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"Muqarnas: Unveiling its Identity and Structuralism in Contemporary Architecture."

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Abstract
Muqarnas, an architectural marvel that traces its roots to Islamic architecture, has captivated architects and enthusiasts alike with its intricate geometry and structural complexity. Originating in the Middle East during the Islamic Golden Age, Muqarnas served both practical and aesthetic purposes, showcasing the ingenuity and artistry of its creators. At its core, Muqarnas embodies a unique blend of mathematics, art, and architecture. Its distinctive honeycomb-like structure consists of small niches or stalactites that form a visually stunning three-dimensional composition. The interplay of light and shadow within the Muqarnas creates a mesmerizing effect, transforming ordinary spaces into extraordinary works of art. In contemporary architecture, Muqarnas has experienced a revival, with architects incorporating its intricate patterns and structural elements into modern designs. By reinterpreting this ancient architectural form, designers are able to infuse new life into their creations, paying homage to the rich cultural heritage from which Muqarnas originated. As we delve deeper into the world of architecture, Muqarnas stands out as a symbol of innovation and artistic expression. Its intricate beauty and structural complexity serve as a reminder of the enduring legacy of Islamic architecture, inviting us to appreciate the craftsmanship and ingenuity of those who came before us. Digital technology, such as computer numerical control (CNC) and computer aided design (CAD), were shown to have influenced the design and regeneration of muqarnas patterns in the 20th and 21st centuries. This study looks at muqarnas, a three-dimensional architectural ornament, and its identity and structuralism on contemporary design and to investigate the influence of muqarnas on contemporary architecture and its adaptation to modern design.The descriptive analytical method was applied for this aim. Local architectural surveys were conducted, and textual research was done to examine it identity and structuralism. In conclusion, Muqarnas continues to captivate and inspire architects with its intricate beauty and structural complexity. As we look to the future of architecture, embracing the legacy of Muqarnas can provide a source of inspiration and creativity, allowing us to create spaces that are not only functional but also visually stunning.

Keywords: Islamic Architecture, Ornamental Element, Muqarnas, Identity, Structuralism, Contemporary Architecture

Introduction

Islamic architecture is considered one of the world's utmost celebrated traditions. Islamic architecture is famous for its rich patterns, radiant colors, and symmetrical silhouettes which is recognized since the seventh century in the Muslim world. Some of the distinctive elements of Islamic architecture are as follows:

- Minarets
- Domes
- Arches
- Muqarnas

Islamic architecture is distinguished by a unique artistic characteristic, whether in its religious or in its civic context, that serves the Muslim community. At the same time when architectural requirements were structural and variational, the muqarnas was considered to be qualitative in the context of art and was viewed as the foundation of other artistic fields, for example, decoration. At the same time, architecture is revealed as the mother of all art. This reflection establishes the general relationship between architecture and art, and that unity and depth are evident in the design of the muqarnas can be identified as being a link between Islamic architecture and art.

The clarity, degree, and extent of the organic connection between Islamic architecture and the arts are reflected in the formation of the architectural elements themselves. The muqarnas is a phenomenon that is part of the structure and decorative finishing strip and its features and ornamentation. It has deep roots in all aspects of Muslim art, as an architectural feature, decorative motif, cultural expression and aesthetic, and symbolic meaning in an enriched block or horizontal bracket, adding to the appreciation of the quality of the environment. It is an Islamic architectural element with a structural function, and it is also a shaped ornamental element that controls, to a great extent, the form of the Islamic building and gives it its distinct characteristics. (H. El-Basha, 1965).

The muqarnas is an Islamic innovation used as a means of exploring the cultural and compositional units (cube, sphere, wall, columns, and arches) of buildings and other structures. This Islamic ornamentation is an expression of Islamic artistic creativity, and it has various roles in design as a complex geometric interlacing of components, producing a three-dimensional surface using concave elements. The practical importance of the muqarnas is evident by its presence in a large variety of architectural structures, including arches, capitals, domes, minarets, mihrabs, minbars, exteriors, and interiors, which are distinct from its ornamental uses. The other importance of the muqarnas is through the multiplicity of its forms, types, and the organization of its parts and proportions, in keeping with architectural entities. Its geometric formation represents a pure beauty and bestows Islamic architecture with symmetry, in harmony with the aesthetic proportionality of all the components in the building, and their various possibilities in terms of the contiguity and relations that attract the play of shadow and light on these forms.

A common structural component of Islamic architecture is the muqarnas. The use of this vault-like structure, which has a faint stalactite-formation-like quality, is common in Muslim-style mosques and mausoleums. Muqarnas consists of descending vaults with flat plates and facets carved into intricate arrangements of cells that surround them. It is used as a structural element and decorative element in domes, facades, portals, arches, and wall niches. Depending on the area, different materials were used to make muqarnas. It is challenging to identify the first location where this architectural component was employed. The plate discovered in Iran's Takht-i-Sulayman Palace is an early example of a muqarnas in the year 1968 (yvonne Dold-Samplonius, n.d.). This plate has served as a foundation for numerous scholarly investigations, leading to

diverse interpretations regarding the techniques employed in the construction of muqarnas and their geometric characteristics. In Islamic architecture, geometrical patterns and geometry are very important. The design of the muqarnas is known to be related to the twentieth-century invention of fractal geometry. This element may have been developed by Islamic architects based on the fractal patterns observed in nature. According to some scholars, these geometric patterns' fundamental principles enabled architects to produce intricate decorative, structural, and spatial aspects (Kiani, 2016).

Islamic architects employed rigorous geometric principles and close collaboration with mathematicians to create intricate Muqarnas configurations (Taheri, 2017). One notable example of the successful application of squinch can be found in the Bahri Mamluk muqarnas in Egypt. This architectural masterpiece managed to achieve intricate structural proportions, as well as a harmonious integration of ornamental and sculptural elements. The impact of this achievement greatly influenced the subsequent development of Islamic architecture muqarnas in other countries (Kashef, 2017).

Literature Review

Identity

The identity of the structure of the muqarnas is very important in the context of Islamic art, because it has a cultural, consistent, meaningful, and symbolic role. This refers to a persistent religious message that the Islamic work of art, regardless of medium, attempts to express in aesthetic terms. The core of that message is consistency and to have a charm in the elaborate epigraphic carvings in Islamic architecture. This allows muqarnas to be differentiated from one another. In other respects, the intricate morphology of muqarnas is derived from the mathematical diffraction of prismatic overlapping volumes, which is the technical basis of muqarnas decoration in general, when considering their structural composition.

The muqarnas' unique visual configuration, which is based on a complex three-dimensional geometric composition, gives the impression of an amazing rotating body that is growing like an organic being and is pierced by light and dark plays and animated by strong optical effects of undulating motion. This is the muqarnas' metaphorical identity. They provide breathtaking visual displays, Evoking the physical rules of cosmic substances, real or imagined, such as up and down movement, concentric attraction or opposing repulsion, fragmentation, diffraction, aggregation, play of light, and so on, they resemble the atoms of a universe in development (Gonzalez, 2001). 'Conceptual' does not refer to the fundamental idea that shapes the muqarnas' geometrical system, which is obviously not movement, pure formalism, or metaphor, but rather the beautiful representation of the idea of geometry as an ideal object. According to David Hume, an eighteenth-century philosopher, identity is the most universal relation which is discovered by perception rather than by reason. He proposed that mankind is nothing but a bundle or collection of different perceptions (Hume, 1967).

Amos Rapoport, wrote very extensively about the human aspect in design, wrote that:

It's challenging to define the concept of identity. Multiple meanings are provided by dictionaries; the two most pertinent ones relate to the constant nature of something under various circumstances or features, as well as the state of being one thing but not another. Both in fact seem relevant, but the latter notion seems to be at the heart of the concept as it applies to the question being considered. The unity in question perceives itself, and is perceived by others, as distinct from other units in some way. It appears that this involves both an exterior border and an interior or contents boundary (Rapoport, 1981).

Structuralism

The term structuralism is a theory with several interpretations, employed in many contexts in different disciplines in the course of the twentieth century. It was first presented in 1929 in the social sciences as a general philosophy but it is now applied in a very wide range of disciplines. This implies that no single definition applies to it unless it is in very general terms. Therefore, it was agreed to define a structure as a system of transformation that takes place over time (Jean Piaget and Maschler Chaninah, 1971), this concept was the principle of the theory of structuralism, whose models try to create the fundamental reality that exists within the studied system (Abubaker, 1996). Therefore, it is thought that structuralism is the expected progression to Systems Theory. In other words, structuralism delineates a process of metamorphosis intended to enhance system phenomena or concepts. According to structuralism, many events don't just happen; they also happen in relation to one another. It depicts an entity as a whole made up of constituent parts, with relationships defining internal relations that constitute a structure. Any system's performance is contingent upon its relationship with the environment, as well as the other systems in that environment.

Consequently, judging the performance of a system should be carried out as part of the larger system that contains it. One can distinguish between subjective and objective system components, as well as between visible and invisible relationships between them. (Islami., 1998). A system also has two levels of meaning: the lateral or the direct interpretation, which in philosophy is known as the denotational meaning, and the hidden, symbolic, and cultural meanings that goes beyond the direct meaning and is called the connotational meaning. For example, the denotational meaning of a pen is an object that produces writing. But how much writing has this pen produced? How many beautiful ideas has it produced that have had an impact on both the individual and the development of society? These are connotational attributes, the hidden meanings (Ujam, 2006). Applying this to the muqarnas, the denotational meaning of the muqarnas is that it is a miniature niche structure. However, the muqarnas also has many connotations, semantics, memories, aesthetics, symbolic values, and indirect meanings. In general, structuralism was used in architecture as a tool to understand human behavior, unlike the instrumental system, which was used in architecture as a decision-making tool. Structuralism is thought to be the most important modern movement in architecture and art design. It appeared in response to the movement of functionalism, which was well known in the initial decades of the 20th century (Heuvel, 1992). Furthermore, the built environment could be measured as a transformation system of physical and socio-cultural space which can be understood not only in the course of the three-dimensional buildings, but in a space-time process (Masaud, 1996).

However, occasion and place mean more than space and time, because, in the image of man, space means place, and time is occasion (Hertzberger, 1991). Hertzberger explains that: If everything we created inspired people to get to know their environment, one another, and themselves better, that would be something. This means reorganizing things so that, to the extent that it is within our power to affect, the world becomes less foreign, harsh, and abstract and instead becomes a more comfortable, suitable, and friendly place—in other words, a world that matters to its inhabitants. (Hertzberger, 1991). Applying this approach to the muqarnas, the research postulates that the muqarnas is a system of transformation, because it has hidden rules that maintain its function and laws, adopted, and accompanied by the social transformation of the Muslim community, which transforms the muqarnas by encoding geometrical and cultural meaning into hidden rules.

Deep structure and surface structure

According to (Bill Hillier, 1973) definition, a structure is an abstract system of formal relationships that underlies the more pronounced manifestation of visible forms. According to Chomsky, there are two types of structures: deep or conceptual and surface or perceptual. An abstract underlying elemental order that permits transformational rules to operate is known as deep structure. Deep structures are mapped by the rules. Then, rather than just being viewed as a system of visual relationships, it is perceived as a generative or transformative process. Deep structure, in his opinion, is partially defined by universal rules. (Patin, 2013). By distinguishing between deep structure and surface structure, Chomsky allows for both description and formalization. He sees only two alternatives, either an innate schema that governs with necessity, or acquisition from outside. Hence, one cannot detect the identifying criteria and essential components in a straightforward way by just looking at the surface appearance of the physical objects instantiating them (Balzer, 1996). Structuralism suggests deep abstract formation as the basis of richness and variety and its application returned structure to the surface level (Bill Hillier, 1973). According to Assiter, structures—which are typically invisible to the naked eye—are the true entities that underlie appearances. But Marx suggested that if there was no difference between the inner structures and the appearance of things, we would have no need of science (Assiter, 1984). The surface structure indicates the design of the muqarnas itself, its ornamentation and decoration, its location, and all the visible aspects. Deep structure is the meaning and the force responsible for producing designs and rules with such geometrical, mathematical, and cultural meanings.

Impact of Technology on Contemporary Development of Muqarnas

Muqarnas are still used as a decorative element in both the inside and outside of buildings in modern architecture. This ornamentation is incorporated into modern design using a variety of methods (Sennott, 2004).One method for producing exact and elaborate muqarnas patterns is the use of computer numerical control (CNC) equipment and computer-aided design (CAD) software. This permits designers and architects to swiftly create intricate designs that would be challenging to accomplish by hand, as well as to experiment with new muqarnas forms and styles (Al-Rawi, 2020).

The Doha Museum of Islamic Art was built in 2008 in Doha, Qatar (Figs. 1a and 1b). The light, geometry, and water principles of Islamic architecture served as inspiration for the design of the Doha Museum of Islamic Art. This building's general layout consists of a square encircled by a circle and an octagon. The design of the dome over the atrium is the primary focus of the museum. The primary purpose of the symmetrically planned dome is to reflect sunlight within the structure. In traditional architecture, the dome of Muqarnas served the dual purpose of reflecting and delivering sunshine into sacred spaces and the buildings that housed Muqarnas. There are several Muqarnas geometrical rules on the dome over the atrium. However, the over-all appearance of this form reminds the spectator of Muqarnas (Imani, 2017).

Figure:1 (a) Atrium of the Museum of Islamic Art, Qatar; (b) Closer View of the Dome in the Atrium

Note. Source: (ArchDaily, 2023)

In 2013, Muqarnas Tower, a commercial office block in Riyadh, Saudi Arabia, was constructed as a gift for King Abdullah (ArchDaily, 2023). The building's facade offers shade given Saudi Arabia's temperature and draws inspiration from muqarnas vaulting techniques. Ancient isometry and geometric constraints are reflected in the façade's-built geometry. It appears that the earlier muqarnas compositions are not depicted on the front of Muqarnas Tower. Instead, although this pattern has the simplest plan, the Tower's symmetrical design is different from previous designs in that it incorporates triangles with different scales and forms (Figs. 2a and 2b).

Note. Source: (ArchDaily, 2023)

Regular geometric forms are the main constituents of both ancient and contemporary patterns. In contrast to modern designs, which primarily use triangles and rhombuses, historical patterns typically used squares and rhombuses. Therefore, one characteristic of muqarnas patterns is the use of regular shapes as basic elements, in addition to the methods and materials that are peculiar to the area. Nevertheless, several key components of contemporary forms have irregular shapes even when the concept for them is based on a regular shape, or they have been altered to have irregular shapes via generative design techniques and CAD system s.

Methodology

Instruments used in mixed method researches consist of closed ended questionnaire, interviews and observations. These different ways of gathering information can supplement each other and hence boost the validity and dependability of the data.

A- Techniques For Samples and Sampling

A simple random sampling technique was employed. Two types of users; the sample included the experts and visitors. Based on the users level of interest in answering the questionnaire question and interviews questionnaire questions, the sample was chosen. Large samples are frequently employed in descriptive research, and it is advised that they represent 10% to 20% of the population that may be reached. A minimum of 30 participants should also be included in a sample since this number enable the use of big sample statistics, which lower the likelihood of standard error. The objective was found out how they interacted with experts (architects) in Hyderabad totaled 250, thus we chose 58 as our sample size. For visitors in Ghulam Shah Kalhora's' mausoleum Hyderabad totaled thus we chose 30 as our sample size.

B- Research Instrument

Closed ended questionnaire, interviews and observations are the main methods used to collect the data for this study.

C- Collection of Data

For this investigation, both primary and secondary data were gathered. A primary set of data was collected to analyze the impact of muqarnas and its elements adaptability on experts' opinion and their attitude, and visitors' perceptions in Hyderabad. The data collected for the analyzes of adaptation and interpretation of muqarnas theme in contemporary architecture was acquired both through participants' responses to questionnaire survey and observation studies. A secondary set of data was collected via published work, Books, essays, websites, and mor of researchers and scholars provides the awareness of the muqarnas identity and structuralism. To compile the necessary data and analyzed the qualitative statistics collection approach, a quantitative statistics collection method was employed to ascertain the muqarnas adaptation in contemporary architecture.

D- Explanation of Data

The study concentrated on the examination using a mixed-method, qualitative and quantitative that was gathered through carefully chosen tools (Questionnaire and Interviews). A statistical tool is used to examine and understand this strategy further. A descriptive statistical data was collected in google response sheet, the data from interviews and surveys with closed-ended questions was analyzed in MS-Excel 2019.

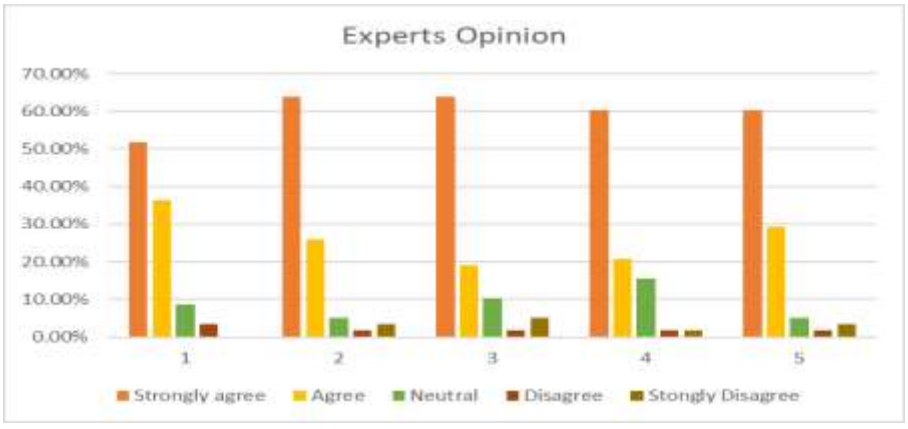
Analysis And Findings

The motive of the questionnaire survey was to inquire into the impact of muqarnas on contemporary architecture and their adaptation to modern design. The survey comprised five simple, easy-to-answer questions. Closed-ended questions were used to quantify the subject. the descriptive statistical analysis approach was used in MS-Excel 2019 software to statistically analyze the data. Table:1 Displays the data analysis of the behavioral responses of experts on the Likert scale of the impact of muqarnas on contemporary architecture and their adaptation to modern design in Hyderabad.

Table:1 Experts' questionnaire response analysis about Muqarnas impact and adaptation to modern design

EXPERT RESPONSES		
Seri 1	Interrogations	Likert Scale Results

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Muqarnas, when incorporated into contemporary architecture, enhance the aesthetic appeal of the design.	51.7%	36.3%	8.6%	3.4%	0%
2	The use of muqarnas in modern architecture adds a sense of cultural heritage and historical continuity.	63.8%	25.9%	5.2%	1.7%	3.4%
3	Muqarnas, when adapted to modern design, create a unique and visually striking architectural feature.	63.8%	19%	10.3%	1.7%	5.2%
4	The incorporation of muqarnas in contemporary architecture allows for a reinterpretation of traditional Islamic design principles.	60.3%	20.8%	15.5%	1.7%	1.7%
5	Muqarnas, when utilized in contemporary architecture, can serve as a bridge between past and present architectural practices.	60.4%	29.3%	5.2%	1.7%	3.4%

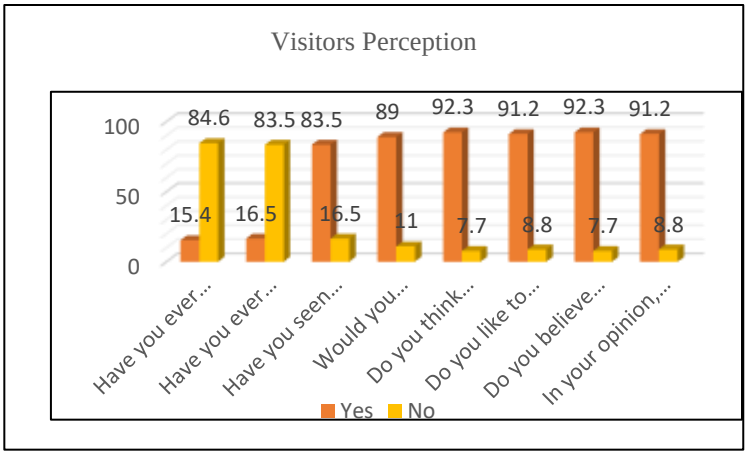


Graph:1 Experts' response analysis about Muqarnas impact and adaptation to modern design

The consequences of the current muqarnas in Hyderabad's building i-e Ghulam Shah Kalhora's' mausoleum were investigated through interviews with visitors. Obtaining a comprehensive understanding of the viewpoints of visitors regarding the muqarnas' integration into modern buildings and society was another goal of the interview. Closed-ended questions were used in the design of the interview questionnaire used a 5-point Likert scale to assess behavioral reactions.

Table:2Interview Questionnaire Response Analysis of Visitors

Interview Questionnaire Response Analysis			
Serial No.	Interrogation	Likert Scale Results	
		Yes	No
1	Have you ever heard of muqarnas before?	15.4%	84.6%
2	Have you ever seen muqarnas?	16.5%	83.5%
3	Have you seen muqarnas in any buildings and structures?	83.5%	16.5%
4	Would you consider visiting a place solely because it features muqarnas?	89%	11%
5	Do you think muqarnas add a sense of beauty and elegance to buildings?	92.3%	7.7%
6	Do you like to incorporate muqarnas and its elements in your creative projects or designs?	91.2%	8.8%
7	Do you believe these muqarnas can create a unique and memorable experience for visitors?	92.3%	7.7%
8	In your opinion, does the presence of muqarnas in a building make it stand out from others?	91.2%	8.8%



Graph:2 Visitors' response analysis about Muqarnas impact and adaptation to modern design

Discussion

The goal of the research was to explore the impact of muqarnas on contemporary architecture and their adaptation to modern design. In order to accomplish this goal, a questionnaire survey with experts and visitors on the relevance of Islamic architectural muqarnas with regards to the impact of muqarnas on contemporary architecture and their adaptation to modern design to was done. The author has become aware of the bond between beauty and perfection, which go together in Islamic art, reflecting the extent of the perseverance of the basic principles. The beauty of architecture is controlled by aesthetic unit, which is one of the most outstanding features of Islamic architecture, define the muqarnas as decorative element. Muqarnas design a process of transformation, and suggests that the freedom of the architect and the artist to create contemporary designs will be aided by finding alternatives to the model (muqarnas blocks), in a way that allows each to be assessed.

correspondingly, to ascertain Hyderabad's expert community's preferences. In order to find out what experts thought about the impact of muqarnas on contemporary architecture and their adaptation to modern design, a survey with multiple choice questions was created. An average 95 percentage of respondents to the subject-specific goal, which was collected through the use of a closed-ended questionnaire, were found to be highly recommended. Similarly, to decide the inclinations of visitors in Hyderabad. A multiple-choice survey study plan to explore the visitor's opinion with respect to these agree around muqarnas noteworthiness on contemporary architecture and their adaptation to modern design, was conducted. A survey carried out reveals that people's awareness of muqarnas is inadequate. Only 15.4% said that they heard of muqarnas whereas 84.6% said that they don't hear of muqarnas. Similarly, when asked that "Have you ever seen muqarnas"? 16.5% of respondent said Yes whereas 83.5% said No. Thus the information was recorded employing a closed-ended survey, the in general result of subject sited objective was found average 93% of respondent were exceedingly suggested.

Recommendation

1- Muqarnas efficiency in terms of constructions, techniques and craftsmanship is widely recognized.
2- The interest in analyzing muqarnas from Islamic art puts artists and architects in the right position to recognize their Islamic architectural tradition, which emphasizes a building's interior design over its exterior, and continues to do this in the present and is likely to do so in the future.

3- It is very important to use technology in creative ways and to build on traditional design elements using scientific technology.

Conclusion

In today's fast-paced world, technology is dictating more and more aspects of our lives and designs. We must adjust to this way of life and design in order to keep up with the rapidly evolving the world, since technology is advancing more quickly than ever and permeating all of our work and creative endeavors. Muqarnas are undergoing changes as well. The muqarnas are under a lot of strain as decorations become outdated. overtime, we need to permit the design of muqarnas to adapt and change alongside us. Otherwise, they would become outdated due to their inability to adjust and be adaptable in response to our changing needs.The research has made it possible to consider many of the concepts and ideas, to communicate with an authentic Islamic architecture's ornamentation history, and to be a witness in Islamic art history. In view of the fact that muqarnas are a living process, this involves growth and change with reference to art and design movements.This study continues to be a bridge between the past, present and future, and a message of goodness of contemporary practitioners and viewers. We require adaptable designs that not only help us but also set the stage for future technological advancements. The need for ornamental patterns that endure change is great for muqarnas. It is our responsibility to appreciate functional decorations and the role they play in design in order to extend their lifespan. The author hopes this research will contribute to muqarnas as an aspect of creative character and how it should be dealt with in a new age of art. The author also hopes to use this experience to contribute to the future well-being of society and culture.

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