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Islamic Art and the Identity of the Architecture Fundamental Design

Mohammad Abdullah Almandrawy[1], Eman Sayed Badawy Ahmad[2]

[1]Professor, [2]Assistant Professor,
[1]Metal furniture and construction (Architecture design),
[2]Textile Engineering (textile printing, dyeing and finishing),
[1,2]Architecture and Design College, Jazan University, KSA

ABSTRACT

The language of Islamic design springs primarily from shorthand, and geometry which plays a central role. The geometry and calligraphy are based on the rule of the underlying laws (proportions). The problem of research related to insert Islamic art in fundamental design subject especially the design of architecture. The research aims to analyze some models of Islamic engineering works. It follows that the Islamic design principles are reflected in geometry and used by designers as the most valuable tool of the design process to produce ordered patterns that govern aesthetic in designed spaces and surfaces. The research consisted of two parts: *Theoretical in which the collection of Islamic decoration and use in architecture. And *Practical in which the analysis of its. The research results are design and construction are used not only by mathematician-astronomers but also by designers, where the most striking characteristic of Islamic geometrical patterns is the prominence of star and rosette shapes.

KEYWORDS: *Islamic Decorative, Design, Fundamental, two and Three Dimensions*

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1. INTRODUCTION

Despite the fact that Islamic art is mainly conditioned by spiritual values and metaphysical attributes of Islamic belief, it also harbors a very pragmatic and material component. In that sense, it is very closes both to the contemporary functional design approach as much as to phenomenological design approaches which place the human senses into the heart of the design of the physical environment. (1) Islamic art geometric elements have been employed since its origin and were used to Creative unique geometric formations, serving as the underlying structure of the Islamic design process. Geometry was independently discovered andapplied by Islamic culture as a universal language, constituting one of the most important multicultural symbols in the design. Geometry or proportional geometry is a sacred art form due to its fundamental association with the Creative's principal laws. The visual expression of the order of these laws is best represented through the discipline of geometry. (2) Islamic geometric art is a distinctive idiom characterized by networks of interlocking stars and polygons, high levels of symmetry on both local and global scales, and various forms of repetition. The designs are usually laid out on some form of a grid.. (3) One of the most famous and most beautiful forms of geometric art is the Islamic star pattern. Mathematically, an Islamic star pattern is a planar arrangement of line segments that together delineate copies of a small number of different shapes, some of which are stars. These designs have been used as decoration in Islamic cultures for over a thousand years, and have still not lost their appeal. (4)

Islamic Mathematics is the term used to refer to the mathematics done in the Islamic world between the 8th and 13th centuries CE. Mathematics from the medieval Middle East is very important to the mathematics we use today. The most important contribution may be the invention of algebra, which originated in Baghdad in the House of Wisdom. Geometry has been set up as a branch of mathematics that contributed to defining relationships among elements in both plane and space. Metaphorically speaking, we can say that this is a sacred language of the universal perception. The use of elementary geometrical figures and of the techniques 6 recurrence, overlapping, symmetry, translation, weaving ...etc., opens the way towards a whole universe of graphical and artistic expression. (5) Geometric patterns occur in rich profusion throughout Islamic cultures. They are found on a diversity of materials–windows, doors, railings, bowls, furniture-specially pulpits in mosques, and on other surfaces. They can be seen in abundance on architectural surfaces of mosques, palaces, and madrasas.

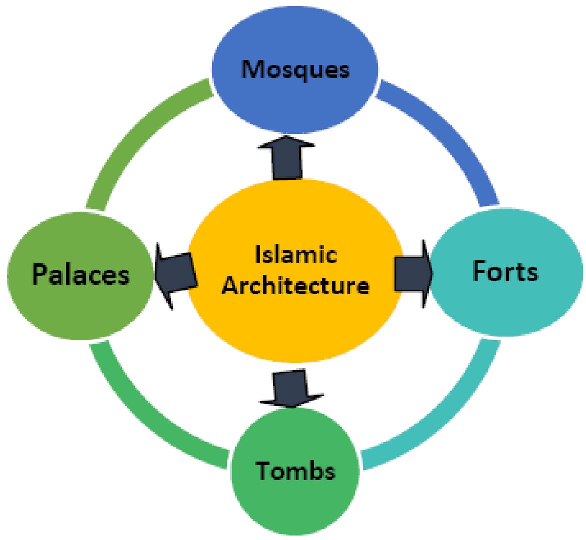


Figure (1) the most important areas in which Islamic decoration was used.

Geometric proportions in architectural patterns represent a design language, as words do in a spoken language. They determine the frameworks within which elements may be arranged into a pattern, a relation between one element and another, and a proportional relation within one element. They address and reflect the natural laws that govern the basic harmonies of nature, being describable by means of mathematics and geometry. (6)

2. Theoritecal part:

2.1. Geometry and Architecture Space

The geometric patterns are one of the most distinguishing features of Islamic art. Islamic star patterns are the most beautiful in Geometric patterns. (7)

In the decorative Islamic stars and Rosettes, an important role is played by the geometrical motifs, achieved at the beginning with simple instruments, such as the rules and the compasses. Using the elementary geometrical figures - the triangle, square, pentagon, hexagon and circle – by repetition, symmetry, shape displacement and recurrence very complex and sophisticated geometrical patterns could be developed. (8)

Since Antiquity, scholars defined and established computational relationships for such figures and shapes. Thus, polygons were defined as figures having a greater than or equal to three sides. Regular polygons received special attention as they were characterized by equal sides and angles and by their capacity of being inscribed in a circle and symmetry: Symmetry means a balance, a repetition of parts or simple uniformity of form. Symmetry simply means pattern. But the range of symmetry is far more than simply appealing architecture and pretty patterns. However, mathematically symmetry can be simply defined in terms of invariance of properties. (9)

Geometry and rhythm manifest a doctrine of unity that is central to Islam, upon which Islamic art developed based on mathematical ratios and proportions which represent the very heart of Islam. Geometry is the blueprint of the Creation and the generator of all forms. It is a science that deals with numbers in space on three basic levels:

The first one is arithmetic (pure numbers), i.e., any measurement or proportion is a geometrical measurement. The beauty of proportions is based on the simple geometry of regular polygons with a set of ratios of side lengths to diagonals, which can be translated into the design process. These geometric proportions are used to quantify aesthetic qualities. This process is, to a great extent, based on objective facts. Judgments on beauty versus ugliness can be based on systematic arguments characterized by unifying principles or patterns. They can be achieved by means of algorithms of visual math as an objective ground which can be founded on geometry and proportions, which are part of their elementary pillars. (10)

The second level numbers in space which represents proportional geometry. They reflect the meanings and "Ideas". Islamic architecture is created based on the essential harmonies of nature together with various symbolic meanings and theories of perfect proportions. The designers based their geometrical vocabulary on what they have seen in the nature around them, in an attempt to develop a codified series of proportions which may improve our psychological comfort with buildings.

The third level numbers in space and time which represent the cosmology of the universe.

Viewing and contemplating these codes allow us to understand the wisdom of the inner workings of the universe in order to fully comprehend and appreciate its beauty based on the concept of proportions. Ikhwan Al-Safa wrote, 'One of our aims consists of demonstrating clearly that the whole world is composed in conformity with arithmetical, geometrical, and musical relations. There, we have explained in detail the reality of universal harmony' (11)

Geometry is the visual representation of the mathematical patterns found everywhere in man, nature, and cosmos. These patterns, with their esthetic and philosophical values, are found within all aspects of the Islamic design process. The understanding of geometry as an underlying part of our existence is nothing new.

2.2. Geometric patterns and form Islamic

Islamic art features stars with many different numbers of points, up to a remarkable 96. The star can arise naturally by running the inference algorithm on a regular polygon. It can also be useful to express stars as higher-level design elements, in order to exert more direct control over them. The rosette is one of the most characteristic motifs of Islamic art. A rosette may be viewed as a star to which hexagons have been attached in the concavities between adjacent points. Each hexagon straddles a line of reflection of the star and thus has bilateral symmetry. (12)

Before Islamic designers started producing 2-level geometric patterns, they had a well-established listed formula for filling rectangular panels with star patterns: place a star in each corner and fill the interior with a symmetrical arrangement of other shapes, usually with a star or other prominent feature in the center. This meant that if the panel were repeated as a template by reflection in the sides of the rectangle, the pattern would continue seamlessly across the joins. The leap to 2-level patterns was accomplished by applying this formula not too simple rectangle, but to the variously shaped compartments in existing Islamic geometric patterns. In general, this is difficult to do, but modularity provides a simple mechanism by which it can be achieved.

The rosette is one of the most characteristic motifs in Islamic art. A rosette may be viewed as a star to which hexagons have been attached in the concavities between adjacent points (one such hexagon is shown shaded in Figure 2). Each hexagon straddles a line of reflection of the star and thus has bilateral symmetry. A rosette can be represented as a two-segment path. (13)

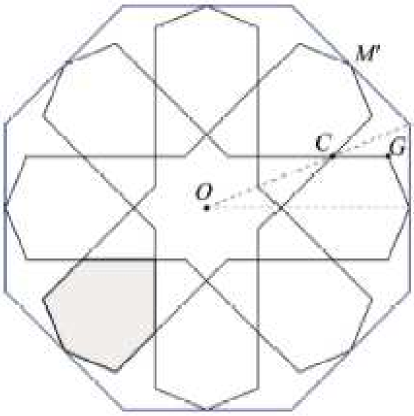


Figure (2) the demonstration of Lee's construction of an ideal rosette. A rosette is a star to which hexagons have been attached (one such hexagon is shown shaded).

For example, when six-fold stars are arranged in Figure 3, a higher-level structure emerges: every star is surrounded by a ring of regular hexagons. The pattern can be regarded as being composed of these surrounded stars, or **rosettes**. Placing copies of the rosette in the plane will leave behind gaps, which in this case happen to be more six fold stars. The rosette, a central star surrounded by hexagons, appears frequently in Islamic art. Pointed star polygon can be drawn by distributing n points evenly along the perimeter of a circle. The construction of star patterns relies on mathematics like measurements of distances and the contact angle θ. The intersections are between lines, even the construction of planar maps. (14)

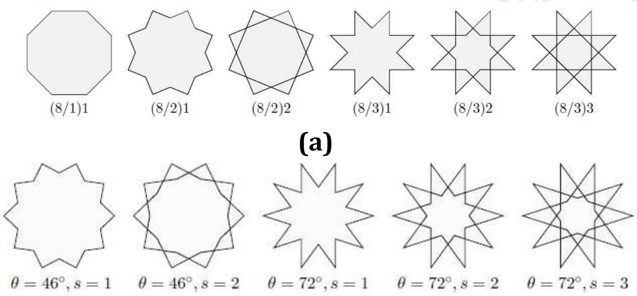


Figure (3) (a) The six possible eight- pointed stars. (b) Examples of stars constructed using the technique of Section 3.5.2

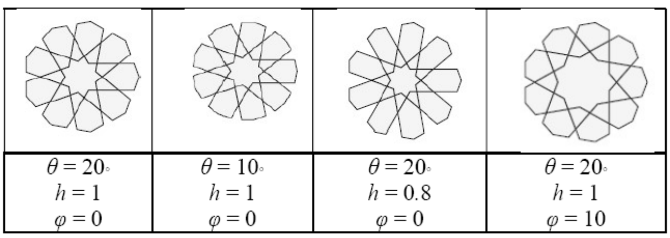


Figure (4) examples of rosettes constructed using the technique of Section 3.5.3. Each example has *n* = 9, *r* = 1, and *s* = 3, and shows the effect of varying *θ*, *h*, and *φ*.

3. Practical part

3.1. Analysis Stars and Rosettes

The pattern could be classified as a hexagonal pattern simply because it contains a hexagonal star or could be classified as an octagonal pattern because it contains octagonal star etc. It may be accomplished by a combination of several geometric shapes like circles, triangles, squares, quadrilaterals, and hexagons, etc., where a Stars and Rosettes unit patterns could be normalized and classified according to its basic design. The main content of the Islamic geometric patterns is Islamic stars. The typical construction of an Islamic geometric pattern consists of a major star in the middle and accompanying stars or other geometric elements around this central star

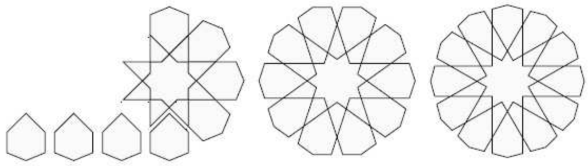


Figure (5) this example of eight-ten and twelve-pointed rosettes.

The eight-pointed rosette on the left is partially decomposed into an internal *{8/3}*2 star and the eight surrounding hexagons.(15)

All patterns in which their main elements are from hexagon or hexagon star come under 6-point geometrical patterns and the star is called a 6-point star.. Accordingly, patterns are further called as 8, 10, 12, 14, 16…-point geometrical patterns. Hence, the patterns containing such elements will come under "n-ford rosette", such as eight or 10- fold rosette. (16)

3.2. Types' constraction of geometric patterns:

Rosette consists of n-sided star shape surrounded by n hexagons and n quadrilaterals shape based on constructive.

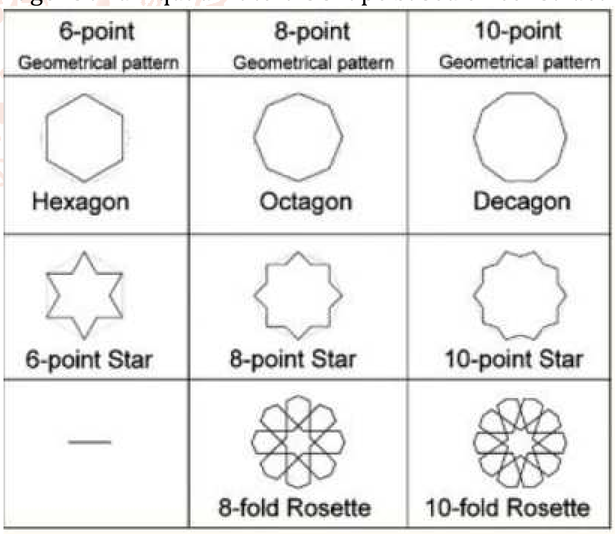


Figure (6): Some types of geometric patterns. Polygons, such as hexagons and octagons:

Star polygons created by connecting vertices of constructive polygons. All patterns whose main elements are from a hexagon classified as 6-point geometrical patterns, all patterns whose main elements are from an octagon classified as 8-point geometrical patterns, etc. (17)

Circle: The circle is an obvious example of basic geometry, constituting all the proportional geometries inherent in traditional architecture. The circle of Unity is the most significant form, for it contains a circumference revolving around a fixed center. It is therefore extremely important to understand that all other geometric shapes can be determined from a circle, from which come the full polygons, including a series of roots and proportions. When the drawing is further intersected by straight lines, an equilateral triangle, a hexagon, a pentagon, a square and so on, have emerged. The circle is a basic unit or the planar surface on which the grids would be placed to achieve an n-gon unit star. Its radius strictly restricts the placing of the grids within the parameters of its size. The system of geometric design starts from the circle (the basic unit), from which the pattern starts to unfold, creating harmonious divisions of the circle in four stages: (18)

1. The planning stage: starting by determining the proportional systems based on the unit pattern structure within the circle of Unity. The decision is based on the symbolic meanings underlying the geometric pattern and its relation to the micro-macro cosmos.
2. The division phase: construction of the basic geometric pattern.
3. Pattern order and structure: initiating the crossing lines to create the artistic shape of the pattern on natural junctions formed by those lines. This type of framework forms the driving geometry for the relatively simple Islamic patterns with which we are familiar.
4. Desired pattern revealing: establishing the geometric variations of the pattern and defining its borderlines. It is derived from all the vital proportion systems based on a single unit. The process can be repeated indefinitely, presenting the same center everywhere and nowhere. It is a ratio, rather than measurement, that determines the relative lengths of crucial dimensions. (19)

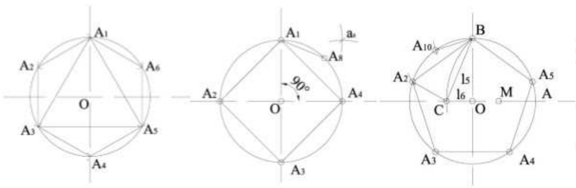


Figure (7) geometric series design and construction of regular polygons inscribed in a circle.

In figure (7), one can notice the way regular basic polygons are built, namely.

A. The construction of the triangle and hexagon;
B. The construction of the square and determination of the side of the octagon.
C. The construction of the pentagon and determination of the side of the decagon.

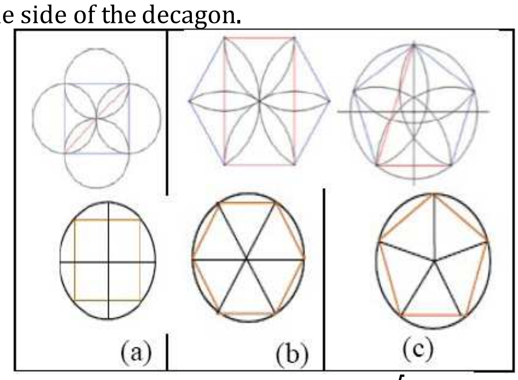
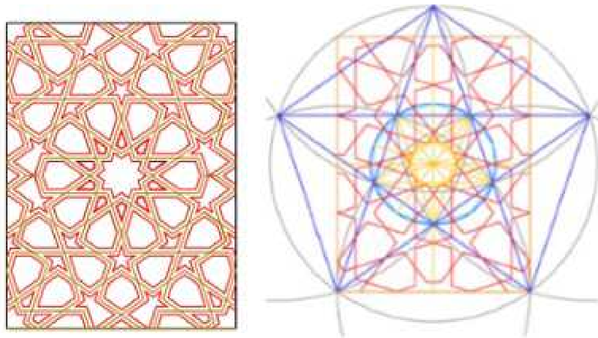


Figure (8) the proportional root (a) $\sqrt{2}$ proportional (b) the golden mean proportional (c) the $\sqrt{2}$ proportional



(Figure (9) construction of a five to tenfold pattern based on the golden mean proportion

With the four-point geometries, for example (Figure (9)) the circle is divided into four parts leaving degree angles, or, 360÷90 = 4. The next multiple of the four-point geometries is 4 x 2 = 8; now I divide the 360 by 8 equaling - the angle in which the shape takes form three- dimensionally. The following multiple is 8 x 2 = 16; 360÷16 = 22.5, etc. As the number of rays doubles, the angle of the circle peeling from the two-dimensional canvas decreases. The same formula applies to the five and six-point geometries respectively. With the understanding of geometric principles of the underlying grids and methods used, I applied added rules to imply a three-dimensional design composition to find a three dimensional Islamic of points, lines, and angles taking form in a three- dimensional composition. Or a rotation of 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees, 315 degrees, and 360 degrees would keep the pattern unchanged. [20]

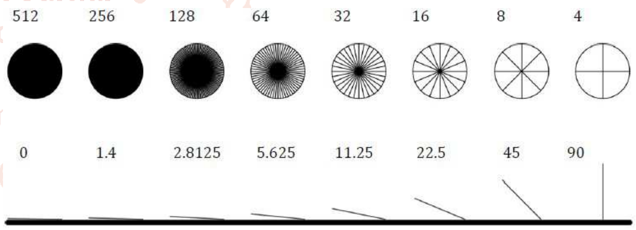


Figure (10) three dimentional calculations 4 point geometries

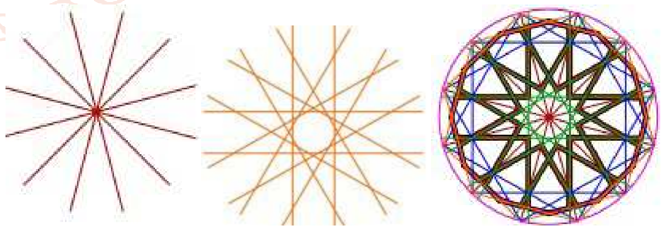


Figure (11) the 12-rayed star is classified as because it uses minimum of 3 sets of grids and the lowest geometry is quadrilateral.

A classical methodology known as the polygonal technique has been made use of grids generated from the diagonals of a regular polygon.

Figure 3 shows such a type of grids that are worked out to keep the pattern symmetrical and to maintain the visual balance. The grids are in the form of a mesh having a large number of irregular polygons. The patterns are created by selecting these irregular polygons in the grid. Design possibilities increase by increasing the diagonals; in fact, with increase in the number of sides of the regular polygon. The patterns derived from 6, 8 and 10-sided polygonal. These symmetrical patterns remain invariant under certain classes of transformations such as rotation, reflection, inversion, or more abstract operations. These rendered patterns are in the form of a star/rosette following radial symmetry. [21]

The grids generated from diagonal gridding stage: [22]
- Planer surface stage
- Divisional stage
- Artistic stage
- Extension stage

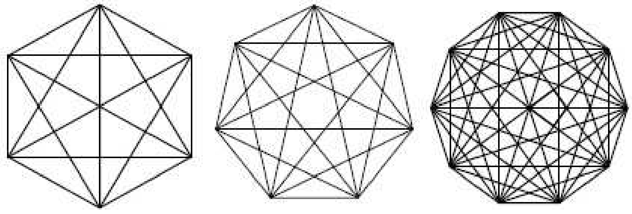


Figure (12) the grids generated from diagonal

3.3. Extended Design Elements
This stage is a Notional or Phantom stage, because this stage might exist or might not exist. In this stage the natural extensions would evolve to accomplish the seamless mesh in the external zone within the notional boundary (usually a square or a rectangle) [23]

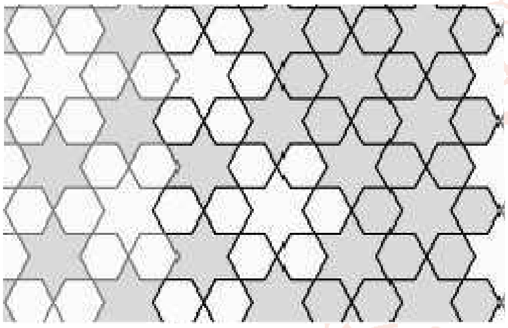


Figure (13) an arrangement of six fold stars can be reinterpreted as rosettes. The pattern is one of the oldest in the Islamic tradition.

For example eight-pointed star:
The square represents the earth, or the physical elements such as earth, air, fire, and water. If a square overlaps another, with the second square pointing upwards, the eight- pointed star is formed. The eight- pointed star is related to the symbolism of the eight bearers of the throne, from Koran and certain cosmological subjects. Different rule-sets are applied to the pattern and these generative rules are based on shape grammar and fractal geometries. (24)

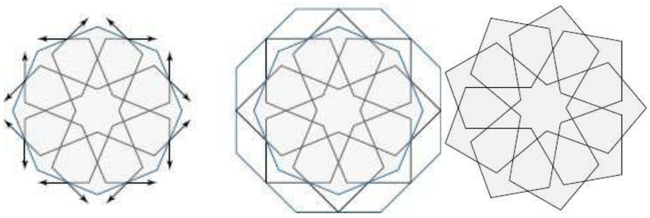


Figure (14): The extension for eight-pointed star process for design elements.

When the contact angle of a design element is sufficiently small, it is possible to connect contact edges from adjacent contacts until they meet outside the tile as in Figure 10, forming a larger motif with symmetry. We refer to this process as an *extension*. Our procedural model for extension takes as input any other procedural model that includes the contact angle θ as a parameter and constructs directly an extended. [25]

3.4. Nonperiodic star patterns:
There is Islamic pattern ornament based on a nonperiodic arrangement of elements. For example, the placement of Muqarnas a system of ornamental corbelling, usually installed under domes or arches) is typically guided by the asymmetric but not periodic patch of squares and 45◦ rhombs. Many domes are also decorated with star patterns that cannot be extended periodically. These wonderful historical artifacts do not imply that Islamic artisans understood the mathematics of periodic tilings. With some experimentation, it is easy to cover a large region of the plane with a radically symmetric arrangement of squares and 45◦ rhombs or Penrose rhombs. The deeper fact that these shapes are related to inherently aperiodic prototile sets need not play a role in the experimentation process. On the other hand, it is reasonable to exploit the modern theory of quasiperiodic tilings in constructing star patterns, provided the results do not stray too far from the aesthetic of Islamic geometric art. Here, I explore several ways of deriving novel quasiperiodic template tilings and the star patterns that can be generated from them.

3.5. Structures made of muqarnas:
Muqarnas is among the principle characterizing elements 6 the Islamic architectural style. Naturally there exist regional differences: for example, they are generally constructed in successive layers of brick in Iran and in Iraq but are often made in stone in Syria and Egypt. In the Arabian-Andalusian, regions the constructions are modular, either of wood orin plaster. They are generally, with rare exceptions, based on an octagonal symmetry, though pentagonal symmetry is very common in the Persian style. [26]

Rules Assembly: muqarnas is accomplished by setting the curved edges together. Two edges will not fit together if they do not have the same orientation. If they do have the same orientation, there exists only one possible positioning. As a consequence, thanks to the codification introduced, a plane representation contains all the information about the structure: if we know the inclination of the muqarnas or the height of only one module, the representation is complete. The other pieces: In addition to the four main pieces, some secondary pieces exist, as for example the piece with a rectangular section shown in Figure (15) and its variants. Two small pieces are derived from the decomposition of the piece number.

There are also half-pieces used to joint angles and some pieces with only one level (the small squares in Figure (16). The chechia is a little dome that replaces a group of pieces at the top of a dome.

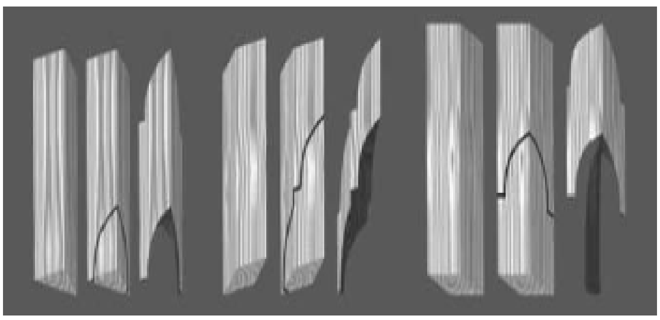


Figure (15) the cuts of the four principle pieces, beginning with a triangular prism for the first two, and rhombic for the remaining two. The visible parts are shown in black.

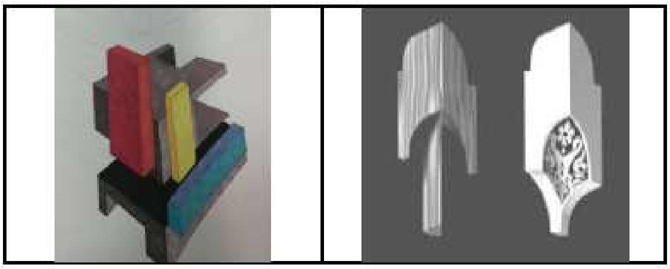


Figure (16) the four principal pieces of the *muqarnas* and their plane representation.

Although floral and figural motifs are dominant decorations the ceiling of its high columned balcony is covered with different types of 8 and 10-point geometrical patterns (Figure (17). The wooden ceiling of the entrance balcony is designed a variety of geometrical patterns consisting of different types of 8 and 10 point geometrical patterns.

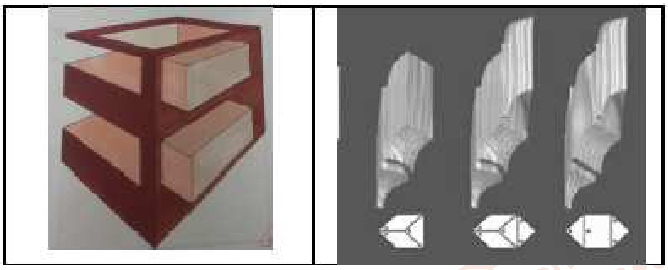


Figure (17) the formation of a group of muqarnas and its variants with a new piece of rectangular section.

The purpose of making use of all these techniques can sometimes be two or three-dimensional optical illusions, an apparent movement of shapes that can be stressed by means of color and contrast. [27]

Their underlying geometry is based on the relationships between the circles containing the 6–12 pointed geometry, which is derived from the central six-pointed rose and a combination of a square, a lozenge, and a triangle. The complexity is introduced on a relatively simple basis by applying colors and doubling of the structure lines while Changing in the selected intersection nodes creates different pattern constructions Stage 1 The planning stage Stage 2 The division phase Stage 3 Order and structure Stage 4 Pattern revealing. We can easily see that the ornament can be outlined with the help of touching circles, as well as smaller circles inscribed in the empty space between large circles. The large stars are constructed on the base of octagons inscribed in circles. Finally, centers of circles are located on vertices of a square grid. The small circles are used to create small four corner stars with diamond-shaped arms. A square with corners located in centers of stars can be the most convenient repeat unit for this construction. (28) The diagram shows the calculated systems for three-dimensional formation. Similarly to the two- dimensional coded structures, the three-dimensional forms are rooted in a circle and the point geometries it holds. Point geometries divide the circle into angles; angles that set a three-dimensional structure to the form expanding from the set two-dimensional grid of geometries. The angle is determined by both the number of line geometries that divide the circle and the angle of the circle that grounds these geometries, etc.

Figure (18) Islamic model used as a source to generate ideas

4. Results:

After the research study, it will be says that:

- The infinitely repeating geometrical patterns and the rules of geometric construction are a reflection of the unchanging laws of Allah. They are based on esthetic proportions as seen in the rhythm of the Creation. to fill: 360°, rotate.
- Islamic geometric patterns are one of the most beautiful examples of the combination of mathematics, visual arts and contain an abundant amount of symbolism.
- Combine mathematics and visual arts through the use of Islamic geometric patterns. To reach this aim, research extensively researched the mathematical and artistic aspects of Islamic geometric patterns.
- Utilize the opportunities and advantages of computers and digital media, serving as a tool of the self- guiding process for esthetically proven design.
- The algorithm can be used to reconstruct (or construct a new) star patterns that have all of the properties: The algorithm allows for “extensions,” or petals with varying edge-angles, and petals with non- parallel sides.
- The craftsmen knew that the mathematicians had worked on some problems related to design and they regarded the solutions with respect, even though they probably did not understand the details and technicalities.
- One of the simplest methods used to create designs of Islamic geometric ornaments with regular hexagons and six-fold regular stars. Sub grids are used only to establish points where the lines of the ornament meet.
- Continue evolution of Islamic geometrical patterns follows the difficulty-path of construction of the polygons from the easiest to more complicated types of polygons and stars.
- Esthetic values in proportions have the foundations of architectural design a key function in constituting them because it forms the underlying structure of order versus diversity, establishing systematic design principles.
- Islamic geometric criteria of esthetic revealed by means of geometric analysis, which would increase, the freedom of design, and to find a system path to a design language that includes esthetic rather than systematically excludes it. It is necessary for the Islamic geometric ornaments were in general.

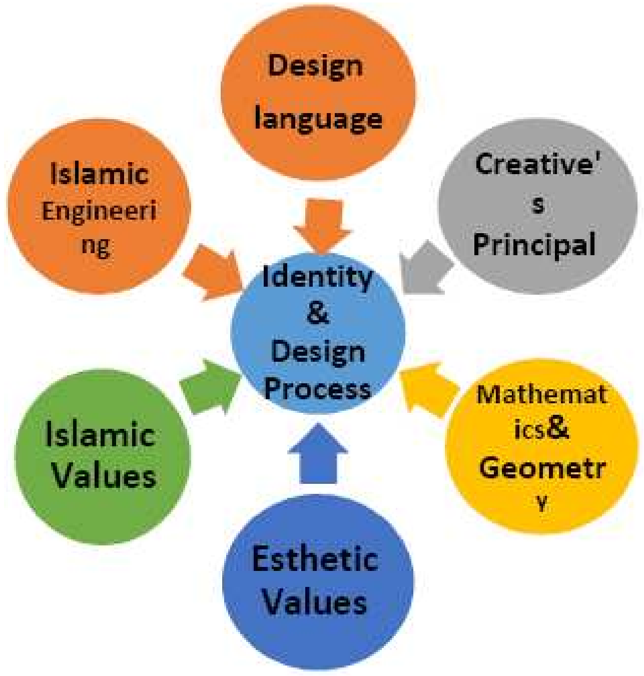


Figure (19) Requirement Identity and Foundations of Architectural Design

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