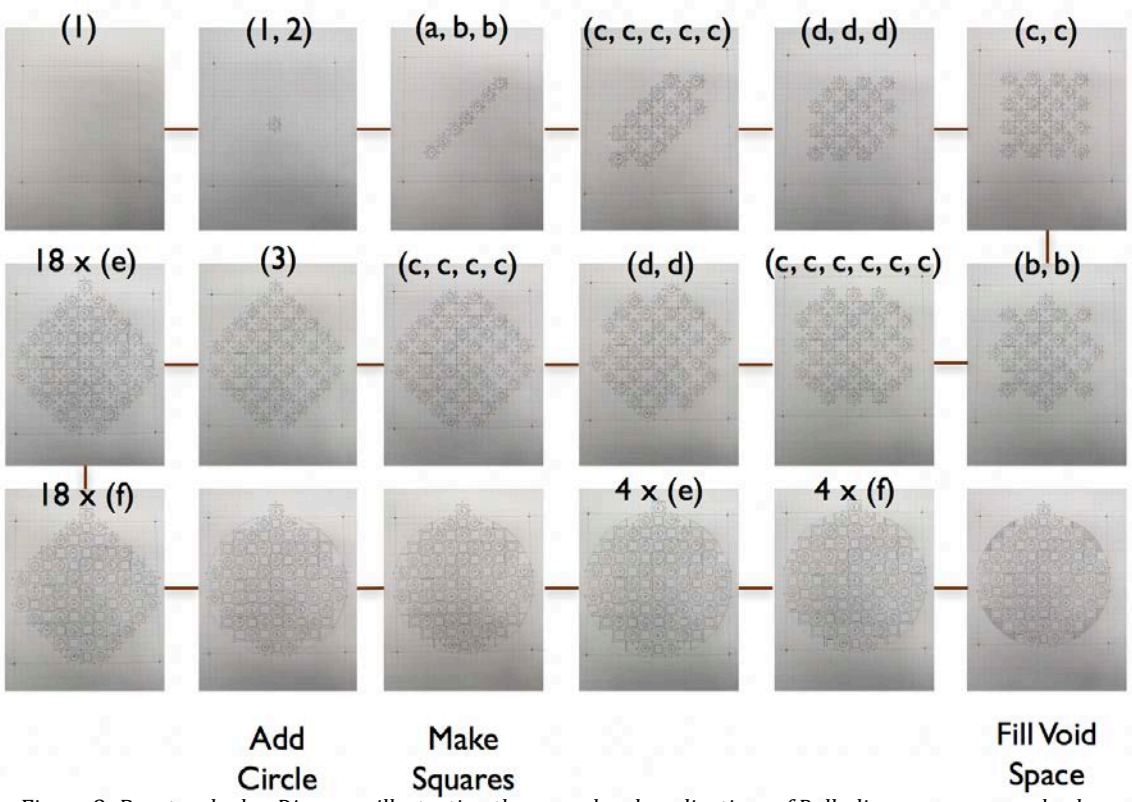



Figure 8: *Boustrophedon Diagram, illustrating the procedural applications of Palladian grammars and rules to produce the Pantheon's floor pattern*

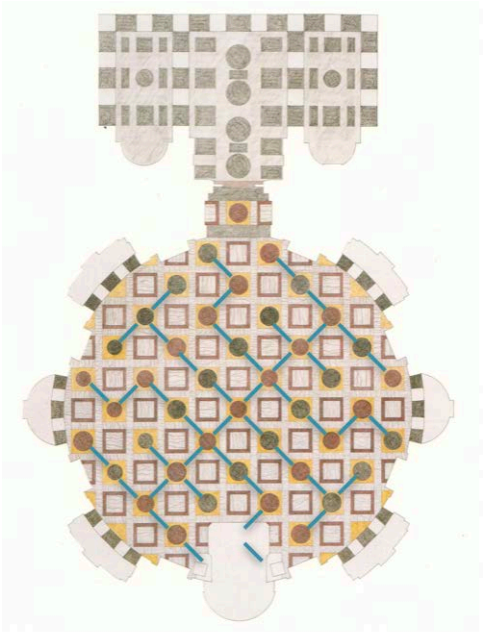


Figure 9: *Pantheon's Diagonal Floor Pattern, relating diagonal symmetry through the application of Palladian grammars to its Cartesian coordinate*

By expanding the Pantheon's floor plan in a diagonal manner from a centralized Cartesian coordinate, the applied steps produce a unique diagonal floor pattern schemata seen in the figure to the left. Through these specific rule applications seen in the boustrophedon diagram above, symmetrical analysis can be identified along the diagonal axes of symmetry to the Cartesian coordinate. The major and minor axes contiguous with the cardinal directions can be seen on the next page's figure, showing the central intersection of these axes with the Cartesian coordinate of the floor's diagonal growth in correlation to the rule schemata used and shown in the boustrophedon diagram. Upon the intersection of sub-symmetrical axes on the

Cartesian coordinate, the floor then divides into eight entities from a centralized point, referring to the initial eight subdivisions found in Figure 5.2 on page 4. By applying further subsymmetry analysis to the interior structural boundary of Hadrian's Pantheon in respect to the cardinal directions, the floor plan can be further divided into sixteen uniform divisions. This proves the subsymmetry analysis explaining Park's 16-gon rotunda, unifying Vitruvius' sixteen-part town and 16-gon rotunda to the 16-step floor pattern. By implementing these subsymmetries together, the unification of the terrestrial floor pattern to the celestial rotunda is made by the integration of a similar number. The significance of such uniformity through axial symmetry is paramount to understanding the detailed intricacies to the number sixteen and its significance to the structure's interior.

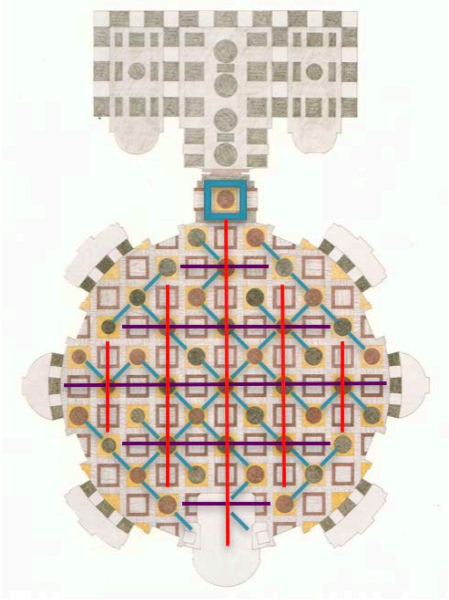


Figure 10: *Pantheon's Axial Floor Pattern, relating to its diagonal symmetry*

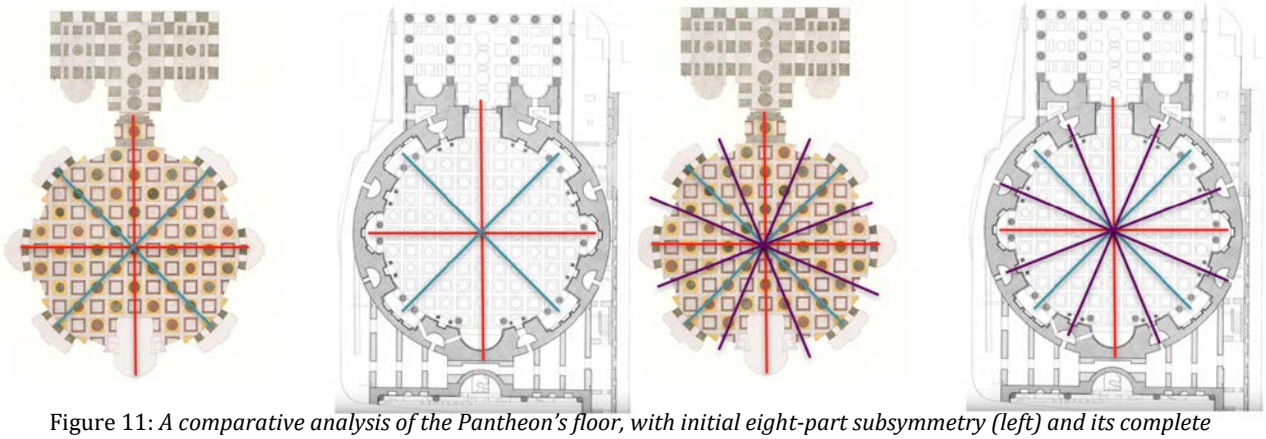
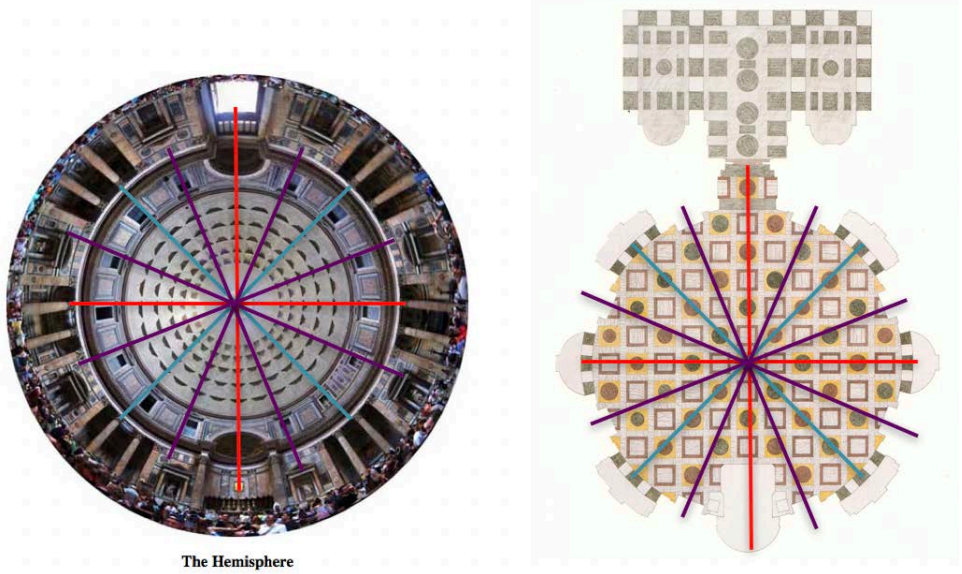


Figure 11: *A comparative analysis of the Pantheon's floor, with initial eight-part subsymmetry (left) and its complete sixteen-part subsymmetry (right), that which correlates to Vitruvius' sixteen-part town*

Figure 12: *A comparative analysis of the Pantheon's sixteen-part floor plan to its 16-gon Rotunda, a visual representation of the Pantheon's structural unification between its terrestrial and celestial sub-structures*



The Hemisphere

## VI. Concluding Discussion

The design implemented into the floor of Hadrian's Pantheon is uniquely explained using Cartesian coordinates and Palladian grammars. By proving the structure's subsymmetrical analysis through these grammars, once can begin further analysis of the geometries used in its design. Design comparisons can initially be made between Hadrian's Pantheon and his predecessor's (Emperor Trajan) Marketplace. Influential works of previous Roman Emperors show similar correlations in structural and visual design. Specifically, structural influences of the Pantheon's oculus can be derived from Emperor Nero's private palace – the Domus Aurea. Visually, the floor design of Trajan's Market – a design constructed under Apollodorus of Damascus - shows similar patterns to those implemented in Hadrian's Pantheon.

Figure 13: *A comparative analysis of the hemicycle ornament to Trajan's Market floor (left), to the marble floor of the Pantheon (middle), and the oculus within Nero's Domus Aurea (right)*

Comparable geometries of these inscribed circles within squares can be seen halfway across the globe in China, specifically within the Temple of Heaven. Potential symbolic correlations between celestial and terrestrial unifications of these integrated geometries can help tell deeper explanations of the structural significance and theological meanings behind it.

Figure 14: *A Google Maps Aerial View of Beijing's Temple of Heaven (left) and the Interior design of the Temple of Heaven's Rotunda (right), both of which share similar geometries of inscribed circles within squares*

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