Technologies to know and share the Cultural Heritage between East and West: geometric patterns in the decorations

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Technologies to know and share the Cultural Heritage between East and West: geometric patterns in the decorations.

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Abstract
In the current global universe, the architecture (in all times and expression) is confirmed also as a highly communicating system. In particular, among East and West, considering the art and architecture (Islamic and not only), we will refer to the geometric patterns: a simple common matrix - the "katem" as "semema" (from Greek σῆμα) - can generate not only formal and significant system, but also structural system. The same geometry, that it is understood as a complex language, can develop architectural, decorative, symbolic or structural systems creatively, as well as to material and technological equipments. Which of these approaches appear confirmed in time and which are the new? An answer can be retraced, for example, from the seventies of the 1900s, when the studies on geometric patterns in architecture were resumed, thanks also to the massive introduction of the digital. You can do a few examples: the Petronas Twin Towers in Kuala Lampur City (in this case the geometric pattern has been chosen for its high symbolic value and it has been used in the plan scheme); the Centre Pompidou a Metz (France) and the Arab World Institute in Paris (in these two examples the pattern has been used in external covering and to absolve structural functions).
But such architecture can be seen and proposed as a cultured and symbolic language and therefore as an instrument of integration and peace between different cultures and peoples, in comparison of the identities, through the similarities and/or the differences. In this study we propose to test the possibility to weld the visual characters of this system to its constructive potentiality, through innovative technologies. Such technologies can help to reconnect formal modes and common meanings, making them more recognizable, appropriate contexts and are finalized coherently. This contribution is played the thesis work of Osama Mansour, quoted in the bibliography.

Keywords: architecture, decorations, geometric patterns

1. The confirmation of some matrices between Europe and the Arab Countrie
Prisse d'Avennes, was the first to observe in the book of 1877 named *L'art arabe* that complex Islamic geometric patterns were based on a scientific notions system transmitted by the Treaties on geometry applied; He argued that if someone possessed the Euclide elements, he could draw, without difficulty, the woven motifs more complicated than those of Cairo, of Baghdad or Grenada.
The publications of Owen Jones, Racinet, Prisse d'Avennes and others, were complemented by specialized books on Islamic ornament pattern. The two books of Jules Bourgoin*, Les arts arabes* of 1873 *and Les elements de l'art arabe: le trait des entrelacs* of 1879 analyzed for the first time the compositional principles of the structures underlying the geometric patterns, selected mainly from the Islamic monuments of Egypt.
As Owen Jones before him, Bourgoin ranking arabic ornament in terms of three geometric elements, plants and calligraphics, noting that these three elemets are always mixed with each other. He identifies the geometric patterns as essential feature of Islamic art in all regions and he attributes their origins to the art of late antiquity. In *Les arts arabes*, Bourgoin defines this art form essentially decorative, led by a conception of composition of geometric patterns, independent observation of nature and free of iconographic meanings.

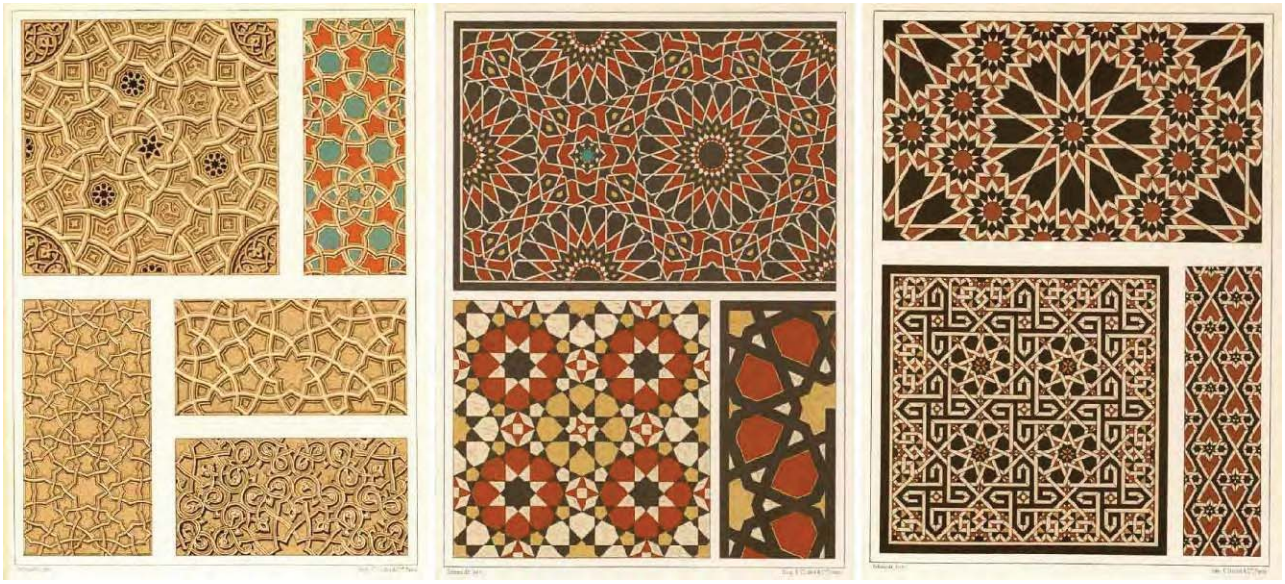

Fig. 1: Panels 193-196-198 on islamic pattern in *Les arts arabes*, Bourgoin.
http://patterninislamicart.com/earlier-published-material/colour/11/elements-art-arabe?page=1

The personal approach he presented in his books for the construction of geometric patterns was based on his own observations, and not necessarily that of origin. He divides the geometric pattern in eight categories based on fundamental geometric elements that generated them: the pentagon, the hexagon, the dodecagon, combinations of hexagons and the triangular grids, the combinations of squares and the octagons. The book had the intention of giving endless possibilities of new geometric compositions applicable on architecture, wood, paint, furniture, metal, bronze, textiles, wallpaper, etc. Publications Bourgoin were followed by a series of other studying the principles from which Islamic geometric patterns derived. One of this is the work of A. Christie*, Traditional Methods of Pattern Designing*. Its access to the scrolls of Mirza Akbar gave him the original formulas used in the construction of geometric patterns on different grids. The scrolls of Mirza Akbar are preserved at the Victoria & Albert Museum, are attributed to Mirza Akbar, architect of the state of Qajar during the nineteenth century. The repeating unit of these scrolls has supported the universal definition given by Christie to pattern as "design consists of one or more devices, multiplied and arranged in an ordered sequence ". The book offered many examples of how Islamic geometric patterns are generated by repetitive modular units. Of course, the result of this research includes a vast repertoire of scientific output.

2. From geometrical motifs to pattern into Arab-Islamic architecture

In the Islamic context, the use of the geometry obtained ornamental effects that have no equivalent. The possibilities offered by the combinations of mathematically defined shapes have always fascinated artists and, in every age and religion in Islam, impose themselves in an increasingly complex, formal rules, patterns of composition and common motifs. In the field of application of geometry to arts, is the leading sector of the architectural decoration: in addition to the ornamentation of facades, portals, minarets, We can also consider balustrades, windows, doors, *mihrab*, *minbar* as examples of ornate geometric related to building structures.
Ornate geometric is applied to all materials used in the architecture, but some have a closer relationship.
The technique most closely linked to the problems posed by the geometric decoration is that of the coating in ceramic tile, by means of which, geometry is proposed as a solution to the math to fill a flat surface starting from standard components. Solutions complicated but satisfactory from the aesthetic point of view, generate plots of the effects of varied. One of these is to assemble the hexagons, solution that has its prototype in natural honeycomb beeswax, by which variant, obtained hinterland between hexes of equilateral trianglesit generates a grid of six-pointed stars. Another solution consists of two modules joint exactly complementary: an eight-pointed star and a cross from the ends triangular.
Diversifying the solutions, always based on the complementarity of complex geometric shapes, ceramists come to multiply the number of elements that fit together, so much so that it is sometimes difficult to distinguish the boundary between the technique of ceramic tile that of the *zellij* or inlay stone. In the first case the pieces are prefabricated, while the other two are cut out one by one, but the basic principle is the same and corresponds to the geometrical distribution of a plan according to precise mathematical formulas.
This principle of the geometric distribution of the plan creates two formal problems: that relating to the configurations and that of the grid (*pattern*), problems that do not concern the only mathematical logic, but also the phenomena of perception. As configurations we mean the new geometric figures from the combination of basic figures.

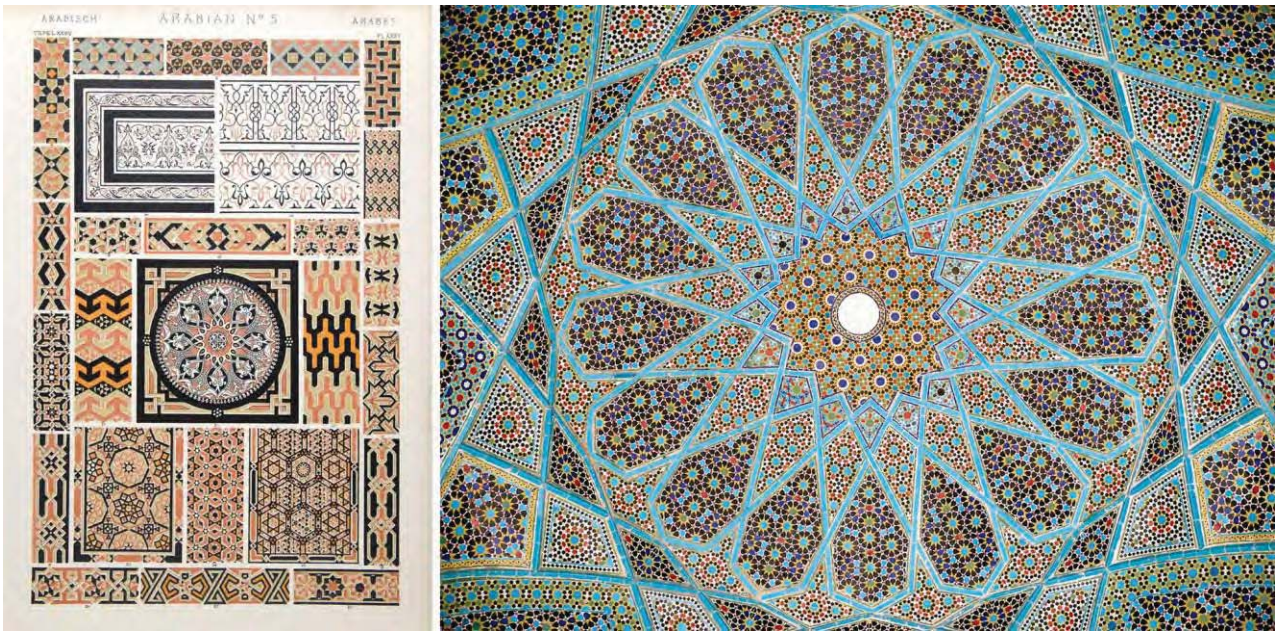

Fig. 2: Right examples of some major Islamic geometric patterns gathered by Owen Jones in The grammar of ornament, 1856 Left Iranian glazed ceramic tile work, from the ceiling of the Tomb of Hafez in Shiraz, Iran. Province of Fars: (1773) Also known as complex patterns Mosaic girih are popular forms of architectural art in many Muslim cultures.

An example is the star formed by the combination of a hexagon and six equilateral triangles, more complex examples are found in *Shamsa*, or "just", which occur in coatings *zellij*. The problem of the plot is similar to that of the configuration, except for the fact that it is based on a linear perception of geometric compositions. The dividing lines are therefore preferred and give rise to more or less complex grids. These games frame lend themselves very well to the realization of curtains carved stone, like that of the Great Mosque of Damascus, where the six gratings that are still in situ, are the oldest example in the Islamic world of decoration in geometric design.

There is talk of "analytical genius" of the "culture of arabesques," referring to two main characteristics of arabesqueshis being a construct formal direct geometric system and its constitution according to a principle of training-iterative combinatorial, characteristics which he defines features of a visual culture of deeply rational and project.

The geometric characterization of arabesques fact is evident when you consider that it is based on geometric principles of saturation of the plan for tessellation, through regular polygons, whose plot is the underlying order of the composition.

One possible classification sees a distinction between "closed orders", such as those stellar or Rosetta, based on rotational symmetries, and "serial orders" based instead of rhythmic sequences unlimited translational type. The modularity of the gratings can then grow indefinitely on all sides of the floor under the translational and rotational symmetries that, through combinatorial variations, generating regular periodic configurations.

The ways of building logical and geometric arabesques, start and grow mainly on repetition of autonomous structures and conventional, hierarchical rules and graduations scalar plant, readability of complex and decipherability bind to a general principle of iterativity which tends to have no limit. This principle involves iterative indefinite absence of a center, but also leads to not favor one of the three fundamental levels of the space in which it unfolds, eliminating any preferential subjective condition of viewing and observation.

These features make the compositions arabesque, flat and three-dimensional constructs essentially "anti narrative", where the ornament may seem an end in itself.

The geometric arabesque is considered the most unique system ornamental Islamic art has developed from the principle of the division of mathematics plan, in it the reason of the plot is combined with the reticular system of geometric texture.

The design of this type of decoration is summarized in three stages: the track base, the grid and the plot.

The track base is constituted by a grid of straight lines generated by the division of a circle into equal segments, the number of segments is generally a multiple of four or six, and consequently may generate squares and octagons, hexagons and equilateral triangles. Intersecting at certain points, the lines of base of the track forms centers of irradiation which, connected together, can be infinitely repeated. The grid constitutes a second linear pattern, obtained by doubling each of the axes of the track base, the effect multiplies the fragmentation of the floor and generates new geometric figures.

Fig. 3: Dome of the Rock, Jerusalem. Completed in 691 BC by artists and Byzantine workers, according to some would be the world's oldest Islamic building which still exists today.

The third stage, formed by the intertwining, is to proceed to a tape which passes from a grid line to another, interweaving with the portions of the grid that meets, alternating above and below. This intertwining binds together the geometric figures as in a mesh network, and some, positioned on the centers of irradiation of the track base, take the form of polygons in a star.
This type of decoration owes its charm to the effects of the perception that it generates, the line becomes a dynamic element that draws the eye and the viewer can follow the movement of the line or to dwell on the polygons that are generated. If formal logic interlacing geometric has the effect of causing a perpetual dissolution and re-composition of the figures, also has the distinction of not recognizing neither a center nor a limit and they can virtually extend to infinity.
A further feature of this aspect of Muslim ornamentation is the taste for symmetry with "changes" and the proposal and further study of very complex woven motifs that result in endless knots of a different nature. this is called "connectivity disjointed", that peculiar way of interweaving and additions that makes it appear each nodal point simultaneously inextricable and resolved, according to the head of the linear performance of which will follow the development.
It is not easy to find the meaning to be given to the Islamic geometric decoration on the interpenetration of different levels of significance, aesthetic, philosophical or symbolic. It 'clear that this complex art, sometimes called conceptual, reflects the development of the mathematical sciences. Louis Massignon, a scholar of Islamic mysticism, claims that the perpetual transformation of the geometric forms of the plot corresponds to the specific guidelines chosen by mathematicians of the Islamic world, overcoming the static model greek, Islam has therefore devised a mathematical concept that matches the dynamic trigonometry. Massignon explains this new orientation with a philosophical view which sees the world as an unstable grouping of atoms, philosophical atomism that reflects the religious idea of the transience of the world in front of the eternity of God.

3. Techniques and materials: the example of the brick

As is known, the construction of the Arabic (the structural type in the construction site, as well as to the details of construction) is rich in various technological possibilities and materials. Among these, the brick is widely used throughout the area that includes Iran and Central Asia. Its quality and mechanical properties have a direct impact on architectural forms: In fact, its weak tensile strength prevents its use in the entablature and involves, in particular in areas where wood is scarce, the use of arches, vaults and domes for coperture151. Beyond the structural implications, so it gave rise to a particular decorative art, favored by the shape of standardized elements and small in size.

Fig. 4: The Palace of Ukhaydir north of Karbala '(Iraq, 766-788). View of the courtyard and the time of the porch, where you see the blind arches and ribs.

This formal aspect was a problem for manufacturers, but also provided them with the solution: the uncomfortable feeling of monotony, in fact, obtained by the repetition of a module so small, it was resolved thanks to the various possibilities of manipulation in which the material is brick lent. In the oldest Islamic buildings in brick ornamental we find solutions that are part of what, in the western architectural tradition, be treated as the molding, the technique that allows to animate wall surfaces with elements in relief, swings, comedians, pillars, etc. Muslims manufacturers, taking a model already in place in front of the palace of Ctesiphon Sassanid (591-628) resort to a game of niches, blind arches or ribs products with the only provision of the bricks in the wall face, as can be seen in buildings such as the palace of Ukhaydir (764-788) or the door of Baghdad in Raqqa (772).
An innovative technique was founded in the tenth century and is located in Transoxiana in the Mausoleum of the Samanids of Bukhara. In this building the brick achieves a perfect balance between the structural function and the decorative. Almost every brick plays its role as an element of the construction and as part of a decorative element both inside and outside. Playing on the contrast between bricks projecting and those arrears, create light and shadow effects of the warp similar to that of a fabric.
The same magisterium (later known by the English term "brick style"), will be significant success Seljuk era (XI and XII century) also spreading to Pakistan and Iran. Pakistan is found in particular in the architecture of funerary complexes, Afghanistan and Iran is manifested in a number of minarets, mausoleums and small burial towers.
Produced in series and of the same size, the bricks become a modular element which allows the manufacturer to adjust their work according to the logic of the combination. As has been noted, the proportions of the brick used efficiently refine and change this logic. Regarding the criterion of construction, it is to explain that, for the purposes of a good cohesion of the whole, it is hardly necessary to recall the need to arrange the elements in such a way that they are offset from each other, implying the production of reasons interacting and tend to coalesce into a plot that can be repeated indefinitely '.
Another aspect of the art of brick is its perfect legibility is an art that performs and enhances its matter. Approaching, the viewer is always able to reconstruct the sequence of operations that have allowed to obtain the various effects, a sequence that is also a set of technical and mathematical formulas.
A simple formula is to place the brick alternately horizontally and vertically. The result is a pattern that takes the form of a herringbone and from which they can derive other by placing bricks cut.
Another formula is to play on the relief to get the effects of light and shadow. It can be done by offsetting in depth some bricks to the vertical plane of the wall or contrasting brick parallel to the plane of the wall to the other arranged at 45 degrees. However, there are more complex processes, which require prior preparation of the material, with a cutout of the bricks and reduction in triangles, or the bevel of the corners; in this way it is possible to create new combinations formal generating, in the veneer, different forms of shadow: zigzag, sawtooth, star. These formulas and magisteria are basic principles that can generate an infinite number of motifs, all to enroll in the logic of the combination of shapes inside a warp costante161.
The Persians artisans for example, does not only apply the principles that derive from the rhythm and geometry of the building using brick as both formal element that material, creating dense textures of mosaics. This technique is particularly suited to the creation of panels and ornamental epigraphic bands: it was used for example in the decoration of tombs and minarets as the Seljuk Gunbad-i Kabud in Maragha (1197) or the tower of Mas'ud in Ghazna (XII century). The realization of this type of mosaic, provides for the cutting of brick fragments according to geometric or calligraphic default, which are then arranged on the floor with his face down. After the composition is poured a layer of plaster so as to form a panel which is then transferred on the wall.

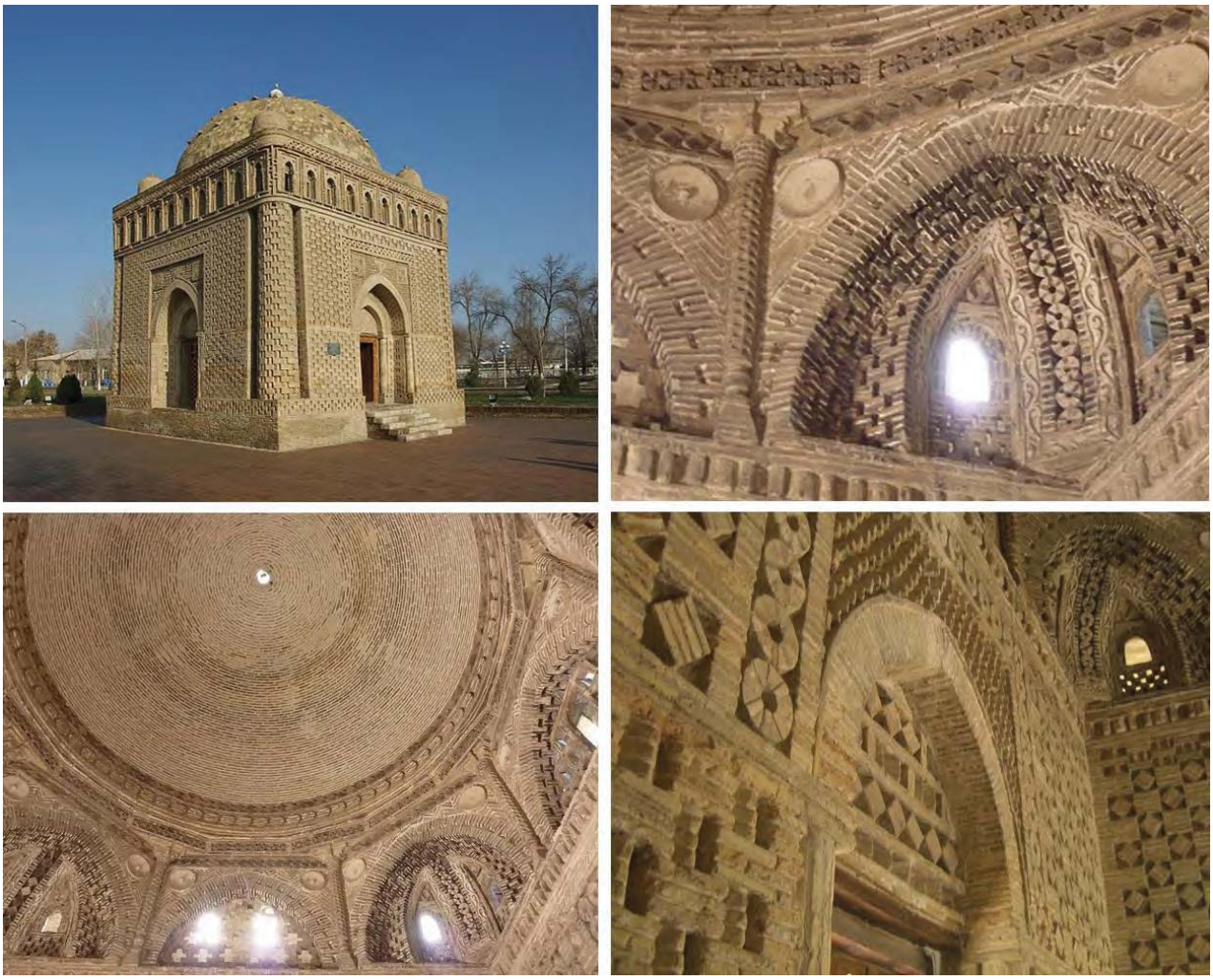

Fig. 5: Mausoleum of Ismail Samani in Bukhara (Uzbekistan, X century). View of the exterior and interior of the Mausoleum.

Some interventions add a touch of sophistication, particularly typical examples in Central Asia or Iran, as the inclusion of brick bearing on the visible side a reason stamped, or the introduction of grouted joints or sculpted or even , the insertion of fragments of clay coated enamel turquoise. Observed in the sunlight these works, clad in brick and glazed, give the impression of being covered in fabric.
Observed in the sunlight these works, clad in brick and glazed, give the impression of being covered in fabric. The mausoleums brick are interpreted by him as the transposition of the solid material tends funerary Turanian tradition.
Even the technical devices that come into play, in addition to visual effects, contribute to understand the link between this type of decorating with fabric. The assembly operations of the bricks have some analogy with those of weaving. Not surprisingly, the analogy between the two types of operations.
Since the beginning of the twentieth century onwards, the study of Islamic art and has developed into a specialized academic field in which research has led to accumulate a wealth of information previously unavailable. Archaeological discoveries, international exhibitions, studies and detailed research covering the entire period of Islamic art and architecture, have raised awareness of the complexity of the assets.
The use of the pattern allows not only to integrate several levels of the project, but can also be limited to delineate only the expressive, representative or symbolic architecture. Clearly it is sometimes difficult to be able to separate the different levels of the project that are often inextricably intertwined: we are still able to find in the history of architecture in attitudes towards the decoration, which are repeated cyclically.
The use and dissemination of the pattern of different scales of intervention manifests as research on the complexity and, at the same time, the consistency. The pattern allows to manage different levels of the project while maintaining a general order recognizable: this is also made possible by new technology, both design and construction. The spread pattern of the facade comes from this growing attention to the outer shell of the buildings, as we have seen, has its precedents in postmodernism.

Fig. 6: Detail of the decoration of the madrasa of Qal'a in Baghdad (XIII century). Pulling back the bricks arranged in horizontal than vertical generates a pattern in slight relief emphasized by square terracotta stamped.

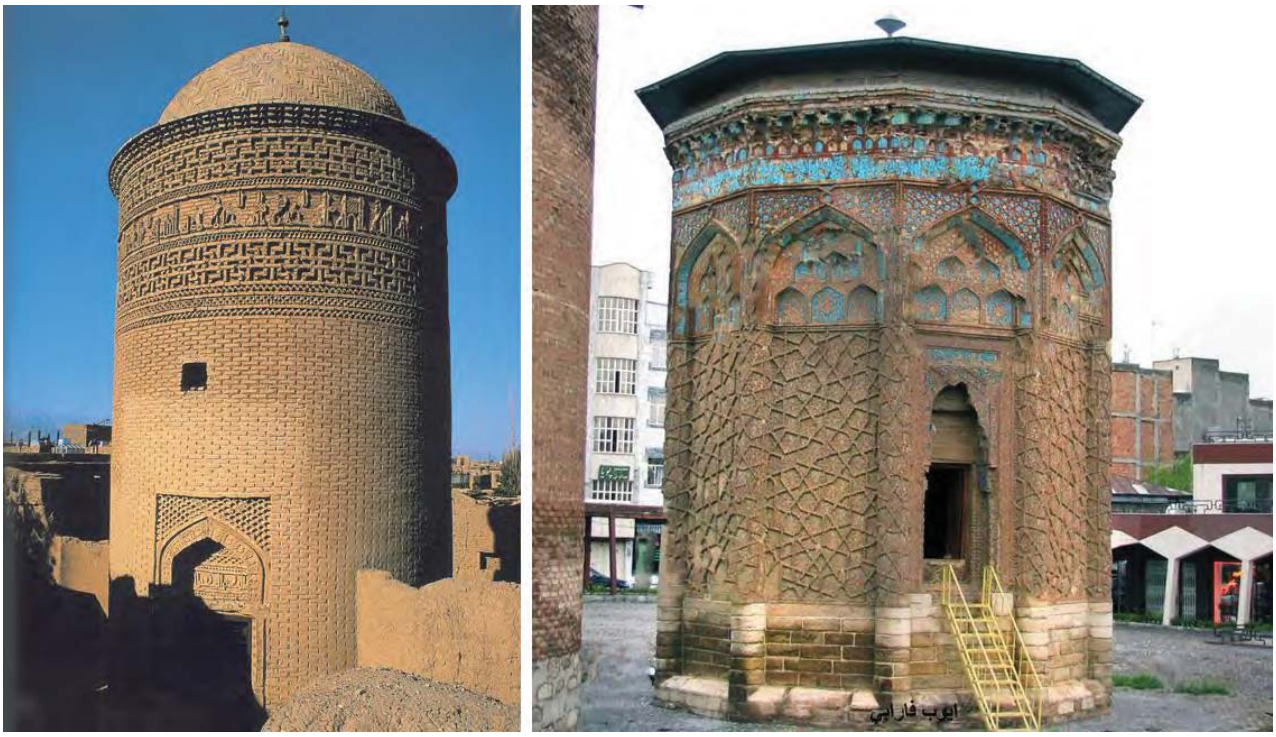

Fig. 7: Left Mausoleum of Pir-i Alamdar in Damghan (Iran, 1021-1026). Effects of light and shadow playing on the relief obtained. To the right of the tomb Gunbad.i Kabud in Maragha (1197).

Occurs then a disconnect between internal and external, that is, between what happens in front and what happens within the architecture: in this way the facade is an attractor and poster communication that does not take into account the internal . In fact, the architect is no longer involved with the design and the development of the entire complex (and therefore of its external and internal): those who design the facade does not coincide with the architect who later will the interior. This is because, as the different owners, the customer called an architect only the design of the exterior, selling different portions to customers who entrust then, in turn, their share to other designers. It is therefore clear that, from the outset, the project is developed taking into account mainly the marketability of the project.

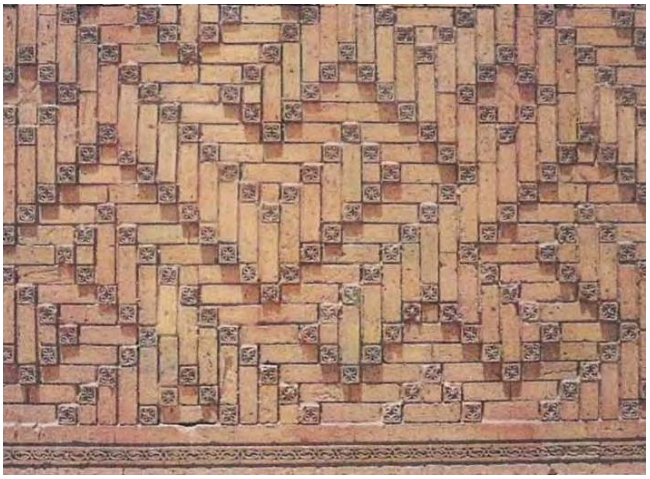

Fig. 8: Detail of the decoration of the madrasa of Qal'a in Baghdad (XIII century). Pulling back the bricks arranged in horizontal than vertical generates a pattern in slight relief emphasized by square terracotta stamped.
Fig. 9: Detail of the decoration of the tomb of Gunbad.i Kabud in Maragha (1197) .li seventies of the twentieth century and the recovery of studies on geometric patterns**.**

Another factor that contributes to the use of patterns in the facade is derived from the new environmental regulations born to optimize the energy efficiency: since the transparency of the modern movement is not efficient from an energy point of view, it is necessary to introduce environmental control systems that operate to layering of different panels, curtain-wall or densifying more opaque areas in the solar orientation.
It is also for this reason that many times the expression of the buildings may not have any relationship with the interior.
An example of an advanced pattern that integrates multiple layers of architecture, is the one used by Cecil Balmond in the project by Daniel Libeskind for the expansion of the Victoria and Albert Museum in London (1996-2004). This project could actually come together in different chapters of this work: it is not only a contemporary use of tessellation aperiodic, but also contains the golden number and fractal, and in it the pattern integrates both ornament and structure.
It constitutes an interesting example of the use, in contemporary times, the aperiodic tessellation, fractals and patterns, integrating aesthetics and structure. This shows that, although for educational matters we are required to separate the arguments for issues or to investigate aspects for separate domains, in reality in a good architecture these issues coexist together.

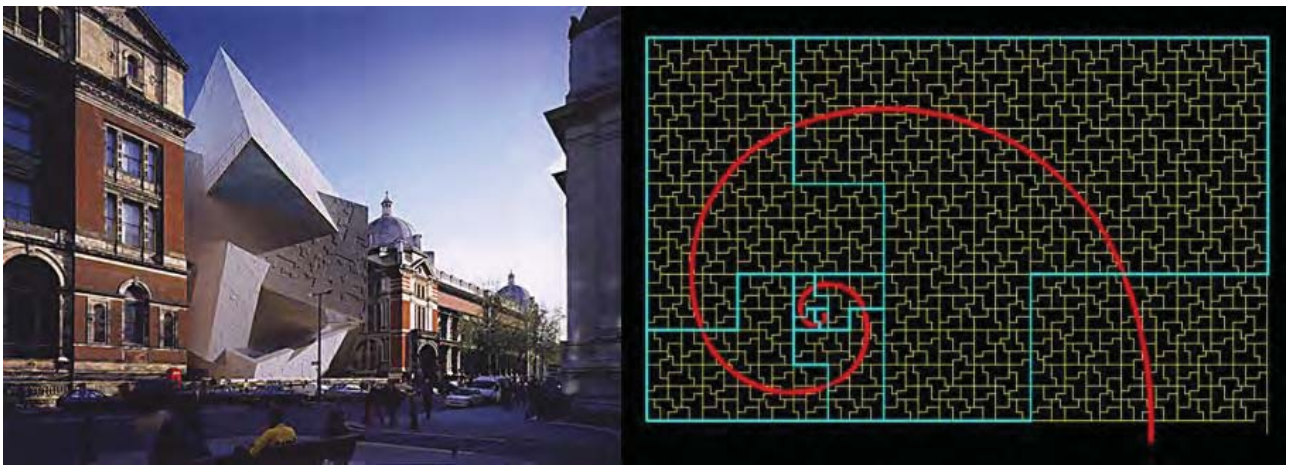

Fig. 10: Cecil Balmond and Daniel Libeskind, project for the expansion of the Victoria and Albert Museum in London (1996-2004).

4. Conclusions: examples in the contemporary

In the contemporary, urban transformations taking place in the territories of the Middle East have led to an "Islamic style", among other events, often flattened on European or American models. But in the world are worthy of interest episodes inspired own decorations derived from the philosophy of geometric decorations (including Islamic) and the pattern of these derivatives. So, inspired by these Cecil Balmond and Daniel Libeskind, the project for the expansion of the Victoria and Albert Museum in London (1996-2004); as well as the group ILUMA, for the Urban Center in Singapore (2009); or as the team FOA, the Ravensbourne College of Design and Communication, London (2010). It is a must, in conclusion, the “forerunner "Institute of the Arab world (of Islamic Arts at the Louvre), made in Paris in 1987 by Jean Nouvel. In one of the best-known texts, Mark Garcia pointedly notes that "the recovery of the pattern could allow, thanks to their flexibility, the overcoming of the gap between Western and Islamic architecture and represent a ground for experimentation and research, allowing, at the same time, aesthetic innovations with high visual performance and structural. " If the research is the art of the exchange, even the decorations between East and West will be an effective way of communication.

Fig. 11: FOA, Ravensbourne College of Design and Communication, Londra 2010.
https://terraincritical.files.wordpress.com/2010/10/dsc01534.jpg?w=500 (consultato il 02/04/2015)
Fig. 12: ILUMA, Urban center, Singapore 2009https://terraincritical.files.wordpress.com/2010/10/dsc01534.jpg?w=500 (consultatoil02/04/2015

Fig. 13: Zaha Hadid Architects , the project for the Department of Islamic Arts at the Louvre , Paris 2005.http://www.eikongraphia.com/wordpress/wp-content/Louvre_4.jpg (consultato il 02/04/2015)
Fig. 14: Atelier Jean Nouvel, the Arab World Institute of Islamic Arts at the Louvre, Parigi 1987.
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