

Visual Perception and Graphic Analysis. The Pattern of Inlays in the Cathedral of Palermo [†]

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[†] Presented at the International and Interdisciplinary Conference IMMAGINI? Image and Imagination between Representation, Communication, Education and Psychology, Brixen, Italy, 27–28 November 2017.

Published: 27 November 2017

Abstract: The Cathedral of Palermo is one of the monuments belonging to the Arab-Norman Itinerary, declared a UNESCO World Heritage site in 2015. This text uses geometric analysis to describe some of the inlaid circular designs from the eastern façade, the corner towers and the apses. The cataloguing of the two-tone geometric motifs also reveals aspects that can be linked back to the laws of visual perception. Hence, the text investigates these aspects based on a new reading. In fact, decomposing these elements based on the experience of their perception also facilitates the recognition of elementary figures. The attempt made in this brief text intends to induce a new perceptive awareness resulting from a more attentive and prolonged period of observation.

Keywords: perception; graphic analysis; geometric constructions; drawing

1. Introduction

The Cathedral of Palermo is one of the 12th century monuments belonging to the Arab-Norman Itinerary, declared a UNESCO World Heritage site in 2015.

The external walls of the Cathedral, in sandstone, are decorated with stone inlays comprised of different decorative elements characterised by geometric and floral motifs in lava inlaid in tufa blocks [1].

In correspondence with the apses, the eastern façade is divided into two levels separated by a floor marker, decorated with geometric, phytomorphic and zoomorphic motifs. The central apse presents a double order of arches surrounded on the first level by a double ring, while on the second level they are intertwined and contain single-lancet windows. The side apses feature a compact and smooth lower level, while the upper level is characterised by overlapping arches and single-lancet windows. The apses terminate with a decorated projecting cornice and crenulations that repeat along the entire eastern wall at a higher level [2]. The apses are characterised by the presence of a series of oculi in inlaid lava, each with a different design.

The inlaid decorations are a relevant aspect of the monument's appearance. Their position, distant from the observer, does not permit a clear understanding of the complex designs generated by their rigorous geometric constructions based on the overlapping and rotation of simple two-dimensional figures.

This text uses geometric analysis to describe some of the inlaid circular designs from the eastern façade, the corner towers and the apses. The cataloguing of the two-tone geometric motifs also reveals aspects that can be linked back to the laws of visual perception. Hence, the text investigates these aspects based on a new reading. In fact, decomposing these elements based on the experience of their perception also facilitates the recognition of elementary figures (circle, square, triangle or other familiar forms).

The perceptive experience is the final product of the process of categorising and elaborating a stimulus. The figure-ground perception proposed by the Danish psychologist Edgar Rubin, the first to study its laws (1921) and those of segmentation in the field of vision, first formulated by Max Wertheimer and his colleagues in 1923, provide the keys to a reading that characterises zones into areas of ground and the edges outlining parts viewed as figures [3]. The multiplicity/unity of elements, from which the complexity/simplicity of the figures derives, are the themes I will use to communicate the perception of the decorative elements on the east elevation of the Cathedral.

In terms of aspects of their perception, these decorative elements were catalogued in two categories.

The first category looks at the relationship between the figure and ground.

The second category proceeds with a methodical analysis of the formal organisation of the elements based on the laws of Gestalt theory.

The following geometric constructions further explore and graphically explain these concepts for both categories.

2. The Relationship between Figure and Ground

The segmentation of the field of vision into areas of figure, or objects, and areas of ground, obeys precise conditions of stimulation. While same element can be read alternatively as figure or as ground, when one of the two characteristics is perceived, the other ceases to be visible. It is not possible to simultaneously conceive the figure and ground, because their characteristics are bivalent. One law of perception does not prevail over the other, and the same element either advances to the foreground or recedes into the background [4].

The decoration represented in Figure 1 is found on the upper levels of the northern apse and the central apse. This geometric configuration may help understand the figure-ground concept, as the white and black forms can be perceived as either figure or ground. The concept is further reinforced by the same configuration represented in the negative, which reveals the same form of visual ambiguity, despite the chromatic inversion. Both constitute ambiguous two-dimensional representations that maintain a perceptive ambivalence even when chromatically inverted.

Inscribed within a circle, the composition consists of a radial series of six circular sectors, inside each of which forms are arranged in a specular manner with respect to an axis of bilateral symmetry. The figure is born of the intersection between a series of concentric hexagons and three couples of lines running parallel to the diagonals passing through the vertexes of the hexagons. The composition, completed by forms generated by further intersections between circles and hexagons set along the radii, is one of the most recurring motifs in Islamic art.

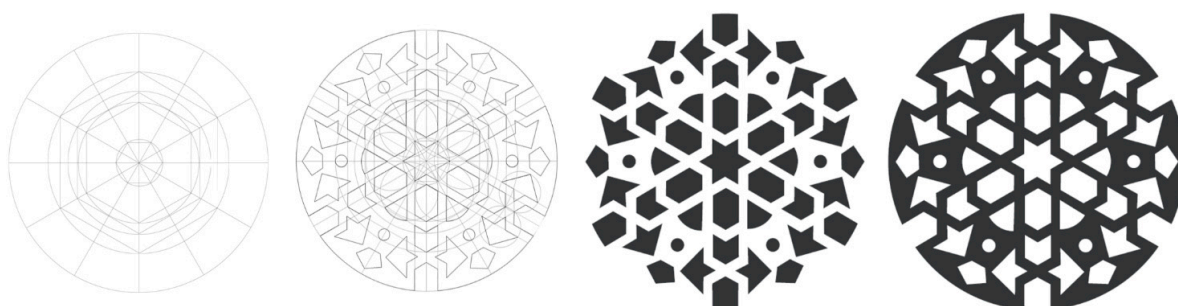


Figure 1. Figure-Ground Relationship.

The decoration illustrated in Figure 2 is found in the upper level of the central apse. Once again, the two-dimensional representation is ambiguous. The subjective position of the observer plays a fundamental role in perceiving either a surface perforated by a form with a flower-like edge or an eight-pointed star surrounded by petals. The geometric construction is created by subdividing a circle into eight sectors. The flower and its eight petals result from the intersection between two squares,

rotated 45° with respect to one another, and a grid of lines running parallel to the diagonals of the squares. The centre of the composition is occupied by an octagon star.

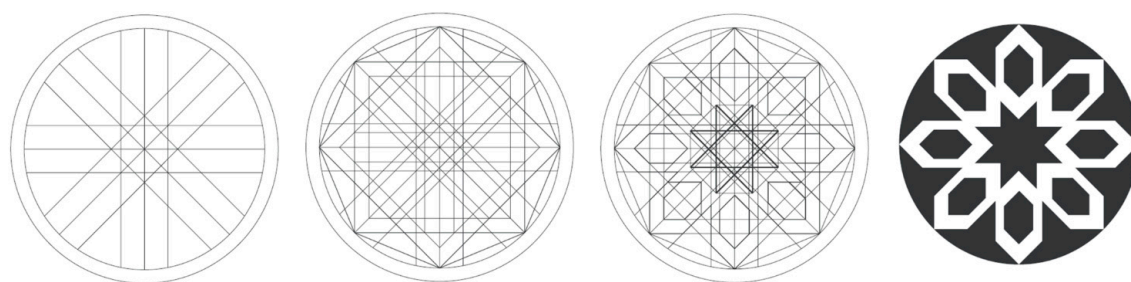


Figure 2. Figure-Ground Relationship.

According to Rubin, one of the conditions that influence the reading of the figure-ground relationship is the convexity of the edges, which favours the emergence of the figure, or their concavity, which favours the perception of the ground. In the example illustrated in Figure 3, the white area at the centre is perceived as an opening with the form of an octagon star, while the black area around it assumes the form of a figure. Furthermore, the eight black forms organised in a radial series at the external limits of the oculus tend to emerge as figures because, as Rubin demonstrated, this is how smaller areas are perceived. The figure is composed along four axes of bilateral symmetry. The centre is characterised by the overlapping of two squares rotated 45° with respect to one another. Their vertexes define the centre of eight small circles. The other forms, resulting from the intersection between three circles and a square, are arranged along the axes of bilateral symmetry.

The oculus that contains this figure is located in the lower order of the central apse.

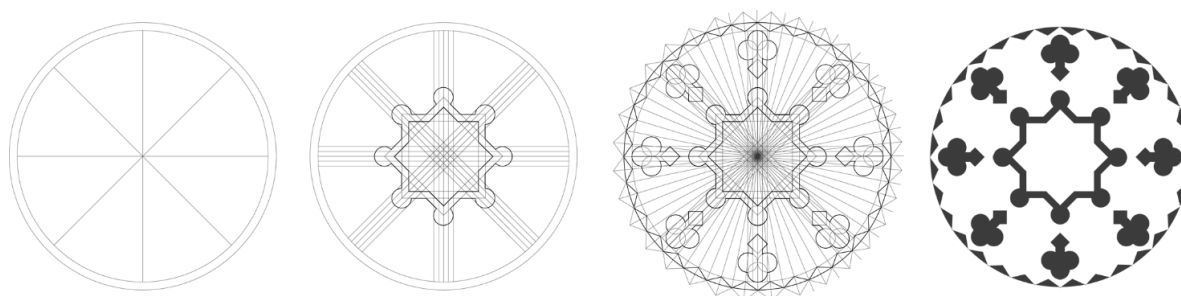


Figure 3. Figure-Ground Relationship.

The central part of Figure 4 is representative of the figure-ground concept. At first glance, the first thing we see is a white *cross pattée alisée* (a footed cross) on a black background and, successively, owing to the effect of inversion, four black petals on a white disc. The interchangeability between figure and ground cannot occur at the same time. The alternating perception of figure and ground requires successive periods of time. In this case, spatial orientation influences perception: the visibility of the cross remains for a longer period because it is perceptively influenced by the x and y axes. If we stare at the decoration for a prolonged period, the figure-ground inversion is perceived multiple times.

The composition is created by uniting the midpoints of the bases of a rectangle with their respective opposing vertexes. Two horizontal lines pass from the intersection between the resulting lines and the diagonals of the rectangle, extending as far as the circle [5] (p. 125). These intersections define a central hexagon inside which a circle is inscribed. The central figure is obtained by intersecting four circles with the same radius and centre on the four quadrants of the central circle.

The oculus containing this figure is located in the lower order of the central apse.

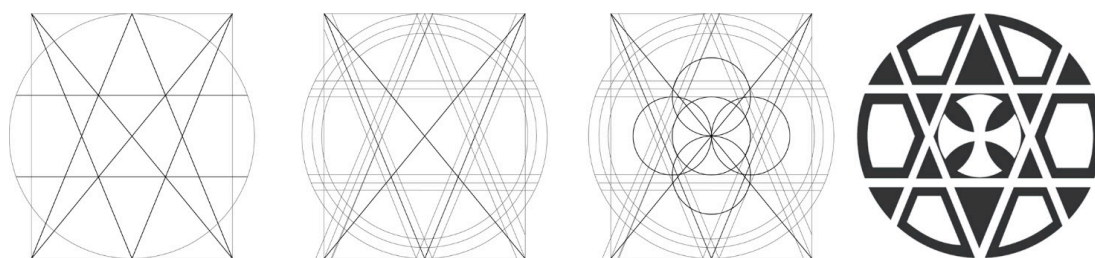


Figure 4. Figure-Ground Relationship.

3. Formal Organisation

As “the segmentation of vision into zones that appear as a figure, in other words an object, and zones that appear as ground obey precise conditions of stimulation” [6] (p. 45), thus a certain number of conditions operate in the perception of form and favour the unification or association between elements. These factors are: proximity, similarity, spatial orientation, closure, good continuation, common fate, Prägnanz and past experience. They were identified in 1923 by Max Wertheimer and his colleagues (Berlin school of Wertheimer, Koffka, Köhler).

3.1. Proximity

The elements of a composition are perceptively grouped together based on their proximity. The areas delimited by edges set close to one another are perceived as a unitary figure on a unitary ground. Close objects set in the same direction in space generate the perception of groups characterised by this particular direction.

The close set elements of Figure 5 are perceived as a unit. The circle of the oculus is subdivided into seven equal circular sectors. Uniting the points of intersection between the sectors and a circle, concentric to the first though with a smaller radius, generates a regular heptagon. The eight black circles of the figure are located at the vertexes of the heptagon and its centre.

The oculus containing this figure is located on the north side of the wall of the *antititulo*.

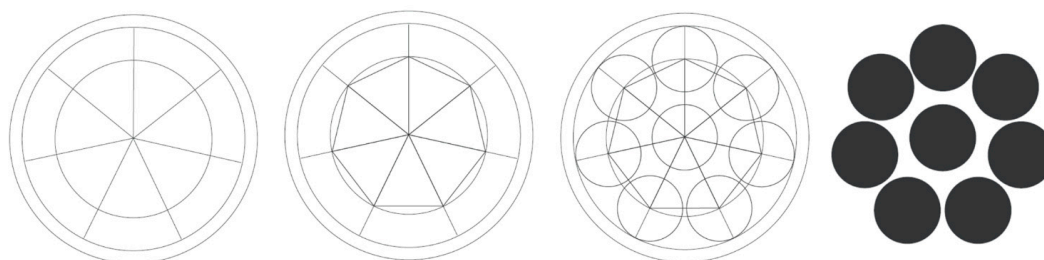


Figure 5. Proximity.

The factor of proximity is also at work in Figure 6. The eight, six-pointed stars, arranged along the exterior, are situated at the vertexes of an octagon and appear to belong to a single unit, independent of the larger eight-pointed star inscribed within a central octagon.

The oculus containing this figure is located at the lower level of the north apse.

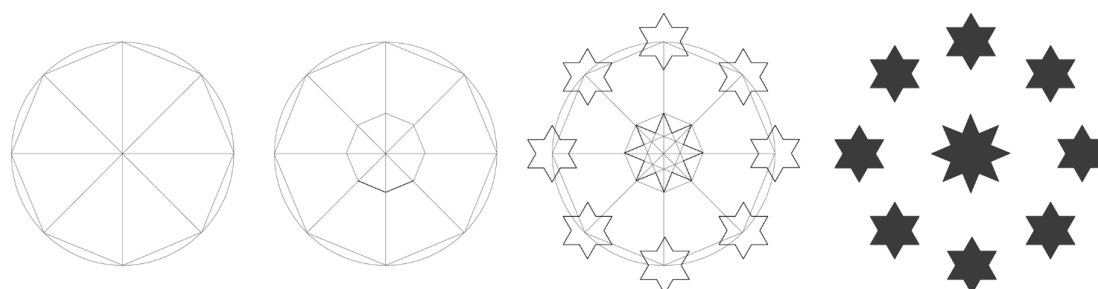


Figure 6. Proximity.

3.2. Similarity

The elements of a composition are perceptively grouped together based on their similarity.

In Figure 7 the field of vision first groups together the smaller forms arranged around the exterior, and then tends to recognise the composition of the central group. In this case, the figure-ground relationship also intervenes. The central part of the figure alternatively shows the visibility of the four white petals or a black *cross pattée alisée*.

The circle of the oculus is subdivided into eight circular sectors. The centres of the eight external quadrilobates are located along the radii of the circle. The central figure is obtained by intersecting four circles with the same radius and with centre on the four quadrants of the central circle.

The oculus containing this figure is situated in the north apse.

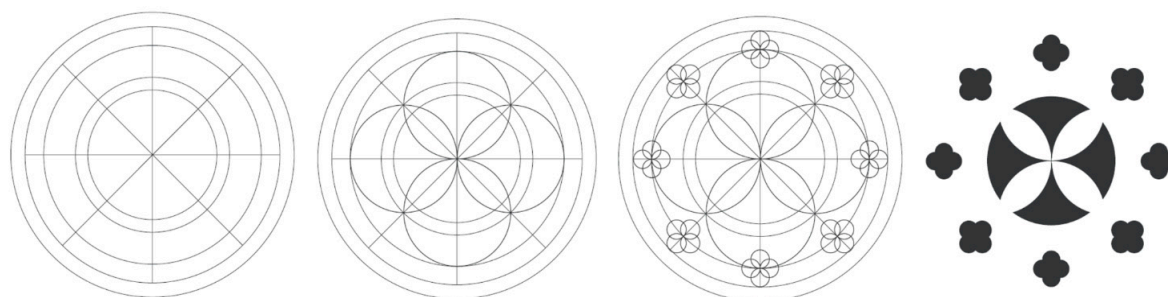


Figure 7. Similarity.

The composition shown in Figure 8 is generated by an octagon, which divides the space into eight circular sectors. Their radii, together with four couples of small circles, delimit the central figure. The external design consists of eight series of three circles grouped together around the vertexes of the largest octagon and of sixteen small circles around a bigger one.

The oculus containing this figure is situated on the north side of the wall of the *antititulo*.

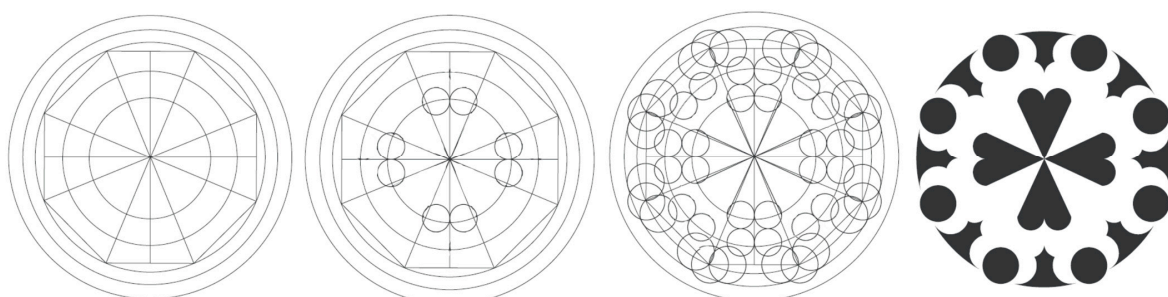


Figure 8. Similarity.

3.3. Spatial Orientation

The elements of the composition are aligned along the main axis of their configuration to which they belong.

Figure 9 is obtained by intersecting five circles.

The area of the composition whose axes correspond with the principal axes—vertical and horizontal—tend to assume the character of a figure. This factor is referred to as spatial orientation. When this composition is inverted and rotated 45°, it is possible to perceive as form that which was previously perceived as ground, specifically the black *cross pattée alisée*.

The oculus containing this figure is situated in the north apse.

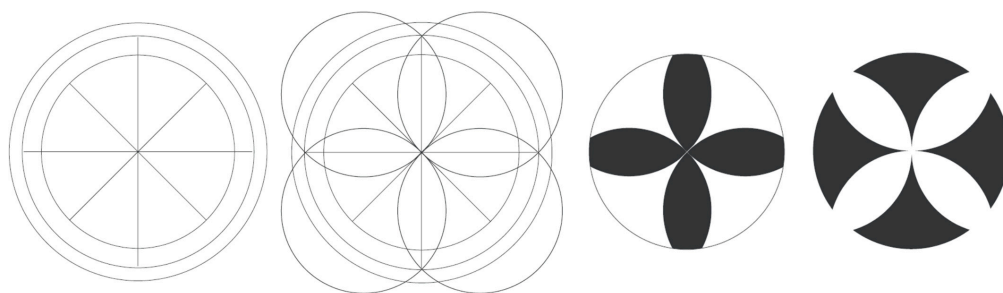


Figure 9. Spatial Orientation.

3.4. Closure

Closure is the factor that permits the vision of closed forms that, in reality, are not closed. It provides missing information required to complete the edges of an incomplete figure. It is the tendency of elements to close and complete themselves in recognisable forms by moving beyond given information.

In Figure 10, the hexagonal forms and the six-pointed star at the edge of the oculus are completed by virtual lines, edges that do not physically exist but which are perceived thanks to the effect of closure.

The composition is the result of a hexagon inscribed within the circle of the oculus, inside of which six smaller hexagons are inscribed, overlapping a central hexagon. The composition is completed by a polar series of a further twelve hexagons of the same dimension distributed around the exterior [7] (p. 35).

The oculus containing this figure is situated in the central apse.

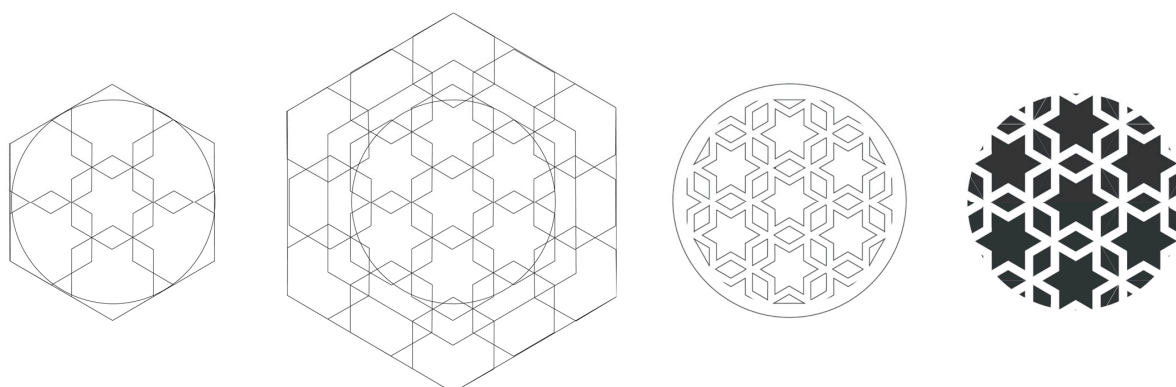


Figure 10. Closure.

In the example represented in Figure 11, the factor of closure tends to lead to the perception of the image of closed figures that are not adjacent to any real edge. Hence, it is possible to observe seven hexagons, inside each of which a composition made of a star, six irregular hexagons and six triangles is inscribed. However, enclosed by the edges of the black hexagons it is possible to perceive six large triangles. Inside these latter, the eye perceives another white triangle, delimited by three small black triangles [6] (pp. 273–308).

The figure is made from a grid of lines running parallel to the diagonals passing through the vertexes of a large hexagon. The points of intersection of the grid identify the focal points of the composition, around which the series of polygons are composed.

The oculus containing this figure is situated in the upper part of the second level of the central apse.

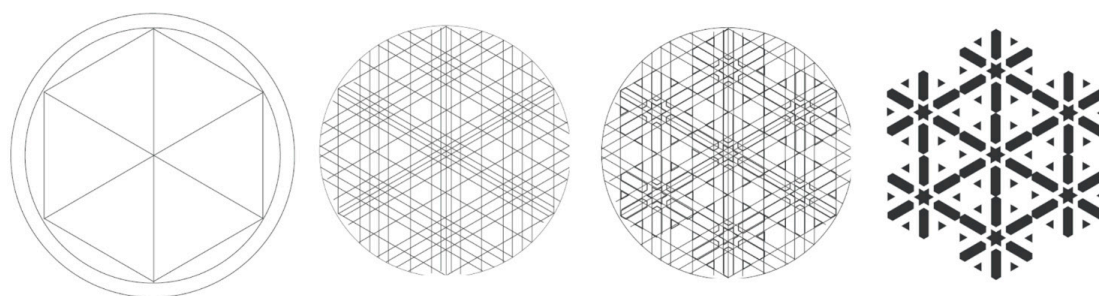


Figure 11. Closure.

3.5. Good Continuation

Elements with a common direction of movement tend to be perceived as belonging to the same object. This phenomenon occurs when the elements present the least number of changes in direction or interruptions in the lines of which they are made or in their edges. This principle causes them to be perceived as united, even if they are in reality separated.

In Figure 12 the lines forming an octagon star are perceived as a unit, despite the interference of overlaps, consisting of elements that recall the form of an arrow. The composition derives from the overlap of two large squares rotated 45° with respect to one another. Each is then subdivided into sixteen equal parts by a grid.

The oculus containing this figure is situated on the north side of the wall of the *antititulo*.

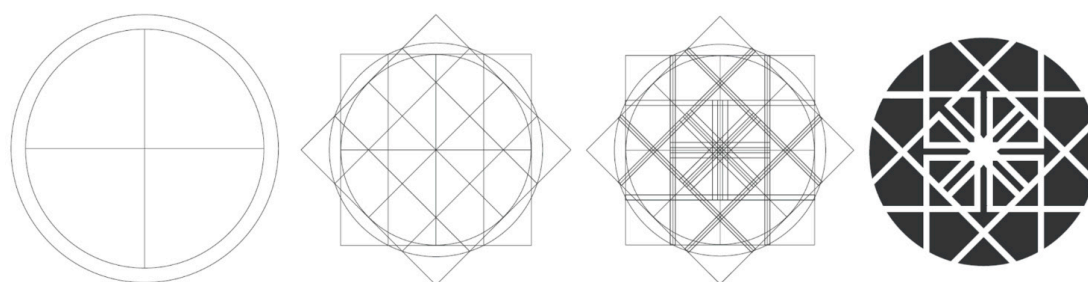


Figure 12. Good continuation.

3.6. Common Fate

The elements of a figure or of a configuration are perceived as a unit when they tend to complete themselves in a privileged form. Common fate is a particular example of unification by similarity [6] (p. 50). According to the laws of common fate, elements are united into forms that share the same type of movement.

In the Figure 13, forms with the same movement, converging toward the centre and the eight-pointed star, tend to resemble a unit.

The composition consists of eight circular sectors whose centre is marked by an eight-pointed star, obtained by uniting the vertexes of a regular octagon. Each radius is overlapped by two circles and a V-shaped element, to obtain the black forms converging toward the centre.

The oculus containing this figure is situated in the upper part of the second level of the central apse.

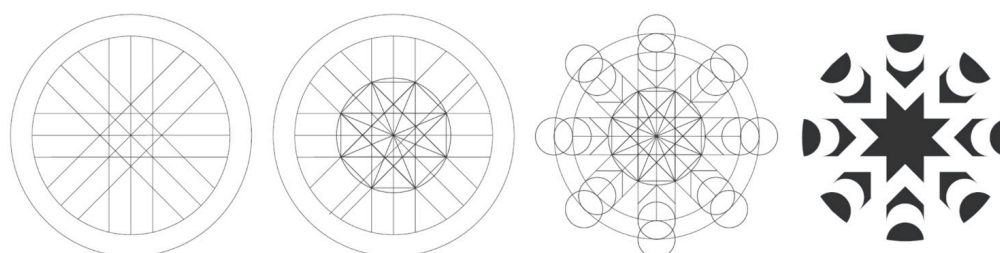


Figure 13. Common Fate.

Figure 14 responds to diverse laws. The forms (white and black) are grouped together by similarity, proximity and common fate. It is possible to perceive a central white octagon, three black and white eight-pointed stars propagating from the inside and moving outward and two black discs. In reality, these forms are the result of the aggregation of basic figures (triangles, circles, quadrilaterals, etc.). The forms deriving from the same geometric figure are visually grouped, for example the outermost white points with 90° angles, because they derive from the overlap of two quadrangular forms. The entire composition is the result of the intersection of circles and squares rotated 45° with respect to one another.

The oculus containing this figure is located between the central and the northern apse.

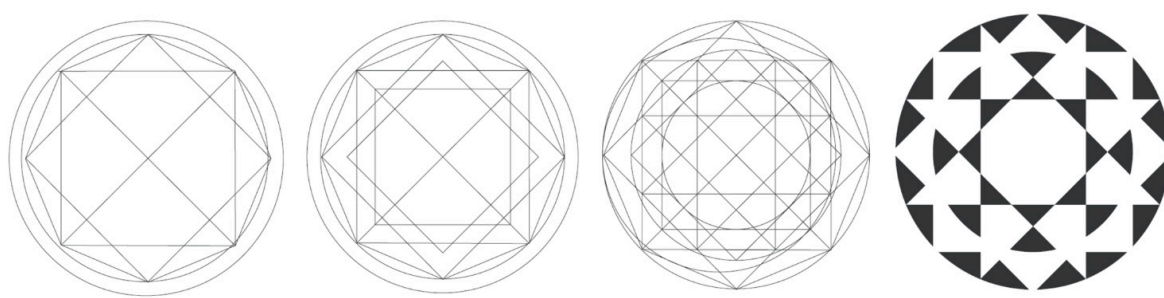


Figure 14. Common Fate.

3.7. Prägnanz

The principle of Prägnanz induces the choice of the perceptive reality that appears most correct (for its characteristics of balance, stability, symmetry, regularity, simplicity, symmetry) from among diverse possibilities.

In Figure 15 it is possible to recognise a six-pointed star, resulting from the intersection of multiple forms. This, however, is what is perceived based on intuitions. In reality, these forms are nothing other than the juxtaposition of six triangles, a hexagon and six arches of the same circle. When the distinct figures come closer to one another, it is impossible to see them in their original individual forms because they are transformed into the final configuration.

This construction is obtained by overlapping two mirrored equilateral triangles set one atop the other [7] (p. 150). The points of intersection between the six sides of the two triangles constitute the centres of the six circles describing the figure with six external lobes.

The oculus containing this figure is found on the lower level of the central apse.

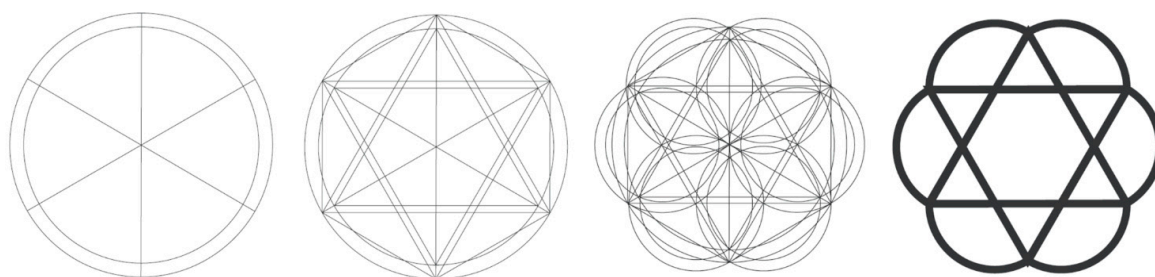


Figure 15. Prägnanz.

Figure 16 is made from the intersection of seven hexagons that create a central six-pointed star and six incomplete six-pointed stars arranged at the edges. Once again, however, we perceive this configuration thanks to intuitions, because this figure is simply the juxtaposition of a six-pointed star, six triangles and eleven irregular hexagons. The observer is induced into completing the figure by inscribing it within a virtual circle.

The oculus containing this figure is found on the lower level of the central apse.

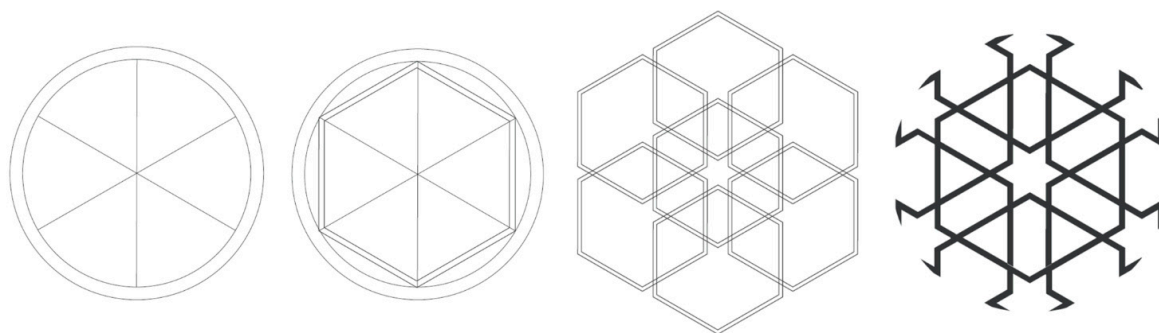


Figure 16. Prägnanz.

3.8. Past Experience

Perception, like other conditions, can also be influenced by past experience, which has a determinant influence on other primary characteristics. The past and experience condition our way of seeing and perceiving that, as a result, varies from one subject to another.

This case favours the construction of objects with which the observer is familiar, with respect to those that are new. Elements that, in virtue of experience acquired over time, are habitually associated with one another tend to be perceived as unified forms.

In virtue of the influence of past experience, the first perception of Figure 17 is the formation of a flower with 8 petals. The geometric construction is obtained from eight repetitions in a circular series of simple figure: a circle.

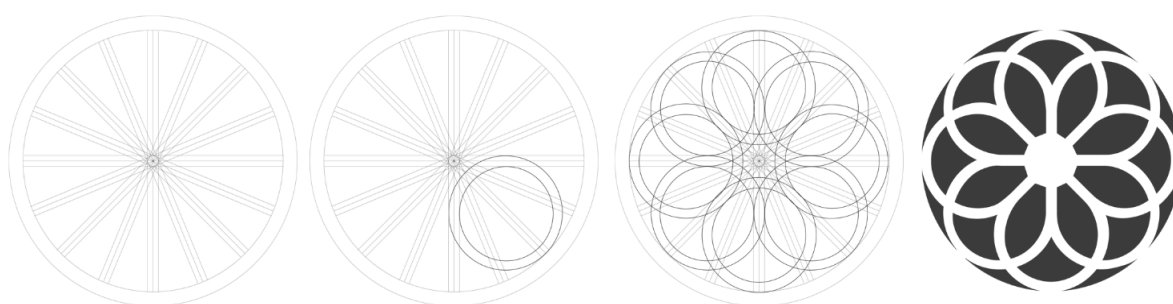


Figure 17. Past Experience.

The first perception of Figure 18 is the formation of eight arrows arranged in a circular pattern. Using the law of closure, it is also possible to identify, at the centre of the composition, a white eight-pointed star whose edge does not exist in reality. The arrows are geometrically generated by the overlapping of two squares rotated with respect to one another by 45°. When the arrows are not visualised, it is possible to perceive two squares and vice versa.

The oculus containing this figure is located on the lower level of the north apse.

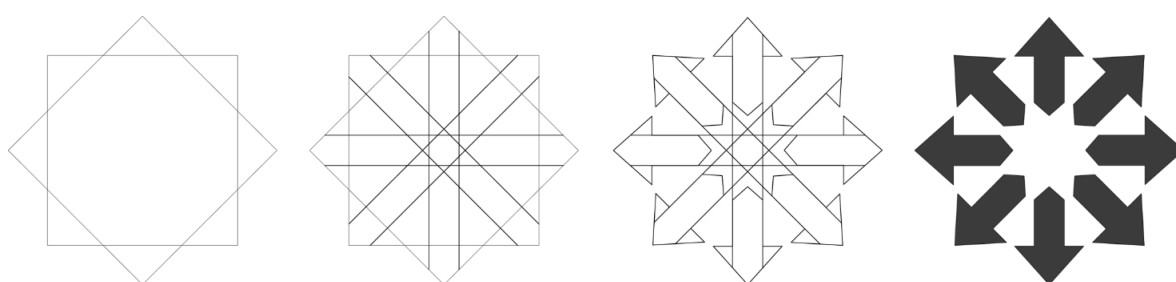


Figure 18. Past Experience.

4. Conclusions

Some of the examples explored here refer to the association of one or more conditions of visual stimulation. The attempt made in this brief text intends to induce a new perceptive awareness resulting from a more attentive and prolonged period of observation. This makes it possible to observe that the drawings differ from one another and, after an even longer period of observation, to perceive the peculiarities of each geometric construction.

Borrowing the concept of “imageability” expressed by Kevin Lynch, in other words “that quality in a physical object which gives it a high probability of evoking a strong image in any given observer” [8] (p. 31), the graphic analysis conducted here wishes to offer a key to the comprehension of geometric characteristics that generate the perceptive effects described.

Acknowledgment: The drawings accompanying this text have been drawn by students Sonja Burgì and Denise Mucera within the course “Disegno e Rappresentazione Multimediale” held by the author at the Department of Architecture of the University of Palermo in the academic year 2014–15.

Conflicts of Interest: The authors declare no conflict of interest.

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