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Beyond Beauty, Life and Nature in Nasir El-Molk Mosque, Iran

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Abstract

The morphology of built environments has a significant effect on human well-being. To match the emotional effect of natural environment, architects need to create connections with its stimuli. In Islamic architecture, and due to the strict prohibition of depictions of human and animal forms, geometry was the only appropriate tool to create these connections through tessellations, stalactites, and motifs that cascade without an end. This paper employs Christopher Alexander's 15 properties of Art and Nature as a preliminary qualitative tool for analyzing the visual properties of Nasir El-Molk mosque to measure how far the architects succeeded in creating these connections. A numerical model by Nikos Salingaros was also employed for a quantitative measurement of these qualities. The paper concludes that the building's design was based on a thoughtful process focused on extracting the qualities of *Creation* and reproducing them in abstract compositions to give the building qualities of *Nature* and *Life*.

Keywords Architectural morphology · Nasir El-Molk · Christopher Alexander's 15 properties · Nikos Salingaros's numerical model · Life in buildings

Introduction

Like animals with the instinct for complicated nest-structures, people have an instinct to build things that embody certain qualities. A plausible explanation for the bare look of prison buildings is that they are intended to be perceptually punishing, being at variance with the fact that humans' neural systems are predisposed to processing complex visual information, which are products of internal forces of growth and evolution in Nature, such as expansion, multiplication, division, regeneration, and off-setting. Reduced contact with Nature in the modern world

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may cause people's knowledge of natural shape-grammars to become narrower, which may cause the neurological integration system to become less stimulated and, ultimately, underdeveloped (Joye 2006). From here comes the importance of integrating metaphors referring to natural life and evolutionary processes into contemporary architectural theory.

The discussions about bestowing the criteria of life and nature upon architecture is essential to strengthen the connections between the natural and built environments. More than just creating a utilitarian structure, architects have always striven to approach the intrinsic qualities of natural forms, which all emerge out of geometric codes. *The Phenomenon of Life* by Christopher Alexander discussed at length how art could be given life by certain morphologies that interact with each other "to create a scientific view of the world, in which the idea that everything has a degree of life is well-defined" (Alexander 1997: 32). He developed 15 geometric properties that can be used to compare and relate works of art to works of nature.

By analogy to basic physical principles, Nikos Salingaros also obtained three laws of architectural order that apply to both natural and man-made structures and may help to create buildings that match the emotional comfort and beauty of natural environment, although not its exact shapes (Salingaros 1995). He created a numerical model, inspired by both the rules of thermodynamics and the notions of Christopher Alexander to evaluate the intrinsic qualities of life in buildings.

Historically, Islamic art and architecture were developed as visual tools for contemplating the underlying geometric nature of the universe (Dabbour 2012). The basic difference between Islamic art and the other artistic styles is the strict prohibition of the depictions of human and animal forms, i.e., living creatures. The question that faced Muslim artists was then how to celebrate God's creation in nature, without direct depiction of figures; how can they put an image of creation into a building, apart from figurative icons and statues? They found the answer in geometry with its intelligible aspects that possess both abstraction and a capacity to express and reveal objectively immutable and spiritual issues through ratios such as the golden mean and roots of integers, which were considered to be the foundations of natural beauty, or the principles of creation. Geometry and proportions have been employed to represent the order of the cosmos since pre-historic eras. Muslim artists developed this technique to create a pattern language based on what they thought to be the essential harmonies of nature, together with various symbolic meanings and theories of perfection, where rules of evolutionary processes such as symmetry, rotations, reflections, and fractals were dominant.

Among the Islamic architectural monuments of Iran, the mosque of Nasir El-Molk is one of the most important mosques of the Qajar dynasty (1876–1888) and one of the most visited sites in Iran (Akbarzadeh et al. 2019). Bright colorful designs distinguish this mosque from traditional Persian architecture of the thirteenth and fourteenth centuries, which were dominated by monochromatic decorations of blue and turquoise colors. Built at the peak of the westernization movement of Iran, Nasir El-Molk stands apart with its stained-glass windows (*Orsi*), colorful tiles, and the unique employment of light and colors (Ehteshami and Soltaninejad 2019).

In spite of the uniqueness of the mosque and its "outstanding features" as described by Nizamoglu (2014), which also led Moayed (2020) to call it an "architectural phenomena" reflecting "Persian style of paradise", and Fallahi (2020) to call it a "revolution in Islamic architecture", very few studies about the patterns and details of this mosque are available, especially in English. Most of the studies about the mosque are focused on the fascinating lighting treatments in the mosque, such as the studies by Nejad et al. (2016) and Matracchi and Habibabad (2021). Shooshtari et al. (2019) studied the language of architecture in the mosque, among other mosques, where meanings and metaphors were investigated at the semantic level. Another study by Sadeghi et al. (2018), studies place making in the Iranian city, and the influence of the presence of mosques in the fabrics of the neighborhoods of Islamic cities in Iran, where Nasir al-Molk Mosque was one of the examples discussed in the paper. Ehteshami and Soltaninejad (2019) and Akbarzadeh et al. (2019) are perhaps the only papers that contain partial references to the details of the mosque, but mostly from a functional perspective from the viewpoint of Islamic religion. However, while the former presents a positive opinion about the "innovative" design and details in the mosque, the latter talks about the "likeness to non-Muslim patterns" as a negative aspect. Yet, the authors did not deny the "originality" of the design and that it has "distinctive features". Patterns and details, however, are not the main issue of criticism in the paper; rather it is the the layout itself, where "the division of the prayer hall into eastern and western parts, and the aberration from the axis of the *qibla*, contradict the rules of prayer hall design in Islam". The authors, although they find that "the extensive decorations, using signs and patterns of imported architecture" reduce the worshipability of the mosque, they still find that "the effect of these features enhances the mosque's exhibitive capabilities" and admit that it is "one of the most visited sites in Iran" (Akbarzadeh et al. 2019: 57).

Called a "mosque with soul" (Fallahi 2020), this present paper analyzes the design features of this building from the perspectives of the philosophy of geometry, where geometry acted as the vocabulary underpinning a pattern language of life and nature. The aim is to study the design formalism of the decoration of the mosque, using a mixed method that incorporates both morphology and mathematics, employing Alexander's properties for the former and Salingaros's numerical model for the latter, to investigate and analyze the visual properties of the building. Unlike the previously mentioned studies, this paper does not discuss the general layout of the building or the functional arrangement of its internal spaces. It is rather focused on the patterns of the designs and the logic behind them, in order to introduce a new understanding of these designs, which were, at the time of the building and even now, unusual in Iranian architecture. The paper assumes that it is not only the lighting system, but also the properties of life that these patterns bestow upon the architecture of the building that inspire the great admiration that visitors have for this comparatively small and simple building, in comparison to other mosques in Iran. In a trial to prove this assumption, the study utilizes an innovative two-fold evaluation process, where both qualitative and quantitative measures are used, for the first time together, to evaluate the qualities of life and nature in the mosque. A comparative analysis, applying the same measures to other mosques of the same era in Iran, is also performed for further investigation of the style in general.

The goal of this analysis is to provide a different understanding of a historical Islamic monument based on the philosophy of geometry and morphology, as an alternative to the conventional formal understanding of this style. Studying the criteria of life and nature, as seen in one of the perfect works of the Qajar era in Iran, may help to enrich our knowledge of this style on a creative, emotive, and epistemological basis and help to engage it in contemporary design theory. It also sheds the light on the importance of geometry in architecture as the basic tool of design for both functional and emotional issues, where historically, architects were either mathematicians (i.e., geometers) or in any case concerned with learning new patterns and understanding how to develop new algorithms, while today, the powerful relationship between geometry and architecture is at risk of being lost.

Theoretical Background and Methodology

During recent decades, different definitions have evolved in the still ongoing debate to answer the question of "What is Life?". Famous thinkers such as Erwin Schrödinger (1944), Maturana and Varela (1980), and Margulis (2000) have all dealt with this question, coming to a set of criteria that an organism must meet in order to be called "alive": order, propagation, growth/development, energy processing, reactions to the environment, homoeostasis, and evolutionary adaptation (Campbell 2000).

Expressions such as "life in architecture", or "living architecture" are commonly used in reference to high quality architecture that is more agreeable to occupants and better integrated to its environment. And although some criteria of life may exist in architecture, not all of them could be ever found in one project. So, it can be definitely said that architecture is not alive, and is not going to be in the near future. However, and by considering the attempts towards intelligent and interactive buildings, it can be also said that the actual quality of "aliveness" is not always appreciated by users, who see their power to control their environment endangered by this idea. For both users and architects this might be a "scary feeling" because, if architecture is really alive, they would have to deal with threats of failures, decay, and death (Gruber 2008). So, the idea of life in architecture must have a different notion, providing a means to talk about certain qualities or values, apart from biological aliveness. Looking at nature for inspiration, characterizing living systems and trying to interpret certain "signs of life" in the context of architecture, are possible notions to fulfill this demand.

In addition to pure biology and biomorphology, such as bionic, biomimetic or biomorphic approaches, which are still important fields of study, an increasing number of indirect approaches for incorporating some criteria of life and nature into an architectural language came with more inventive results. In *Nature and Architecture*, Portoghesi (2000) compiled an extensive summary of the different attempts, where going beyond the mere translation of form is the real challenge of architectural design. Anthropomorphism, or the use of the human body as a metaphorical and symbolic referent, has provided what is perhaps the most prolific trope for architectural theory since the writings of Vitruvius. The image of the

"Vitruvian man" took on particular significance during the Renaissance, when the human body, as a microcosm, was the means for representing the order of the cosmos as a whole (Drake 2003). Organic architecture, represented by Frank Lloyd Wright, was another major threshold, making use of natural geometries such as spirals to translate biological to technical functional compartments. The "Gaia Charter" by Pearson (2001) proposed a list of criteria to define organic architecture, by which architecture may integrate into nature and be part of it. Pearson and other influential organic architects further streamlined or fine-tuned these principles into the following principles; inspiration; growth and evolution; rhythm and repetition; flexibility and fluidity. In another attempt to depart from the mere formal approaches to mimicking the laws of nature, the so-called "Natural Constructions" by Frei Otto and his group in the 1960s took a more technical approach, using analogue models to find the form of a building in relation to the flow of forces.

More recent developments in architecture started to employ psychological approaches to enhance the human connection with the universe by introducing cosmic ordering systems into architecture (Jencks 1997). These approaches claim that the agreeability that people perceive in nature has causes at different levels, notably in the geometry and mathematics that govern what patterns can physically form. The biosemantics approach in the 1990s, which proposes the semiotic character of life, characterized by processing of signs on all levels of animate nature (Hoffmeyer 1997) and the Biophilic architecture by Kellert (2008), which suggests specific architecture strategies as means to establish connections with inborn human affiliations, are both remarkable approaches in this direction. Geometrical features of biological forms such as fractals, scale-invariance, as well as some sophisticated notions of symmetry, self-similarity, and complex hierarchy are proposed as primary formats to indirectly connect people to patterns and features of natural elements (Ramzy 2015a).

One of the most prominent tools for activating the potentials of life and nature in architecture is geometry, which was seen as "the keeper of the living earth" (Tyberonn 2007) since ancient times. It was used in Gothic architecture as a visual tool to contemplate the formal properties of the universe and was directly linked to the Divine, as illustrated in the famous painting of *God the Geometer* (Ramzy 2015b). In Chinese culture, geomancy is the art of placing objects, and has been used recently by contemporary architects and planners to gain harmony between people, buildings and environment. Schlosser (2017) describes it as "fundamental design principle in a new earth to help developing the man-made environments to reach their full potential as sustainable life-enhancing environments". Other geometric applications are "Ley lines", "song lines" or "dreaming track", which are several names for energetic grids and intersecting nodes that are suggested as acupressure points, performing functions similar to energy channels. BioGeometry is another form of endowing architecture some qualities of life through geometry, where "BioGeometry Signatures" are linear diagrams suggested by Ibrahim Karim as a means to help balance the subtle energy of body organs through "resonance" of shapes (Gin 2015).

One of the most prominent attempts to formally recognize the links between biological and architectural life is that of Christopher Alexander, who proposed a set of geometrical rules to govern architecture, derived from both biological and physical principles. They are based on the hypothesis that matter obeys a complex order on the macroscopic scale and that architecture can be reduced to the same set of formal/geometrical rules that are akin to the laws of physics (Alexander 1997). These rules are supportive of life and growth and are all based on geometry, emphasizing the fact that the concept of life does not necessarily mean "creatures" in a biological sense, but rather "creation" in a broad sense, such as waves and fire that have some degree of life. Considering these principles, one may easily recognize that most of the afore mentioned "criteria of life", such as order, propagation, growth, development and evolutionary adaptation are applicable in them.

But, in spite of all the above mentioned attempts to connect architecture to the criteria of life, very few attempts had been made to quantify these criteria in architecture, whereas they have always been considered qualitatively. A numerical model was developed by Salingaros (1997) to make the relevant visual properties of buildings measurable by developing a connection between biological life and architectural forms that arise from the thermodynamics of living forms. In physics, thermodynamics is the branch that studies how thermal energy is converted to and from other forms of energy and how it affects matter. The architectural temperature (T) is defined as the degree of detail, curvature, and color in architectural forms, while the architectural harmony (H) measures the degree of coherence and internal symmetry. Salingaros's model predicts the building's emotional impact and how much life (*L*) a building has by multiplying the temperature (T) by the harmony (H): $L = T \cdot H$. Further, the perceived interest of a design—complexity (C)—is measured by calculating $C = T(10 - H)$.

The computed values of L and C in any building correspond directly with what is emotionally perceived by people, based on the intrinsic qualities of architectural forms and the subconscious connection they establish with people, independently of whether they may like it or not. In this context, life (L) refers to the degree that one connects with a building in the same way that one connects emotionally to trees, animals, and people, while complexity (C) is understood to essentially refer to the organization of elements in architectural forms and how far they correspond to the organization of matter in living forms. It is the complexity of an object that arouses the viewer's interest as an inverse measure of how boring a building is.

The study in this present paper utilizes a mixed method that employs both Alexander's qualitative/geometric analysis and Salingaros's quantitative model in two sequential phases to evaluate the visual properties of Nasir El-Molk mosque and how much life it contains: first, by testing its morphological qualities against Alexander's 15 properties of art and nature, to describe its formalism and explore the representational codes of life in its design; second, by measuring it against the Salingaros model to acquire numerical measurements of these properties. This dual methodology is meant to establish a connection between intuitive visual qualities, based on feelings and perception, and scientific quantities, based on numerical measurements. The same measures are used then to evaluate four other mosques in Iran that also date to the Qajar Dynasty, in order to compare the qualities of life and nature in these four mosques with those of Nasir El-Molk, for further evaluation to the qualities of the building.

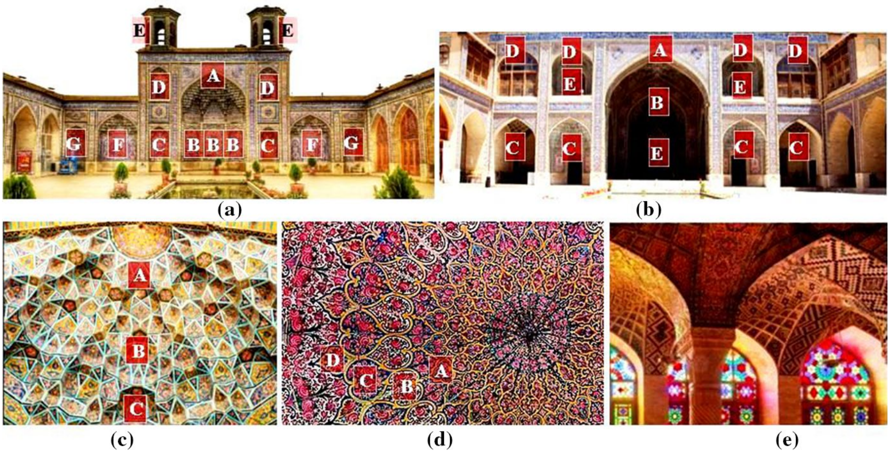


Fig. 1 Levels of scale

Testing the Building Characteristics Against Alexander's Properties of Nature

In the following is a short summary of Christopher Alexander's 15 properties that buildings should possess in order to have life, and how far the design of Nasir El-Molk and its visual characteristics fulfilled each of them.

Levels of Scale

Levels of scale should exist along with a scaling hierarchy. Repeating components of the same size and similar shape define one scale. They have to be spaced closely enough in size (magnification) for coherence, but not too close to blur the distinction between nearby scales (Alexander 1997). A mathematical rule generates a distribution of scales via the logarithmic constant $e \approx 2.7$ and the Fibonacci sequence (Salingaros 2012).

The fronts of Nasir El-Molk, inside and outside, are all good applications of this rule. For example, the main façade (Fig. 1a) is composed of a large arch (A), containing three smaller arches (B), with two smaller arches on the sides (C), surmounted by two other smaller arches (D). At the top of the whole composition are two minarets containing two smaller arches (E). On either of this main gate are two relatively large arches (yet smaller than the main one) (F), followed by smaller arches (G), etc. The other fronts also have similar compositions (Fig. 1b).

The same thing could be said about the ornamentation. Figure 1c shows the stalactites on the upper part of the portal, where one may easily recognize repetitive pentagrams of different sizes. Distantly, it is easy to observe the big and small swells and various darkness and lights, which has been created by playing with the volume. Repetitive heart shapes and four-sided diamond shapes are also shown in Fig. 1b, e. As the visitor draws closer, finer layers are seen from these ornaments.

Fig. 2 Strong centers (implied centers)

Strong Centers

Strong centers are formed when a substantial region of space is tied together coherently. In physics, electric, magnetic, gravitational, and nuclear forces are carried by spatially symmetrical fields, thus most often creating centrally and bilaterally symmetrical structures (Alexander 1997). There is often a principal strong center in a whole, where smaller centers support each other on every scale in a recursive hierarchical property. It is useful to distinguish two types of centers: "defined" and "implied". A "defined" center has something in the middle to focus attention, while an "implied" center has a boundary that focuses attention on its empty interior. Each center combines surrounding centers and boundaries to focus on some region.

In Nasir El-Molk, both kinds of centers are to be found. The façade in Fig. 1a is a "defined center", while the one in Fig. 1b is an "implied center". "Defined centers" are also easy to recognize in different ornaments, especially in the roofs (Fig. 2), where the "recursive hierarchical property" (Alexander 1997) of strong centers are easy to recognize everywhere.

Thick Boundaries

Thick boundaries in nature evolve as a result of the need for functional separations and transitions between different systems; wherever two different phenomena interact, there is always a "zone of interaction", which is a thing in itself (Alexander 1997). According to the scaling hierarchy, a thick boundary arises as the next scale smaller than what is being bound. An "implied" center is defined only through its own thick boundary. Therefore, thick boundaries play a focusing role as well as a bounding role.

In Nasir El-Molk, strong boundaries surrounding all major elements, or centers, are to be noticed at the first glimpse. This includes architecture elements, such as portals and arches, as well as ornamentation and decorative elements (Fig. 3). The façades are completely covered with tiles, with wide bands of tiles as boundaries between arches and strong projecting edges as frames. The tile bands around the main portal are extended by short minarets. Horizontal bands of calligraphy form the upper boundaries of the façade's skyline. The same thing could be said about decorative elements (Fig. 3).

Fig. 3 Thick boundaries

Fig. 4 Alternating repetition. Images: author, except bottom left image taken by Maite Elorza, licence CC BY-NC-SA 2.0, overlay by the author

Alternating Repetition

Alternating repetition helps in the informational definition of repeating components. Contrast, acting together with repetition, reinforces each component through alternation that help to better define essential translational symmetry (Salingaros 2011). In nature, the repeating units in most cases alternate with a second structure, which also repeats. When atoms repeat, so do the spaces which contain the electron orbits; when waves repeat, so do the troughs between the waves; as mountains repeat, so do the valleys (Alexander 1997).

In Nasir El-Molk, the western prayer hall has two rows of columns with twenty-one vaults. The seven vaults in the middle have different design than the vaults on the sides (the two designs are shown in Fig. 2). Alternating repetition is also seen in the alterations between (A), (B) and (C) color-compositions of the *Orsi*, Persian stained-glass windows that are a combination of wood and brightly colorful glasses, in the western hall (Fig. 4a).

Islamic geometric patterns are generally dominated by four characteristics: symmetry, interlacing, unboundedness (infinite expansion), and flow. They normally consist of a repeated unit, which is the polygon that holds the base

Fig. 5 Positive space

geometry, and a repetition structure, which is the product of systematically repeating this unit to fill the space (Abas and Salman 1995). Within the repeat units, symmetries occur as the repeat units are populated by smaller units used to fill the repeat units. This type of alteration appears in the repetition of the triangles and hexagons in the compositions of the *panj kāseh-i* (five-concaves roof) of the ceiling in the Pearl Iwan (Fig. 4b) and in the different ornamental compositions of the glazed tiles (Fig. 4c) and the *Orsi* windows, where four colors—blue, red, green and yellow—are alternatively repeated in their design. It also appears in the overall designs of vaults and arches (Fig. 4d).

Positive Space

Positive space is necessary to preserve the wholeness of the system. In the majority of naturally developed systems, the shape of the form and the spaces between the forms are equally important. Not only buildings but also the spaces between them should be well shaped and well proportioned. A ratio of 2:3, tends to lead to a good design (Alexander 1997).

In Nasir El-Molk, one can immediately notice an undeniable effort that was taken to compose "positive spaces" that properly unify the basic elements into a well-shaped whole. The basic shapes in the mosque are obviously the arches, between which a variety of geometric patterns and tessellations had been introduced to create high level of synchronization and coherence between the different elements of the whole (Fig. 5). The ratio between the sizes of the arches and those of the spaces between them is also rather pleasing and lies within the limits of 2:3 as defined by Alexander.

Good Shape

Natural systems have a tendency to form closed, beautifully shaped figures that are made up from multiple coherent centers. Good shape arises when symmetries reduce the information overload. "Good" means "easily graspable", satisfying the brain's innate need to compact information. Shapes that are not easily represented strain mental computation; hence they induce anxiety (Alexander 1997).

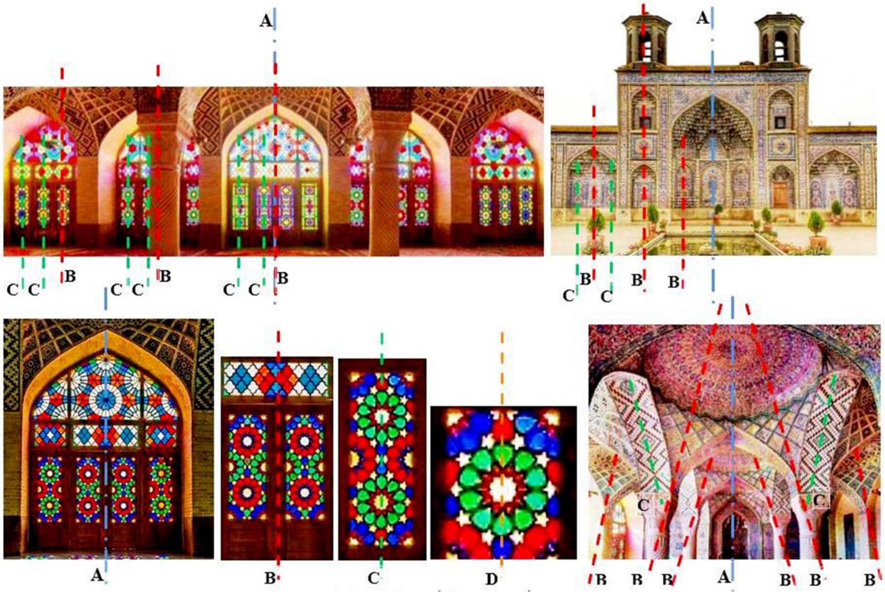


Fig. 6 Local symmetries

According to this definition, the architectural composition of Nasir El-Molk mosque has “good shape”. As previously discussed, the building contains a lot of strong centers and symmetries that make each front and each “snapshot” of the building “easily graspable” as defined by Alexander. In Islamic architecture, symmetry and standardization is dependent on a basic unit, known as a “cell” or “seed”, and a breakdown of patterns born from repeating this cell. Four-, five-, and six-pointed geometries, such as those used in Nasir El-Molk, are also the most common in nature and, hence, they are easily graspable for the human brain.

Local Symmetries

Local Symmetries are symmetries within the scaling hierarchy. They occur in nature because there is no reason for asymmetry; an asymmetry occurs only when it is forced. Symmetries must act on every distinct scale; it does not mean overall symmetry on the largest scale, but rather multiple hierarchical sub-symmetries nested within larger symmetries (Alexander 1997).

In Nasir El-Molk, each and every surface exhibits local symmetries, illustrated by axes A, B, and C in Fig. 6. In general, the base of each pattern (the previously mentioned cell or seed) in each front/surface is symmetrical shape (star, diamond shape…etc.) (D), each group of shapes are then included in symmetrical panels/surfaces (C). These panels/surfaces are then symmetrically arranged around local axis (B), where the whole composition is also symmetrical around the main axe of the front (A). The *Orsi* windows in the western prayer hall are one of the most

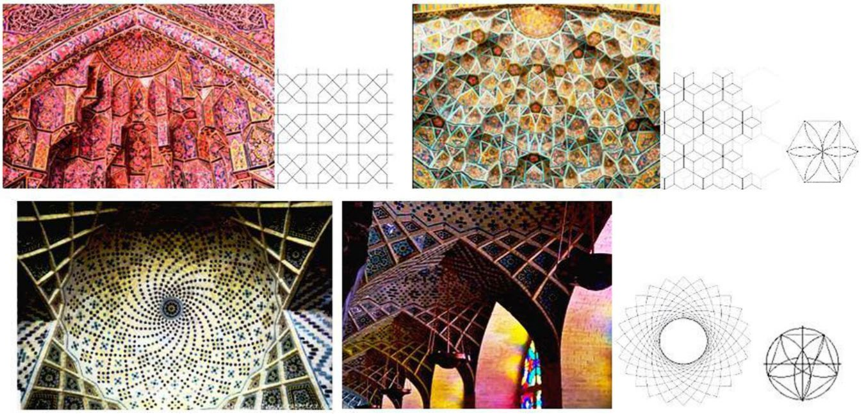


Fig. 7 Deep interlock and ambiguity with proportions of $\sqrt{3}$ (hexagon), the golden mean (pentagon and vesica pisces)

obvious applications of this concept in the building. This type of windows appeared in Iran during the *Safavid* era and became dominant in the mosques of *Qajar* era. Connecting the interior to the courtyard, the seven openings create a key feature engendering colorful light in the interior. The geometric shapes of the windows are formed of cascade of bilateral symmetries of star shapes, as shown in Fig. 6, but with alternating colors.

Deep Interlock and Ambiguity

Deep interlock and ambiguity are strong means of connection in natural systems. An analogy comes from fractals, where crinkled lines tend to fill portions of space, and surfaces grow with accretions. Two regions can interpenetrate at a semi-permeable interface, which enables a transition from one region to another. Abrupt transitions such as a clean straight line, however, do not bind objects coming up to each other (Alexander 1997).

In Nasir El-Molk a high degree of interlock and ambiguity is seen in the connections between the roofs and the walls. Stalactites, three-dimensional ornaments that extrude horizontal layers of patterns that serve as a transition from the walls of a room into a domed/vaulted ceiling, with geometric knot-like patterns known as *Girih* or hexagon-patterns and tessellations of diagonal lines that overlap to create diamond-shapes (lotus flower patterns) are the most dominant shapes (Fig. 7). Another shape of interlock and ambiguity appears in the upper parts of the *Orsi* windows (Fig. 6).

Contrast

Contrast is necessary to establish distinct subunits and to distinguish between adjoining units. Almost all natural systems derive their organization and energy

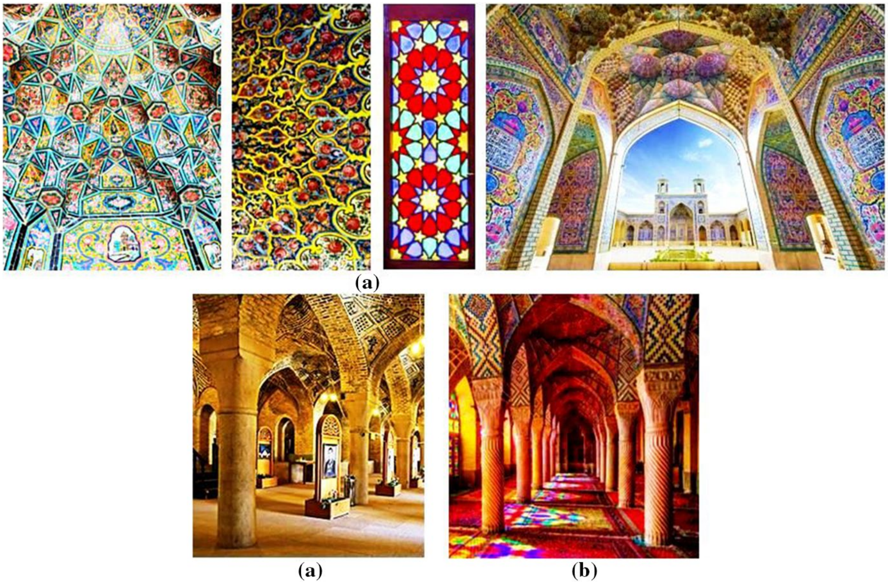


Fig. 8 Contrast of colors and texture

from the interaction of opposites; particles/antiparticles and positive/negative electric charges are some examples (Alexander 1997). Contrast is also needed to provide figure-ground symmetry of opposites; strongly contrasted regions can be strongly connected. An example of weak (ineffective) contrast is inside spaces and outside spaces separated by a glass curtain wall.

In Nasir El-Molk, there are multiple types of contrast; three of them are really effective. The first is the contrast of light. A special feature of Iranian architecture in this mosque is the unusually long *hashti*, or hallway, which is a rather dim space. After passing through it and by entering the courtyard, one is amazed by the grandeur of the buildings' fronts under the sunlight (Akbarzadeh et al. 2019). This contrast appears again between the glowing light in the courtyard and the dim colorful light inside the in the *shabestans*, or prayer halls.

The second is the contrast between warm and cold colors. The beautiful mixture of blue, pink, and yellow colors in the tile works of this mosque is not found in any other mosque in Iran, which is well known for the extensive use of blue and turquoise colors in its traditional architecture. The introduction of warm colors is characteristic of the architecture of the *Qajar* dynasty as a result of the aesthetic influence of westernization. It was actually for the first time in this mosque that Iranian designers used pink color (Pedram et al. 2017). This strong contrast of rich and bright colors appears here as complementary and balancing, as they are used in small interlacing areas that as loudly contrasting (Fig. 8a).

The third type of contrast in the mosque is contrast of texture. Unlike the extensively decorated western hall with its smooth colorful surfaces, the walls of the eastern hall are covered by monochromatic brick, and the ceiling is also covered by

(a) (b)

Fig. 9 Gradients

a combination of tiles and brick of neutral colors known as *maqeli* tiling. Even the stone columns in the eastern hall are flat and deprived of carvings like those found on the columns of the western hall (Fig. 8b). In general, the eastern hall is smaller than the western, with 7 columns in the former and 12 in the latter.

Gradients

Gradients represent controlled transitions. The designer should not divide a form into discrete pieces, but must instead transform it gradually. In nature, each time a quantity varies systematically through space, a gradient is established. For instance, as one climbs a mountain, trees become more thinly spaced, giving way to grass and then to rocks, and then to rocks and ice (Alexander 1997).

In Nasir El-Molk, ornaments were used for creating gradual transitions, but not on all surfaces. Diagonal lines that overlap to create gradual diamond-shapes (Lotus flower patterns) are used in most of the transitional areas between the surfaces (Fig. 9a). Yet, some transitions are sudden and display no gradients, for example the transition between the patterns of inner surface of the arch and the capital of the column (Fig. 9b).

Roughness

Roughness, or irregularity, is pervasive in natural systems. A deliberate roughness should be sought in order to avoid monotony. Adaptation to local conditions creates roughness, since it breaks regularity and perfect symmetry. It appears as a result of the interplay between well-defined order and the constraints of three dimensional spaces (Alexander 1997).

According to Salingaros (1997), calligraphic script in Islamic buildings provides the small-scale randomness necessary to contrast with the large-scale symmetry (Salingaros 1997). In Nasir El-Molk, the main entrance is completed with a copestone with azure tiles and *Tholoth* script. At the top of the stone frame, there is a small inscription of *Nastaliq* calligraphy for a poem by Shurideh Shirazi and the date of writing. At the bottom is another one and the name of the architects.

Fig. 10 Echoes

As for larger-scale roughness, the building has two *iwans* in the court facing each other, with two different designs and different types of vaulting (Fig. 1a, b). The northern *iwan* is called the Pearl Iwan due to its distinctive vaulting (the *panj kāseh-i* mentioned earlier), which look like pearl shells. The southern *iwan* is distinguished by two minarets and a vault with unique design of stalactites and tile work.

The two entrance porches of the mosque are also asymmetrical. The main entrance leads to a large *hashti* that consists of two parts; the first has an irregular, almost hexagonal design, where the second is rectangular, leading directly to the court. The second (lateral) entrance leads to a perfect rectangular porch that leads to an arcade in front of the eastern hall (Ehteshami and Soltaninejad 2019). Entering the courtyard, the eastern wall also differs slightly from the western wall. Geometrically, the two walls are symmetrical, but instead of eight openings leading directly to the western hall, there is an arcaded space in front of the eastern hall.

Echoes

There are two types of echoes in the design: first, translational symmetry, where similar forms found on the same scale but are shifted by some distance; second, scaling symmetry, where similar forms existing magnified at different scales. Mathematical fractals are exactly self-similar, but all natural fractals obey only approximate or statistical self-similarity; they are not exactly the same when magnified, but are only "echoes" (Salingaros 2010).

In Nasir El-Molk both kinds of echoes exist. Arches, (the main elements) are echoed in both directions (side by side or parallel to each other) all over the building. Ornaments and geometric shapes, such as star shapes and diamond shapes, are also echoed all over the building both on the same scale and at different scales (Fig. 10).

The Void

Centers are intensified by the existence of an empty center. It is not possible to fill in the entire surface with detail. In "implied centers", a complex boundary focuses on the open middle, that is, the void (Fig. 11). Therefore, an empty portion is necessary to balance regions of intense detail (Alexander 1997).

Looking at the overall composition of the mosque of Nasir El-Molk, it is clear that without the arches, which compose the voids that generate the centers of interactions of the smaller structures, the design would break down into a chaotic collection of bits and pieces.

Fig. 11 Voids

Looking at the two portals on the sides of the court, as the most significant voids in the whole composition, it is easy to recognize that what differentiates them from other openings (voids) is not only the shape and size, but depth and details that make them distinctively identified.

Simplicity and Inner Calm

Each configuration occurring in nature is the simplest one consistent with its conditions. For example, a typical three-dimensional form of a leaf is the structure of least weight for a cantilever supporting a uniformly distributed load (Alexander 1997). Balance is achieved by an overall coherence and lack of clutter. Coherent design appears effortless (but is in fact very difficult to achieve). Simplicity in nature is never actually “simple” in the sense of being minimalist; it means extremely complex but highly coherent. A system appears “simple” to us because it is so perfect.

In Nasir El-Molk, is spite of the extensive use of ornaments and patterns all over, the design itself is quite simple, forthright, and coherent. The clever use of daylight (Figs. 8, 10) also adds a feeling of inner calm. The exterior fronts exhibit even more simplicity and coherence than the interior surfaces.

Non-separateness

Non-separateness comes after achieving coherence; it corresponds to the fact that there is no perfect isolation of any system, and that each part of every system is always part of the larger systems around it and is connected to them deeply (Alexander 1997). In a larger coherent whole, no piece can be taken away. When every component contributes to a coherent whole, nothing looks separate, and nothing draws attention to itself.

This rule applies perfectly in Nasir El-Molk, where one cannot see any individual component that draws attention to itself; there is no central piece in the whole composition, but actually each surface of the building is composed of complementary elements that are composed in a specific rhythm and order. If any

Fig. 12 Well-defined detail (T1). Images: author, except photo left by Joan Simon, license CC BY-SA 2.0

element were taken away from any surface, the whole composition would look incomplete.

Values of Temperature (T) and Harmony (H) in Nasir El-Molk

In this section the values of temperature and harmony in the building according to Salingaros's model will be calculated. The model examines how small and large scales contribute to the success of a building independently. Small-scale structure is described by what is labeled architectural temperature (T); the higher the temperature, the more differentiations, curves, and color. Large-scale structure is identified with the degree of symmetry and coherence of forms and is labeled architectural harmony (H).

Values of Temperature in Nasir El-Molk

Salingaros proposes a simple method of measuring temperature through five elements: textural differentiations (T1), density of differentiations (T2), curvature (T3), rich color (T4) and contrasting colors (T5) that contribute to a total value of T. Each quality is measured on a scale of 0 to 2 according to the scale: very little = 0, some = 1, considerable = 2.

Textural Differentiations (T1)

Detail must be articulated against the ground.The limit of perceived textural differentiations at arm's length is roughly 1–5 mm. Well-defined detail in those surfaces that a person can touch, regardless of whether it is localized or spread over the entire region, makes T1 equal 2. Coarser, or less sharply-defined detail rates T1 = 1. For detail that is too small or is faintly-defined, T1 = 0. Smooth or textured monochromatic surfaces rate a 0.

Fig. 13 Differentiation or texture in black-and-white photograph (T2). Images: left, author; right, photo by Maite Elorza, license CC BY-NC-SA 2.0

In Nasir El-Molk there are no smooth or monochromatic surfaces; roofs, walls, columns, even Orsi windows are all ornamented with richly colorful, well-defined, protruding patterns, with obviously generous cut-offs of more than 5 mm per arm. Even tiled surfaces are not flat, but rather slightly convex at the middle (Fig. 12, left). The spiraling columns, the textured fractal stalactites, the colorful geometric patterns,… etc., all dazzle the eye with overwhelming beauty and complexity.

Result of the evaluations of textural differentiations in Nasir El-Molk: T1 = 2.

Density of Differentiations (T2)

Here, every geometric differentiation is treated as having the same effect as a greyscale surface design, i.e., T2 of a colored relief is judged from its flat black-and-white photograph. In this two-dimensional projection, any differentiation or texture is perceived in terms of its contrast in color value, or by the shadows it casts. A high density of sharp differentiations rates $T2=2$, whereas a plain surface rates $T2=0$. The color value itself, which represents a particular shade of grey, doesn't contribute to $T2$.

The interior of Nasir El-Molk is a fascinating interplay of lights and shades. Inside, the mosque shows rows of finely carved pillars. Arches and ceiling are decorated with sophisticated textured patterns that give a sense of depth and are visually pleasing. The two-dimensional projection and the sharp differentiations of surfaces appear clearly in the black-and-white images of both interior and exterior surfaces of the mosque (Fig. 13). Most of these differentiations are sharp enough to be perceived from a distance of 2 or 3 m.

Result of the evaluations of density of differentiations in Nasir El-Molk: T2 = 2.

Curvature (T3)

An inflected curve (for example, a higher-order polynomial) or zigzag has a higher structural temperature than a straight line. The temperature is proportional to the curvature of forms. Curves on the intermediate scales rate T3 = 1. If they have a high degree of curvature, T3 = 2. Straight lines and rectangular forms rate T3 = 0.

As for Nasir El-Molk, Figs. 8, 10, and 11 show an organic complex of curves in the mosque, both in the architectural elements themselves (arches and columns) and in ornaments and patterns.

Result of the evaluations of Curvature in Nasir El-Molk: T3 = 2.

Rich Colors (T4) and Contrasting Colors (T5)

A richly colored building, even if it is of one hue, has a higher temperature than a grey building (for which T4 = 0). A design will have T4 = 1 if it has some color overall; an intense though not necessarily bright color gives T4 = 2. The actual hue (yellow, green, or purple) is immaterial.

Architectural temperature is further increased by contrasting color hues, for example, the placement of red next to green. If there is any contrast in color hues, T5 = 1; if there is a great variety, or the contrast is particularly vivid, T5 = 2. A uniform color or no color at all results in T5 = 0.

As discussed before in Sect. 3.9, the building of Nasir El-Molk is rich with colorful surfaces; the combination of colorful glass and the reflection of sunrays on the floor, make the western prayer hall of the mosque unique from all other mosques in Iran, where ornaments colored with yellow, blue, red, and most specially pink, are the most dominant feature of the building. Thus, visitors have given the building different names: Pink Mosque, Rainbow Mosque, and Kaleidoscope Mosque.

Result of the evaluations of Rich Colors in Nasir El-Molk: T4 = 2.

Result of the evaluations of Contrasting Colors in Nasir El-Molk: T5 = 2.

Values of Harmony (H) in Nasir El-Molk

In Salingaros's model "randomness is measured by the entropy", the measure of a system's thermal energy per unit temperature. Because entropy is not an intuitive concept, he introduced architectural harmony (H) to measure the lack of randomness in design (Salingaros 1997). Harmony is a property of the whole structure, due to the correlation between the parts on all the distinct levels of scale.Where individual details and shapes relate to each other, architectural harmony is high.

The model depends on direct measurements from perceivable architectural surfaces and forms, i.e., walls, doorways, passages, etc. Symmetrical forms and patterns have a higher degree of harmony. When thinking about symmetries, many immediately look at a building's plan. But, as the plan is not directly perceivable to the users, it is irrelevant to this model, as the model doesn't cover the formal organization of spaces, only the immediate impressions from a human viewpoint (Salingaros 1997).

The architectural harmony (H) ranges from 0 to 10. It is decomposed into five components: vertical reflectional symmetries (H1), translational and rotational symmetries (H2), self-similarity (H3), geometrical connections (H4), and color harmony (H5). Each of these can assume a value from 0 to 2.

Vertical Reflectional Symmetries (H1)

An average numerical value has to be assigned for the presence of symmetries on all scales, not just for the largest scale. The quantity H1 depends on the orientation of the symmetry axis, because gravity defines a preferred direction for both man and materials. Of the possible axes for reflectional symmetry, the vertical one raises the architectural harmony the most. Symmetry about a diagonal axis clashes with natural symmetries created by gravity. Lack of reflectional symmetry on different scales rates H1 = 0.

In Islamic architecture, symmetry is seen as a reflection of the natural symmetries found throughout nature and a symbol of the universal balance (Dabbour 2012). As mentioned before, in Nasir El-Molk, each and every surface exhibits different kinds of symmetries on different scales (Fig. 6). All the fronts of the building are bilaterally symmetrical, consisting of smaller elements that are also symmetrical. For windows, arches, vaults and ornaments bilateral symmetry is dominant on all surfaces. For the roofs, radial symmetry is the rule.

Result of the evaluations of vertical reflectional symmetries in Nasir El-Molk: H1 = 2.

Translational and Rotational Symmetries (H2)

The quantity H2 measures translational symmetries (and the less common rotational symmetry) not on a building's plan, but on walls, doors, and windows. If elements are repeated regularly, then H2 = 2. In plain surfaces with no distinguishing elements, H2 is defined by the edges; if they are parallel, then H2 = 1. Elements repeated randomly lower H2 to 0.

Islamic decoration is based on the concept of repetitive pattern, in all directions and all scales. In Nasir El-Molk, arches, as the fundamental architectural feature of the building, are repeated in both directions (side by side or parallel to each other), so are ornaments and patterns, such as star shapes and diamond shapes (Fig. 10). Windows define rows and columns of translational symmetry. Rotational symmetry is also demonstrated in roofs and ornaments (Figs. 2, 9a).

Result of the evaluations of translational and rotational symmetries in Nasir El-Molk: H2 = 2.

Self-Similarity (H3)

Self-similarity raises the degree of architectural harmony: the same figure is scaled up to several different sizes, and then all the scaled copies are aligned. The value of H3 measures the similarity of overlapping or spatially-separated figures occurring at different sizes. For example, a group of parallel lines or nested curves is related by a scaling transformation, so H3 = 2. Large plain surfaces with no distinct subfigures harmonize by default, so H3 = 2. Pieces with different shapes do not harmonize, and H3 = 0.

In the fronts of Nasir El-Molk, as previously discussed in Sect. 3.1, elements and figures of different sizes are easy to notice all over the building, in the fronts,

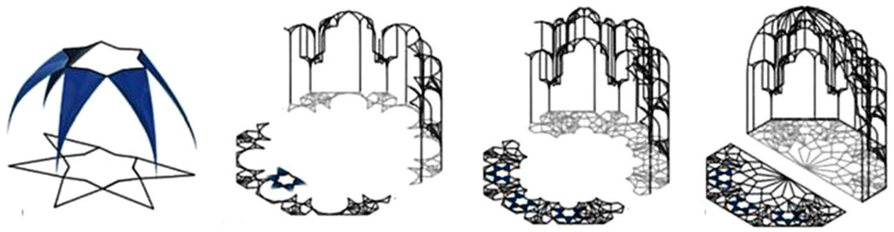


Fig. 14 Self-similarity in the composition of stalactites. Images: from Moradzadeh and Ebrahimi (2020), figure by Sam Moradzadeh, reproduced by permission

as well as in the interior. An example of this was shown above in Fig. 1a. Similar arrangements are demonstrated in the other fronts and surfaces such as stalactites (Figs. 1b–e, 14).

Result of the evaluations of self-similarity in Nasir El-Molk: H3 = 2.

Geometrical Connections (H4)

The quantity H4 estimates the presence of geometrical connections. Internal and external connections can take many different forms: connecting lines or columns; intermediate transition regions; a wide surrounding border, etc. Piecewise connections raise H4 to 1 or 2. Edges that touch but fail to join, jutting overhangs without obvious supports, and breaks in lines lower H4 to 0. The main connection of any building is to the ground; if this is not strongly expressed, then H4 = 0.

In Nasir El-Molk, geometrical patterns were used in some places for gradual transitions, but not on all surfaces. As shown in Fig. 9a, gradual diamond-shaped flower patterns were successfully used in most of the transitional areas between the surfaces. Yet, some transitions were sudden and without gradients, as seen in the connections between the inner surface of the arches and the capitals of the column (Fig. 9b). However, a strong connection between the building and the ground is created.

Result of the evaluations of geometrical connections in Nasir El-Molk: H4 = 2.

Color Harmony (H5)

A building of a single color or without any color at all has color harmony, so H5 = 2. If different colors are used, one has to estimate how well the various hues blend to create an overall color harmony. Even with bright colors, a harmonious ensemble has H5 = 2. The departure from a unified color effect—something unbalanced, clashing, or garish—lowers H5 to zero.

As previously mentioned, a strong contrast of colors is demonstrated in Nasir El-Molk, all in rich and bright forms. Used in rather small areas, they blend together in complementary and balancing compositions (Fig. 8). At dawn, the sun shines through the Orsi windows and fills the space with a glorious array of colors, especially on the carpets, which are the original carpets installed by the designers and still in use now. The harmony between the colors of these carpets and the colors of the windows is indisputable (Figs. 5, 8b).

Result of the evaluations of color harmony in Nasir El-Molk: H5 = 2.

Comparative Analysis

The same measures used in 4–1 and 4–2 were applied in four other mosques that also belong to the Qajar Era in Iran, in order to obtain deeper or more accurate understanding to the overall cultural and architectural environment of this era. The mosques are: Jameh Mosque in Babol, 1814; the Jameh Mosque in Zanjān, 1826; the Sepahsalar Mosque in Tehran, 1879, and the Mirpanj Mosque in Khamaneh, 1867). Table 1 shows the results of this analysis.

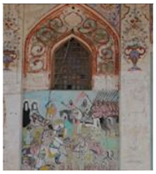
Results and Discussions

The discussions in "Testing The Building Characteristics Against Alexander's Properties of Nature" of this study show that the design of Nasir El-Molk corresponds to all the 15 properties of life as identified by Alexander, with some of them more prominent than others, as demonstrated in the figures. These properties give rise to coherent compositions, which although simple and abstract, yet they contain properties of life and nature.

The designers of the mosque certainly had no idea about Alexander's rules or Salingaros's measures. Yet, by means of geometry and abstraction, they produced a building that is full of life according to these measures, where life was introduced to the design of the mosque through clever techniques of folding patterns that grow like living organisms from a basic geometric element that works like a seed and spreads in all directions (Fig. 14). The analysis and the figures in the previous sections show that the patterns in the mosque are rhythmical and coherent showing a balancing 'unity in multiplicity' and 'multiplicity in unity' within regular geometrical figures, where repetitiveness can be continued in all directions. These qualities were meant in Islamic architecture, in general, as reflections of the unchanging laws of Creation as seen in the rhythm of evolutionary processes and the eternal relationship of the 'parts to the whole' and 'the whole to the parts'.

Another property of the patterns of the mosque is that they are based on mathematical ratios or geometric proportions that were considered influential in the universe, man, and nature and were, therefore, essential ingredients in sacred geometry. These proportions are those of $\sqrt{2}$ and $\sqrt{3}$ and the golden mean (Figs. 7, 15). They are expressed by the pentagram (includes $\sqrt{2}$ and the golden mean) and the hexagon (includes $\sqrt{3}$). These two shapes are the most prominent shapes in the building, and in Islamic architecture in general. In addition to their symbolic connotation to nature, they are simple to construct, and, via repetition, they have the capability of producing

Table 1 Comparison of criteria of life and nature in four mosques of the Qajar Era in Iran

Measure	Jameh Mosque	Jameh Mosque	Sepahsalar Mosque	Mirpanj Mosque
	 	 	 	 
Levels of scale	×	×	√	×
Strong centers	×	√	√	×
Boundaries	√	√	√	√
Alternating repetition	×	×	×	×
Positive space	×	×	√	×
Good shape	×	√	√	√
Local symmetries	√	√	√	×
Deep interlock	×	×	×	×
Contrast	×	√	×	√
Gradients	×	×	√	×
Roughness	√	×	×	√
Echoes	×	×	√	×
Void	×	√	√	×
Simplicity and calm	×	×	√	×
Not-separateness	√	√	×	×
Sum	4	7	10	4
T1	1	1	1	0
T2	1	1	2	0
T3	1	2	2	1
T4	2	1	2	2
T5	1	1	0	2
T	6	6	7	5
H1	2	2	2	2
H2	1	2	2	0
H3	1	1	2	1
H4	0	0	1	0
H5	1	0	1	0
H	5	5	8	3

Photos: Iran Tourism and Touring Organization, https://www.itto.org/iran/attractions/category/51-Mosques-in-Iran/, public domain

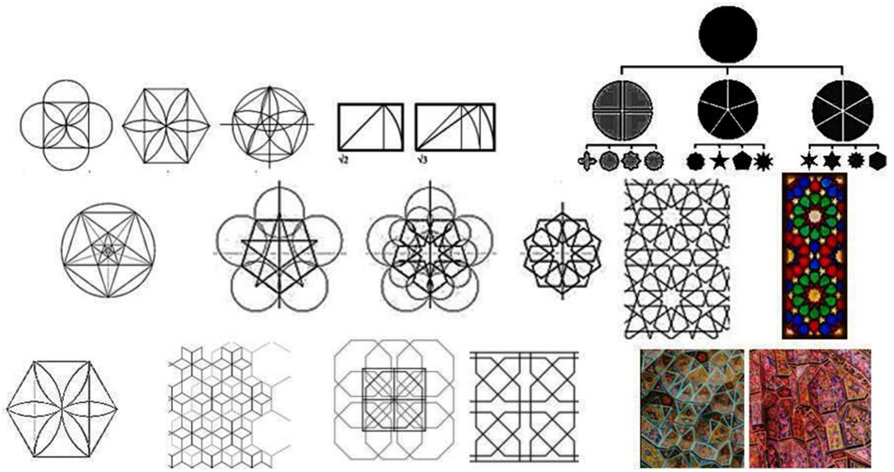


Fig. 15 Proportional roots and folding patterns: *above left* the geometry of proportional roots; *above right* the family tree of the division of a circle: fourfold, fivefold and sixfold [based on Ramzy (2015b) and Broug (2013)]; *middle* pentagram (tenfold pattern) in the Orsi; *below* hexagon in the stalactites

Table 2 Values of L and C in four mosques of the Qajar Era in Iran

	Jameh Mosque Babol	Zanjan Jameh Mosque	Sepahsalar Mosque	Mirpanj mosque
L	6×5=30	6×5=30	7×8=56	5×3=15
C	6 (10–5)=30	6 (10–5)=30	7 (10–8)=14	5 (10–3)=35

an overall coverage of a whole surface. They also bear a strong reference to the circle, which is a symbol of the Creation in Islam (Dabbour 2012).

In defining *life* and *Complexity*, Salingaros's model mimics the thermodynamic potentials, where architectural life and complexity are relative and not absolute values, defining architectural life L as L=TH, and architectural Complexity C as C=T (10 − H) (Salingaros 1997).

The calculations in the previous section for Nasir El-Molk are summarized as follows:

$$T = T1 + T2 + T3 + T4 + T5 = 10 \tag{1}$$

$$H = H1 + H2 + H3 + H4+ = 8 \tag{2}$$

From the values of T and H, the values of L and C in Nasir El-Molk are calculated as follows:

$$L = TH = 10 \times 8 = 80 \tag{3}$$

$$C = T\,(10 - H) = 10(10 - 8) = 20 \tag{4}$$

Fig. 16 Figurative art in Dome of the Rock, Taj-Mahal and Al-Hambara. Images: https://www.freeimg.net/search/islam, public domain

The results calculated for the other Mosques in the comparative study are shown in Table 2.

The comparison in Table 2 illustrates also that even among mosques that belong to the same era and the same country (Qajar era in Iran) values of life and complexity are not the same like those in Nasir El-Molk or even close to it. This applies also to Alexander's properties of nature. The two mosques of Zanjan and Sepahsalar, although they have several formal features in common with Nasir El-Molk, yet they have big differences in terms of colors and details. Looking, for example, at the details of the dome in Sepahsalar Mosque, the repetition of the pattern is not clearly alternative as in Nasir El-Molk but rather random. Details are also repeated on the same scale and not different scales. The colors of the decorations in Zanjan and Babol Mosques are mainly achromatic or neutral with extensive use of white, black, gray, and brown colors. Instead, the mosque of Mirpanj has completely different character, where human and animal forms are extensively used for decoration and the rule of prohibiting figurative art is not applicable.

In his study, Salingaros calculated the architectural temperature T of twenty-five famous buildings. Five of these had values of T similar to those of Nasir El-Molk: Hagia Sophia, the Alhambra in Granada, St. Peter's in Rome, the Taj Mahal in Agra, and the Watts Towers in Los Angeles. Similar values for H were found in six buildings: the Parthenon in Athens, Hagia Sophia in Istanbul, the Temple Karnak in Luxor, the Baptistery in Pisa, the Seagram Building, and Carson, Pirie, Scott Building in Chicago. Yet, only in Hagia Sophia and the Dome of the Rock similar values for L were found—L = 80–81 (the values in the Alhambra and the Taj Mahal, i.e., Islamic monuments, are even higher than Nasir El Molk—L = 90). The values of C calculated for Nasir El-Molk are the same as those found in the Hagia Sophia, Fallingwater by Frank Lloyd Wright, and the Sydney Opera House in Salingaros's study, although the two former buildings (Nasir El-Molk and Hagia Sophia) have three times the values the architectural life L of the latter two buildings (Fallingwater and the Sydney Opera House).

These results show that Nasir El-Molk, in spite of its simple and abstract design, ranks among some of the most notable examples of historical buildings in terms of life and complexity.

It should be also taken into account that the three buildings that Salingaros included in his study to represent Islamic architecture (Al-Hambara, Taj-Mahal and Dome of the Rock) none of them is a mosque. The first is a castle/palace, the

Fig. 17 BioGeometry in Nasir El Molk mosque. Images: author; symbols based on Gin (2015)

second is a funerary monument, and the third is a shrine. This means that the rule of prohibiting figurative art does not apply to them strictly as in mosques. It was then important to apply this model to a building in which complete abstraction was the rule. Unexpectedly, the building had values of life that is so close to other Islamic monuments, where figurative art and sculptures were included (Fig. 16).

Conclusion

Throughout history, buildings have reflected mankind's drive to produce spaces which people can relate to on a deep emotional level. In this paper, it had been shown that the pleasant atmosphere in Nasir El-Molk (which has made it the second most photographed place in Iran after Golestan Palace, according to the popular website TripAdvisor) was not an outcome of a mere design process aimed at creating a 'beautiful' building; but rather at reproducing the patterns of nature, which Muslim architects believe to be the language of the Creation. To reach this conclusion, patterns of nature and life in the architectural work of Nasir El-Molk mosque were explored, in search of what Alexander had claimed to be the essential patterns of natural/living objects. With high values of life (L) and complexity (C), as measured by Salingaros's numerical model, the outcomes of this study suggest the presence of thoughtful geometrical order in the building, which was focused on extracting the qualities of life and reproducing them through geometrical patterns or abstract art in order to 'visualize' the cosmic order of the universe in an abstract form, illustrating an infinite variety and allowing minds to wander and contemplate the infinite. The comparisons in Tables 1 and 2 provide further evidence of the distinctiveness of the visual qualities of the building and explains visitors' admiration of this comparatively small building, which appeals to their 'neural systems' due to distinctive qualities of visual information.

A careful look at the details of the decoration of the mosque will also show that some of the "BioGeometry Signatures", as suggested by Ibrahim Karim, are to be noticed in the patterns in the building (Fig. 17), as well as some biophilic qualities (such as fractal patterns),[1] which opens the door for further studies of qualities of life in the visual patterns in the building.

Our study has exploited qualitative, quantitative, and comparative methods of analysis to evaluate the qualities of Nasir El-Molk, which is alleged to be a generic method of evaluation that enables exploration beyond traditional methods of studying historical buildings. The analyses of the mosque's design show that architects can produce buildings that are, by all measures, sensational, interesting, and full of life using only simple cost-effective techniques of geometric abstraction of patterns of nature. It sheds light on how a building may have its own *genius loci*, opening the door for developing shape grammars inspired by similar examples. By understanding how to generate life in built structures, architects can drastically improve the way buildings relate to people, where the universe's wonderfully rich complexity is reflected. Although such designs may not be immediately recognized as highly similar to actual natural environment, they still can activate the perception of natural-like features, while still not copying each other, or following rigid stylistic rules.

Although the focus here is on the mosque of Nasir El-Molk, it opens the way to engage historical Islamic architecture in general as source of inspiration that copes with the digital age by introducing an understanding of its tools and visions, based on mathematics and morphology, not only looking at it as solid figures and empty motifs. Eventually, this will reduce the gap between traditional Islamic styles and contemporary practice of architecture.

Acknowledgements All images are by the author unless otherwise indicated.

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[1] Especially that most of the criteria of biophilic architecture were inspired by theories of Alexander and Salingaros.

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