Geometry in Early Islamic Art

The Alhambra, a palace in Granada, Spain is famous for its use of geometric decoration. Famous artists such as M.C. Escher and Owen Jones traveled there to explore the mesmerizing ornamentation. Escher’s tessellation projects may have been directly related to his experience at the Alhambra, and Jones developed “his theoretical formulations of principles of design, which he proposed were comparable to natural laws” after studying the palace complex.\(^1\) Geometry is a large and fundamental value in Islamic art. It stands alongside calligraphy and vegetal patterns as the top three most important types of non-figural Islamic art.\(^2\) Geometry weaves its way into every aspect of Islamic ornamentation, and can be seen on the walls of mosques as well as pages of the Quran.\(^3\) This paper will look at the various places geometry appears throughout Islamic art. The possible symbols behind geometric patterns in Islamic culture will be discussed as well.

Greek philosophers and mathematicians valued numbers and proportion. Certain numbers such as \(3/2, 4/3,\) the square root of two and the square root of three, were of special interest to the Greeks. Their belief in the spirituality of numbers spread and


influenced early Islamic ideas and art. Alain George has studied the geometry of the Quran. Through his research he discovered the same celestial numbers seen in the Greek tradition in the calligraphy and page setup of the Quran.

The Quran of Amujar was made in 262 AH/876 AD. Named after Amujar, the governor of Syria, the Quran has many geometric properties. First of all, the letters are written based off of an invisible grid system. George can see this through the elongation of the marks. The letters are all reaching towards invisible lines on the page. The letters also begin on the same vertical line as if a meticulous left hand margin was placed. Every page has invisible boundaries surrounding it creating a clean rectangular border. Each line of letters with a ruling just below the bottom layer of letters and a ruling just below the line of letters above it has a height equal to eight times the thickness of the pen (Figure 1). Inside each line ‘the ratio of the height of the line to that of the alif is 8/5=1.60.” 1.60 is very close to phi (1.618), which was revered among Greeks. It is part of the Golden ratio which when applied to different shapes creates the most aesthetically pleasing figures, which is why the principle is often used in architecture. The rectangle that the writing is limited to has a horizontal length of 3/2 multiplied by the height of the box. Mentioned earlier 3/2 was another number that was significant geometrically in the Greek period that traveled into Islamic culture. Other geometric consistencies that occur on the page are as follows: the pages height is equal to “the width of the text area”, the writing is vertically centered onto

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4 Alain George, “The Geometry of the Qu’ran of Amajur: A Preliminary Study of Proportion in Early Arabic Calligraphy.”

the page, and the inner margin's thickness measured horizontally is equal to the thickness of eight pens, or the lines that define the text. 6

These specific measurements could not have been created without a template used by the calligraphers. George believes that the artists may have used strings put through a wooden frame to guide their script. Creating a guide on paper and slipping it underneath the Quran pages as a template could have also been done. The latter technique would account for the slight variations in spacing from page to page. 7 As you can see, the line thickness of the pen and the dimensions of the Quran pages were well thought out with regard to geometric principles. 8 The mathematical relationships between the text and the area was important enough to early Islamic people that it was incorporated into their greatest book, the Quran, which contains the word of Allah.

The Islamic style that people instantly recognize today has been developing for centuries. The unique art form was created with the hard work of mathematicians, astronomers, scientists, and artists meeting and discussing ideas. 9 Since at least the eleventh century Islamic artists and mathematicians have been collaborating. 10 These

6 Alain George, “The Geometry of the Qu’ran of Amajur: A Preliminary Study of Proportion in Early Arabic Calligraphy.”

7 Alain George, “The Geometry of the Qu’ran of Amajur: A Preliminary Study of Proportion in Early Arabic Calligraphy.”


meetings drew in mathematicians such as the famous Abu’l Wafa al-Buzjani. Together the men would discuss ornamental patterns and architecture. Mathematicians would help artisans learn the basics of geometry.

In his book Geometric Constructions al-Buzjani tried to explain how to cut figures geometrically. Through his involvement in meetings in Baghdad he saw that artisans often made mathematical mistakes that could be easily avoided. His tutorial uses the cut and paste method, cutting a square into different shapes, and then rearranging them (Figure 2). The new outcome could be “expanded by repetition or by radial enlargement.” Meetings between geometers and craftsman helped create a dialogue that resulted in greater creativity. After artists learned basic elements of geometry they were able to branch out and create more unique patterns. 11 As the meetings between math and art continued throughout the centuries12 it became apparent that as much as mathematicians wished to teach artists geometry, the artists focused more on the aesthetics of a pattern than the mathematical purity. 13

Whether or not the mathematical proofs work out, the beauty and complexity of Islamic geometric ornamentation is difficult to deny. The craft was passed down from artists to apprentices. Over the many centuries, the art was forgotten. Mathematicians over the last few centuries have studied the artwork and come away with the seventeen

11 Alpay Ozdural, “Mathematics and Arts: Connections between Theory and Practice in the Medieval Islamic World.”

12 Alpay Ozdural, “Mathematics and Arts: Connections between Theory and Practice in the Medieval Islamic World.”

symmetry groups or wallpaper groups that can describe patterns made on a Euclidean plane. P4m and p6m are the most commonly seen wallpaper groups in Islamic art.14

Tessellations are shapes that can interlock to cover an entire plane without gaps or overlapping areas. In early Islamic art, tessellations are found all over mosques, palaces, and artifacts. One of the most unique ways you can see geometry at work in the Islamic world is through tessellated calligraphy. At the palace of Shirwanshahs in Azerbaijan (fifteenth century) ornamentation of the calligraphic “Ali” is tessellated six times (Figure 3). The simplified version of “Ali” is tessellated within the confines of a hexagon.15 The geometry found in the Quran’s calligraphy is mixed with wallpaper patterns found on the walls of mosques to create these unique ornaments. The connection between God, writing, math, and art can be seen through the tessellations.

According to Carol Bier “pattern in Islamic monuments...flourish” after the eleventh century.16 Why geometry began to spring up in Islamic decoration is a mystery. Somehow it was introduced to the Islamic art world, and has stuck around till today. Around the ninth century the idea of zero is formed, and spreads across the Islamic empire. From there the tradition of math continues. The basics of Algebra, trigonometry, and geometry are being discovered.17 Scholars such as Al-Khwarezmi discuss pattern, space, time, math, and


16 Carol Bier, “Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran.”

17 Carol Bier, “Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran.”
philosophy. Astronomy and math are used as tools to figure out the direction of the Qibla in order to pray. The concept of rationale seemed juxtaposed against the idea of religion. Through mathematics, Islamic people tried to find reason in their belief. By the eleventh century artists and architects were becoming more invested in math, shapes, and patterns. The advances in math and science plus the flood of monetary support from patrons may have been one of the reasons geometry was solidified in Islamic tradition¹⁸.

Some reoccurring shapes seen in Islamic art include circles, stars, and multisided polygons.¹⁹ All of those shapes and more can be seen at the Tomb Towers of Kharraqan. Built twenty-six years apart (between 460-486 AH or 1067-93 AD) these squat, round, brick and mortar towers rise up out of the Iranian landscape. The tombs are Seljuk funerary monuments. Each tower has eight faces that are entirely made up of a plethora of geometric patterns (Figure 5). The earlier tomb, in the east has thirty different patterns covering it, while the western tomb has seventy. The geometric patterns were created in relief. Artisans carved away the brick until the pattern they envisioned emerged. The entrance to the tombs and the faces to the left and right of them are more highly decorated and in higher relief than the other five faces Quranic verses mingle with the patterns in various ways. On the west tower there is a Quranic verse as well as a historical inscription that is above the entrance. Surrounding the inscription is a pattern of pentagons. The East tower has ribbons that interlock to create twelve point stars “in negative space, in each of

¹⁸ Carol Bier, “Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran.”
these stars, occurring nine times, is the name, Allah.”  

Bier writes in her paper that there is no central focus on either tower, within the patterns, or on the towers overall. None of the patterns are contained, meaning the patterns seem to keep reaching past the actual borders that contain them.  

Carving the brick in relief creates shadows that change and play with the patterns as the sun and moon rise and fall each day. Bier connects the elements of light and dark that appears on the tombs with the visualization of Allah described in the Quran. God is often described in the Quran as a guiding light. In Islamic ornamentation lanterns, and lights within niches often refer to God. The philosopher Avicenna wrote that light lets the invisible become actualized. Perhaps the light hitting the patterns every morning actualizes Allah’s presence.  

Douglas Dunham hypothesizes that geometric patterns seen throughout early Islamic art that seem to continue on into infinity past the confines of the borders may symbolize God’s infinite presence.  

To me, the geometry seen in Islamic art is both mesmerizing and calming in its complexity. The patterns are enticing, sucking a persons mind in, reminding them of God’s great ability to create as Bier suggests.  

Faced with patterned ornamentation a person

20 Carol Bier, “Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran.”

21 Carol Bier, “Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran.”

22 Carol Bier, “Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran.”

23 Douglas Dunham. “Hyperbolic Islamic Patterns - A Beginning.”

24 Carol Bier, “Geometric Patterns and the Interpretation of Meaning: Two Monuments in Iran.”
would feel small, like a man looking out at the stars. The inner reflection that comes with geometric ornamentation could be a reason for its popularity in Islamic culture. The beautiful mathematical lines remind even illiterate Muslims of God’s work, and their duty to serve Him.

The elaborate use of geometry in early Islamic art, as well as its continued use throughout the centuries makes geometry in Islamic ornamentation an important subject to study. While the meaning behind it is unclear, the ability to see geometry in Quran’s, buildings, and patterned decoration is undeniable. Borrowing ideas from the Greek philosophers, Islamic scholars advanced math into the modern period. With their newfound knowledge mathematicians were able to apply their skills to architecture, ornamentation, and religion. The Kharraqan towers are only one example of the amazing results from such a philosophy. Along with vegetal themes and inscriptions, geometry is a key theme in non-figural Islamic art. Without it, Islamic art would not have become such an incredibly recognizable art style throughout the world.
Figure 1.

Page from Amajur Quran. Red lines show the start and end of each line. The blue lines show the eight thicknesses of the calligraphy pen used to measure height of lines and width of margins.

From Alain George’s The Geometry of the Qu’ran of Amajur: A Preliminary Study of Proportion in Early Arabic Calligraphy.

Figure 2.

Depiction of cut and paste method.

From Alpay Ozdural’s Mathematics and Arts: Connections between Theory and Practice in the Medieval Islamic World.

Figure 3.

Tessellation of “Ali” at Shirvanshah’s palace.

From Aslam Mangalore, Palace of the Shirvanshahs, photograph.
Figure 4.

Towers of Kharraqan.

From Tehran Times, photograph.

Figure 5.

Geometric Pattern on Kharraqan Towers.

From Seljuk Tomb Tower, Photograph.
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Seljuk Tomb Tower, photograph.

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