

EMPLOYING HERITAGE ELEMENTS IN CONTEMPORARY ARCHITECTURE THE CASE OF ISLAMIC GEOMETRIC PATTERNS

Dr. Samer AL-Ratrout*¹ and Rizeq Hammad²

¹Assistant Professor, Department of Architecture, Faculty of Architecture and Design, Jordan University of Science and Technology, Irbid, Jordan P.O. Box: 3030, Irbid 22110, Jordan.

²Professor, Department of Architecture, Faculty of Engineering, University of Jordan, Amman, Jordan P.O. Box: 11942, Amman, Jordan.

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***Corresponding Author**

Dr. Samer AL-Ratrout

Assistant Professor,
Department of Architecture,
Faculty of Architecture and
Design, Jordan University
of Science and Technology,
Irbid, Jordan P.O. Box:
3030, Irbid 22110, Jordan.

ABSTRACT

This paper examines the motifs in general, the types of ornamental expressions, and the rules and principles employed in ornamentation. It deals in particular with the Islamic motifs and the distinctive features of types of motifs. It introduces examples of motifs displayed on walls, doors and domes in interiors and exteriors. It reviews the specificity of Islamic motifs in comparison with the motifs in other civilizations. Artistic opinions of artists, architects and critics associated with such

motifs is also presented. The paper inspects the specific philosophy in Islamic civilization these motifs expressed. These expressions lead to an independent paradigm that distinguished these Islamic motifs from any other prevailed motifs in other civilizations. Furthermore, the influence of Islamic motifs reached other civilizations and impacted related arts. The legitimacy of the excessive use of motifs is also discussed in this paper in whenever an exaggeration is perceived in the case of mosques. It examines the ornamentation compatibility with the Sharia scripts that decline the extravagance in the use of motifs in general, and in mosques in particular. Innovative computational design and simulation tools are also introduced in the paper. Emergent architecture thinking is presented and progress anticipations are raised up into awareness.

KEYWORDS: Islamic motifs; geometric patterns; architectural heritage; contemporary architecture.

INTRODUCTION

Ornamentation is a process of producing intertwined set of points, lines, geometric shapes, and sometimes illustrations of animals and plants, that are collected in harmonious arrangements to produce visually appealing compositions (Talo, 1986). It is commonly employed to decorate buildings, utensils, clothes, mosques, churches, gravestones, coins, currencies, palaces and some country flags. Ornamentation art enhances enjoyment and pleasure, meets emotional needs, inspires imagination and devise aesthetic and spiritual concepts that generates a state of euphoria and satisfaction.

Since prehistoric ages, ornamentations accompanied humans and flourished in all historical eras. They reflect human civilizations where successive nations use motifs to indicate their life styles, living activities, own customs and particular traditions. Ornamentation is considered as knowledge sources for learning about the history of previous and contemporary nations. It works to support understanding the extent of nations development and the specificity of their intellectual, religious and cognitive sophistication.

Prehistoric human realized the art of ornamentation. The life at that time was primitive and living interests did not go beyond the tasks of daily life concerning the matters of securing food and safety. Consequently, ornamentations were primitive in its inception and remained so for a long time. At that time, Humans sketched and etched some rudimentary configurations of lines and points.

By the time when man suspected the existence of ambiguous forces in the nature that he assumed were responsible for the motion of creatures, the shapes of motifs and inscriptions evolved. At that time, abstracted animal drawings, plants configurations and some natural phenomena were primitively graphed.

With the cognitive and cultural advancement of human beings, the urge for aesthetic appeal became essential. Hence, the ornamentations were utilized to decorate caves walls with engravings and bodies with tattoos. Utensils, tools, clothes and many other objects were also embellished using various graphics, decorations and inscriptions which were intended to serve aesthetic appeal.

1. Ornamentation Rules And Principles

Ornamentations have rules and principles inspired from nature and basic decorative works and the most important are (Talo, 1986).

2.1. Equilibrium

It represents a basic rule that must be present in every ornament's composition or any artistic work. It expresses the integrated artistic formation through a careful distribution of elements, units and colors. It is a rule inspired from formations contained in the nature with their surfaces and shades of color that are in balanced relations with each other.

2.2. Symmetry or Similarity

It is one of the important rules upon which some ornamentations are based. In this rule, one half of the motifs applies to the other half in relation to a straight central line called the axis. Symmetry is of two types, half symmetry and total symmetry. The half symmetry includes the elements in which one of the two halves complements the other half in the opposite direction. The most prominent examples of this are nature. The other type is the total symmetry where the composition is shaped from two completely similar elements in opposite directions.

2.3. Radiation

Most ornamental formations include radiation rule, especially botanical ones. It is of two types, the radiation from a point and the radiation from a line. In the radiation from a point, the lines of an ornamental unit radiate starting from a point outward. In the radiation from a line, shapes and units branch out from straight or curved lines on one side or two sides. It is such as palm fronds and like the growth of leaves from its branches, the branches from its shanks, and the shanks from the trunks.

2.4. Proportionality

It is the most important rule of beauty, as the nature is characterized by the proportionality of each part to another. This rule has no specific regulation but depends on artistic taste, accuracy of observation and the power of distinction.

2.5. Entanglement

This rule appears frequently in Arabic motifs in the form of a regular wrap, spiral wrap, or the wrap of two shanks of plant in an opposite direction.

2.6. Repetition

It is one of the important rules of ornamentation and is found in abundance in nature, such as in tree branching. Repetition is one of the simplest rules for creating motifs. It is of three types, normal, opposite and reciprocal repetition.

The normal repetition, is the type in which the ornamental units are adjacent in a fixed, alternating position. The opposite repetition, is the type in which the ornamental units are adjacent and in opposite positions, sometimes upward or downward, and sometimes to the left or to the right.

The reciprocal repetition is the type that uses and shares two different ornamental units that are juxtaposing and alternating one after the other. This repetition is also known as the sequential or the cascadic.

2. Islamic Geometric Patterns

Before Islam, in the countries in which Islam spread, the motifs were in line with what was mentioned previously by ornamentation of clothes, buildings and tools with all kinds of motifs, with no limits to their types, quantity or materials. It is known that the civilizations that preceded Islam had innovated in ornamentations, sculpture and embodiment, such as the Indian, Persian and Roman civilizations. However, the emergence of Islam greatly reduced these motifs and prevented imaging, embodiment and extravagance, and this ban was final and delimited. Therefore, Islamic ideology became a way of living in general and a guide for the smallest details for the everyday activities of a Muslim.

This Islamic ideology destroyed the idols, prohibited their manufacturing, and warned their makers. It rejected and banned the images that embodied human beings and animals out of clothes and fabrics, warned the images makers, and put an end to pre-Islamic ideas and beliefs. This ideology created a generation of monotheists who do not compare anyone with God, directing the individuals to establish their relationship directly with God.

The Muslim artist realized the occurrence of the prohibition on embodiment art. Therefore, arts were approached through abstracted methods using the motifs to achieve fluidity of lines, equilibrium of geometry, harmony of chroma, and intonation of music. This was the necessary introduction to an authentic abstracted art that was pursuing originality (Khair & Abdo, 1990).

Over the centuries, Artists of Islamic motifs replaced the embodiment by developing polymorphic geometric patterns. In Islamic art, Geometric designs were dominated by frequent use of clusters of circles and squared shapes that overlapped and intertwined. This replacement paved the way for the emergence of arabesque art that included various forms of mosaics. The complexity and diversity of the used patterns ranged from simple stary and diamond shapes in the third century AH to a variety of six-headed stars towards thirteen-headed stars in the seventh century AH. Then the patterns were evolved to stary shapes with fourteen and sixteen sides in the tenth century AH.

Geometric motifs were used in various forms of Islamic art and architecture. including the Lime, Persian Lime, Moroccan Zellij, Muqarnas arches, perforated gallic windows, pottery, leather, stained glass, woodwork and metal configurations (Fig. 1).



Figure (1): Some Types of Islamic Ornaments.

3. Features Distinguishing Islamic Art (Willson, 1999)

As is the case in all aspects of Islamic life, the ornamentation took a novel approach away from the ornamentation approaches of other different civilizations. Among the most important features that characterize Islamic ornamentations are the following:

The first feature that accentuate Islamic art is its basic unity in terms of the general perception of shapes, spaces and volumetric forms which represent the tangible components of this art.

The variety of the employed elements of shapes, techniques and materials are admirable wherever they are located. These elements are characterized by aesthetic unity that dominates all related artistic achievements. This cognizance of unity is one of the characteristics that

distinguishes Islamic art in addition to the characteristic of repetition, diversity, and abstraction. The characteristic of the abstraction is specifically a unique characteristic of Islamic graphics. Contemplating about the relationship between art and crafts will lead to realizing the profound intertwining between the two subjects. Craft is not only considered a starting point for art, but rather plays a fundamental role in emphasizing it. Therefore, it is common that every craft or even industry that exists has to get a touch of art (Thahabyyah, 2013).

Some of the basic rules in Islamic art are the following

1. The artist completely avoids the embodiment of living beings, or the display of human figurines, as the artist believes that God is a singular and the only one that is solely entitled to create living beings.
2. Arabic calligraphy is employed in motifs and decorations while maintaining harmonious correlation with the Islamic ornamentation.
3. This art was and is still evolving to a large extent from the patterns of abstract ornamentation of Islam, through geometric patterns and analogous expressions from nature.
4. The use of calligraphic motifs in this art was, to a great extent, what distinguished it most from other form of arts.
5. The craftsmanship and mastery of the Muslim artist for this art supported it with more than one remarkable art form of geometric motifs.
6. The employment of botanic motifs reinforced unveiling the beauty of the surrounding nature.

The civilized aspect of Islamic ideology and its creative conceptions is traceable through realizing the relationship between the Islamic intellect as a philosophical model and its relationship to the arts.

This approach is essential to comprehend the ornamental nature of geometric patterns that is based on mathematical systems backed with the measurability of mathematics and applying concepts from Islamic philosophy. This can be approached by highlighting the mechanism of employing Islamic oriented concepts in producing distinctive and unique ornamentations (Hazem, 2011).

Henri Focillon (1881 –1943), the French art historian and a director of the Museum of Fine Arts in Lyon, stated that he didn't expect that anything could strip life of its apparent dress, and take the observer to its hidden content, such as the geometric formations of Islamic motifs do.

These formations are the result of careful calculation, which may turn into a kind of diagrams of philosophical ideas and spiritual meanings.

However, it should not be missed that, in this abstract framework, a life is flowing across the lines. A life that is forming configurations that proliferate and increase. Sometimes they are scattered and many times they are combined, as if there is a wandering spirit that blends those formations and separates them, and then reunites them again.

Each composition is convenient for more than one interpretation, depending on what one aims to look at and contemplate into. Thus, all of them both hide and reveal the secret of their limitless potential and possibilities. Each configuration is appropriate for more than one interpretation, depending on what one is aiming at and what is hoping from it. At the same time, every one of them obscures and reveals the secret of its boundless potentials and energies that they embed and contain (Al-Shami, 1990).

The artist Keith Critchlow, a professor of architecture and author of a book on Islamic decorations, claimed also that Islamic decorations were designed to attract the viewer to it to understand the implicit truths, not just the apparent ornamentation (Critchlow, 1983).

David Wade, author of a collection of books on decorations in different arts. (Wade, *Pattern in Islamic Art*, 1976), in his article "The Evolution of Style" Stated that: " Much of the art of Islam, whether in architecture, ceramics, textiles or books, is the art of decoration." He claimed that the hidden purpose of ornamentations was to transform mosques into a bright light form, and the ornamentation of the pages of the Qur'an makes them an entry to infinity (Wade, *The Evolution of Style*, 2006).

On the other side, Doris Behrens Abouseif said in her book "Beauty in Arab Culture" that there is a big difference between philosophical thinking in medieval Europe and the Muslim world, as the concepts of beauty and quality in Arab culture are not the same. She also claimed that enjoying beauty in both poetry and visual arts was a pleasure for beauty itself, without addressing religious or psychological standards (Behrens-Abouseif, 2019).

The complex designs of the ornaments of the Alhambra Palace of Spain (Fig. 2), inspired Dutch artist Escher to study the mathematical sequences the mosaics of this palaces, which influenced his artistic style as an influence that accompanied him in the rest of his artistic career (Greg, 2005) (Monroe, 2004), where he said: “it was the richest source of inspiration I could ever exploit” (O'Connor & Robertson, 2000).

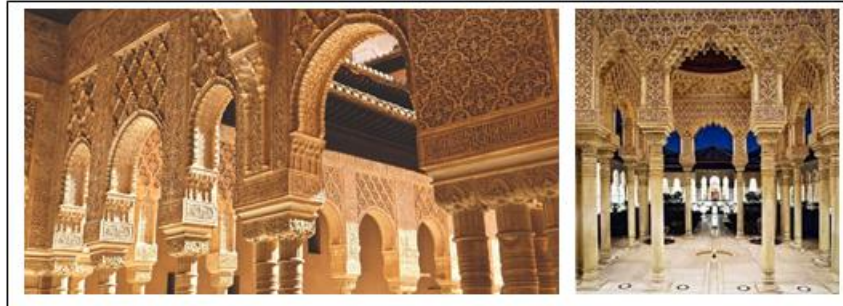


Figure (2): Examples of Alhambra Ornamentations.

Organizations such as the Institute for Mathematics Research and the Institute of Advanced Studies have organized events on geometric motifs and its association with Islamic art (Bier, 2015).

In 2013, a Saudi researcher concluded in her master thesis that Islamic botanical elements are important units that can be addressed as a basis for deriving innovative designs. The researcher added that these elements affect the diversity of creativity in decorative design, which starts from simplicity to complexity and these units overlaps to reach unspecified compositional solutions. (Al-Ghamidee, 2019).

A researcher of the decorations of the Al-Aqsa Mosque and the Dome of the Rock affirms the unity of content and the artistic character that are reflected in the decorations of the Dome of the Rock (Fig. 3). He added that their aesthetics are related to the place in which they were found in. He emphasizes that these decorations are innovative and integrate with the architectural design of the building, and are closely related to Islamic ideology and philosophy (Aslan, 2016).



Figure (3): Ornamentation of the Dome of the Rock from the inside.

Former President, Alija Izetbegović, did not just link Islam with art, but rather links religion in general with art (Hafeth, 2019). He argues that it is based on the fact that art is the son of religion, and if art wants to survive, it must always draw from the source that it descended from. He states that the essence of the similarity between them lies in the fact that art speaks of personality and religion speaks of the soul. He concludes that religion and art are not different in essence, but they differ in the way of expressing the same idea.

4. Decorations In Mosques

It is agreed upon among the scholars of the nation that decorating mosques and place various figurative images in them is forbidden based on Islamic texts from the hadiths of the Messenger which were agreed upon in authentic books (Islamweb, 2001). This stance is based on that decorations distract the worshipers from focusing on prayer and supplications in addition to wasting public or private money (Islamweb, 2001). Its sanctity is increased in the Qiblah wall, where Muslims face in prayer. As for pictures and figures of animals or humans, or whatever the artist can imagine, they are certainly prohibited and forbidden, and none of them are found in the mosques of Muslims from the Far East to the Far West. As for ornamentations, they began to spread in some mosques in different quantities, and sometimes even cover the entire surfaces of the mosque. As for lighting the mosque, cleaning it and covering its floors with luxurious carpets, it is not forbidden, but the extravagance is hated.

As for the decorations in places other than the places of worship, they are permissible and conditional on not being extravagant in terms of quantity and cost. Houses, ballrooms, public halls and other buildings have had amounts of decorations, drawings, artistic panels, muqarnas, artistic artifacts, household items and clothes with various inscriptions and ornaments. The Muslim artist created faience, carpets, clothes, etc. (Fig. 4).



Figure (4): Examples of Islamic Ornamentations.

5. Modern Geometrical Patterns And Techniques

Geometrical patterns are determinedly existed all over the Islamic historic architecture and still presently recurring.

Geometric ornaments like star shaped patterns are commonly implemented to support conceptualizing the building structure and material order. These conceptions produced the inherent cultural and social orders that has been employed through buildings designs, buildings shapes, ornaments and processes of construction. The associated ornaments functioned as an instrument of identity (Stavric, 2011).

At present, the use of computational algorithms to digitally parametrize Islamic geometric patterns is attainable. There is a significant awareness for the applicability of generating sophisticated and innovative geometric pattern designs of new geometric territories. The capacity to explore and compare several design decisions with great flexibility, synergistic dynamicity, and the rapidity of outcomes, are the noticeable advantages of employing computational algorithms and exploring through the power of the computer. The algorithmic procedures typically use variety of basic polygonal tessellations as historically were employed. Hence, these procedures are contemporary expressions of ancient operational practices (Bonner, 2017).

One of the most important features of Islamic ornaments is that they can be designed and produced using modern technologies.

2D designs of patterns is developed into 3D formation using software such as Adobe Illustrator, Rhinoceros 3D and AutoCAD. Construction of a three-dimensional object from a digital 3D model is applicable using computer numerical control machines (CNC), 3D printing, or what is known as additive manufacturing. The digitally designed ornaments can be produced on glass, wood, plastic, and other metals (Bonner, 2017).

6. Parametric Approaches Of Computational Generative Geometries

“Grasshopper”, a free plug-in of McNeel’s Rhinoceros is a software used in architectural and industrial design fields for three-dimensional modeling is a computational solution than can be employed to generate forms of 2D Geometric ornaments like star shaped patterns (Marina & Trombeva Gavriloska, 2013).

Designed algorithms can be employed for generating geometries of shapes that can be parametrically handled. Figure 6 is a screenshot of Rhinoceros 3d software with “Grasshopper 3d” plugin showing a demonstration by the author for a workflow procedure to develop designed algorithm for generating parametric star shaped geometry.

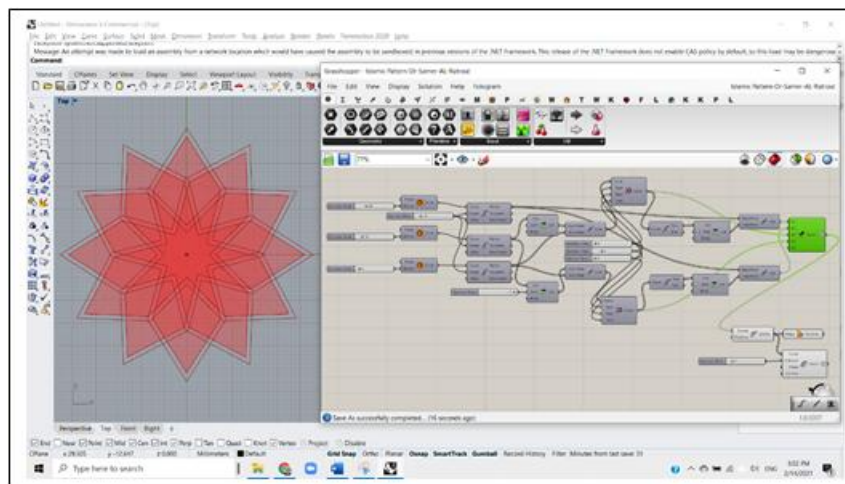


Figure 6: Generating parametric algorithm in Grasshopper for star-shaped geometry.

Figure 7 is a screenshot showing parametric generations of the designed algorithm to produce variety of star shaped geometries by varying the number sliders of identified parameters to instantly generate alterations of the basic geometric star in Grasshopper.

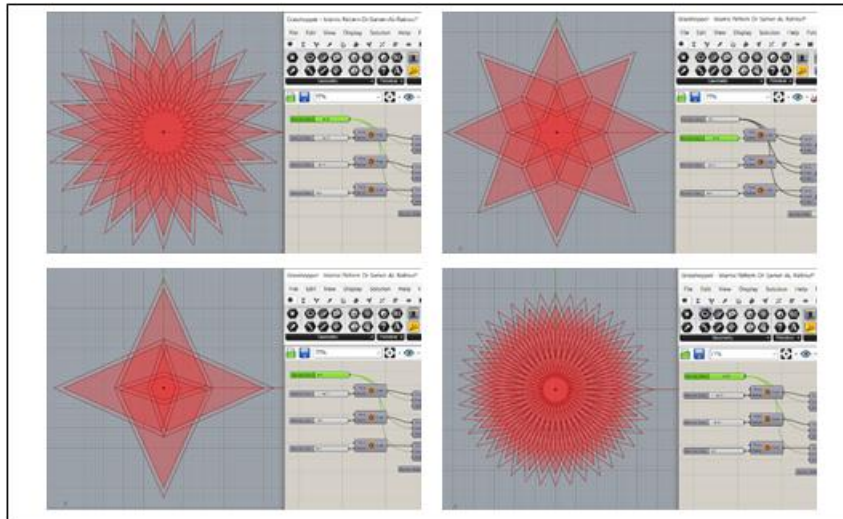


Figure 7: Parametric generations of algorithm of star shaped geometry in Grasshopper.

Figure 8 is a screenshot showing parameters manipulating to readjust pre-generated algorithm in Grasshopper to produce varieties of star shaped geometries by changing the number sliders of the pre-identified parameters to instantly generate alterations of the base star unit of an Islamic Pattern Geometry in Grasshopper.

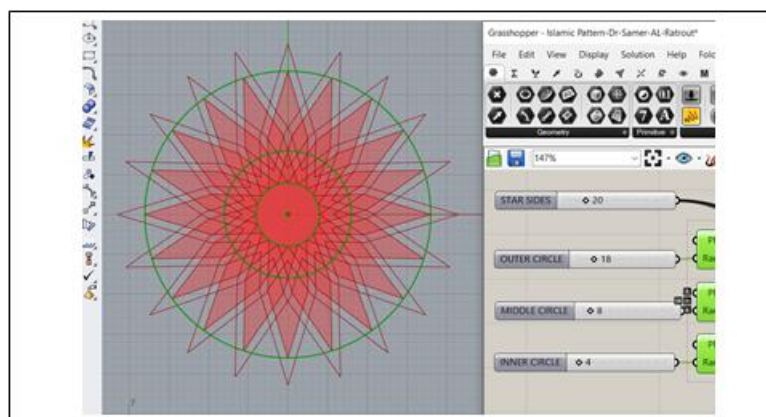


Figure 8: Parameters manipulating to readjust pre-generated algorithm in Grasshopper.

The Cambridge Central Mosque, a mosque in United Kingdom is an example that gained attention for its contemporary interpretation of traditional Islamic architecture. Professor Keith Critchlow (MARCHESE, 2021), an expert in sacred architecture and Islamic geometry, designed the geometry introduced in the mosque. The geometry was involved in all the forms starting from the pattern of the dome to the brick bonding patterns, the atrium floor tiling and the door marquetry (Figure 9).



Figure 9: The Cambridge Central Mosque and its contemporary interpretation. of traditional Islamic architecture.

7. Evolutionary Types Of Modern Geometries

The characteristic of geometricity sets Islamic geometric patterns apart from other decorations. The fundamentals of geometry, as practiced by historic Islamic artistes, involved Euclid's Elements. Euclidean geometry was strictly recognized for centuries, as a straightforward description of the universe. Though, In the nineteenth century, parallel postulate, one of the five axioms upon which Euclidean geometry is based approved to be false. As a result, mathematics was transformed by recognizing that geometry could exist with different rules. Nowadays, mathematicians are departing the flat world of the Euclidean plane and exploring the non-Euclidean geometries.

The construction of star patterns can be formulated in a way, so that the shape of space is one more parameter to the algorithm. By varying the choice of geometry, conceptually related families of Euclidean and non-Euclidean patterns can be formed (Bonner, 2017) (see Fig. 10)



Figure 10: Three-star patterns with similar underlying geometry, rendered in the Euclidean plane, the surface of a sphere, and the hyperbolic plane.

Ever evolving computational technology offers innovative solution for unconventional and unprecedented challenges in producing patterns as in some new Islamic star complicated patterns. Starting parametrically from an already defined Euclidean design of a pattern and transforming it into non-Euclidean geometry is computationally applicable. It is also applicable to map Euclidean pattern designs to the surface of a three-dimensional model, as long as the surface can be parameterized (Bonner, 2017). (see Fig. 11).



Figure 11: A two-point Islamic star pattern based on the regular tiling by hexagons, mapped onto a 3D Bunny model.

8. CONCLUSION

Islamic motifs are considered a unique form of decoration that did not evolve from the universal motifs that existed in the first period of Islam. It stems from a pure Islamic philosophy that moves away from the representation, figuration and embodiment of humans or animals. It is represented in geometric and botanical motifs designed from endless geometric principles and relations. These formations allow Muslim artists to produce decorations and artistic paintings that reflect Islamic ideology and philosophy.

The ideology was based on the principle of monotheism and the rejection of polytheism of all kinds. The philosophy was reflected in all aspects of a Muslim's life, who excelled in the formation of original Islamic art. The art did not depend on previous artistic formations or decorations and did not develop from any previous civilizations. Ornamentations have rules and principles inspired from nature and basic decorative works. These decorations are still present in historical buildings, tools and fabrics, and they are still present in the modern era with their features. These creations are still developing and taking advantage of modern techniques for shaping and execution.

The features that distinguish Islamic art are unity, variety, repetition, diversity, abstraction, and craftsmanship. Based on Islamic texts from the hadiths of the Messenger, decorating

mosques is not accepted for it distracts the worshipers from focusing on prayer and supplications in addition to wasting money.

Geometric ornaments like star shaped patterns are commonly implemented to support conceptualizing the building structure and material order. The paper presented examples of these motifs in the life of a Muslim, including utensils, interior decorations, fabrics, doors, carpets, inscriptions and other works and arts.

It is established that the characteristic of geometricity sets Islamic geometric patterns apart from other decorations. The fundamentals of geometry were dramatically evolved within the last three centuries where mathematics was transformed by departing the flat world of the Euclidean plane and exploring the non-Euclidean geometries.

At present, the use of computational algorithms to digitally parametrize Islamic geometric patterns is attainable using procedures to introduce contemporary expressions of the ancient operational practices. This was established through examples of emerged architectural designs and simulation tools introduced in this paper. These presently emerged computational technologies and unprecedented parametric tools inspires their utilization to introduce innovative Islamic patterns for novel engagement and employment in contemporary Islamic Architecture.

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