The Whispers of a Window Wing in Istanbul

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Abstract

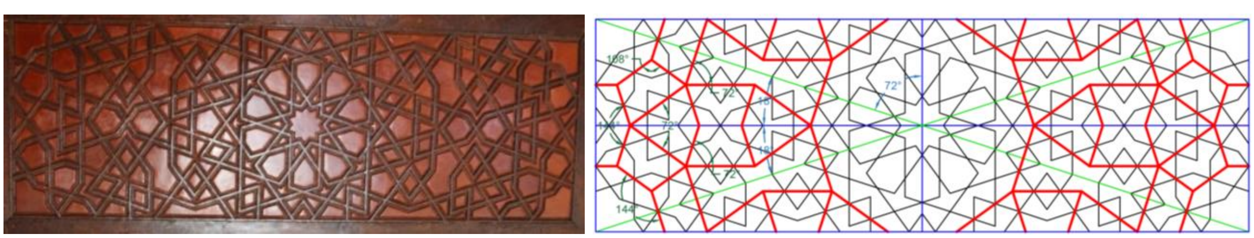
In this workshop we will explore a design with a mysterious underlying pentagonal system on a wooden window wing in the Suleymaniye Mosque, Istanbul. We will examine the basis of this system and learn how the features inherent to its design can go through changes with the application of mirror symmetry, glide symmetry and rotational symmetry. We will analyze how the structure of this unique design allows us generate other compositions.

Introduction

The Süleymaniye complex in Istanbul is one of the signature works of the great Ottoman architect Sinan, completed in the 16th century. The doors of the complex exhibit many different examples of kundekari [11]. A general characteristic of these kundekari doors is that their designs consist of a geometric arrangement of forms based on a pentagonal system where one or several ten-pointed stars can be found at the center of the composition and a quarter of a ten-pointed star on each corner. The properties of the central and corner stars would typically be the same, however, in the design of this one window wing we are presenting in this article, they are not the same. Finding out how this characteristic affects the generation of new designs yields new insights into its potential use in arts and architecture.

The Potential of New Designs from the Window Wing

Jay Bonner identifies this kind of geometric design as being derived from a series of polygonal modules that he refers to as the five-fold system. He names the geometric conditions that provide for the four historical pattern families within this pentagonal system as the acute, obtuse, median and two-point [4,3]. According to this methodological analysis, the ten-pointed star at the center of the geometric design on the window wing is a product of the two-point family, while the quarter stars in the corners are from the median family (Figure 1). In Figure 1, the pieces highlighted in red color show the polygonal pieces of the design where we can see the lines of the design cuts the lines of the polygonal pieces at two points which is the reason why Bonner would call this a “two point” polygonal system.



(a) (b)

Figure 1: *The wooden window wing in Sinan’s Suleymaniye Mosque (a), and the analysis of its design showing its underlying polygonal system (b).*

The general nature and characteristics of pentagonal pieces that make up this system have been detailed elsewhere [6, 7, 9]. The polygonal technique, as described by Craig Kaplan, combines the use of different polygons to create the repeated pattern [8]. In this design, the corner angle of the central star is 36° (acute) and that of the corner stars is 72° (median). The intersection angle of the diagonals of the rectangular piece of the window wing to the center is 36°. By applying rotational symmetry ten times to the area, this 36° angle enables us to create new patterns in accordance with the design principles of the minbars of Sinan mosques [10, 2, 1]. Generally, in the works Ottoman kundekari when ¼ of the wooden door is cut in half diagonally, the two half pieces, which are also the smallest units of the pattern, would be symmetries of each other. And by repetitively applying mirror symmetry to this unit we can arrive at the rectangular pattern. However, on the pattern of the window wing, because the ten pointed stars at the corners and at the center are different (Figure 2), we have two distinct pieces as the smallest unit of the design that are not symmetrical. As a result, while the common examples of kundekari designs would only allow us to produce a single design through rotational symmetry, with this example of kundekari, it is possible to create three different window wings along with the original pattern (Figure 3).

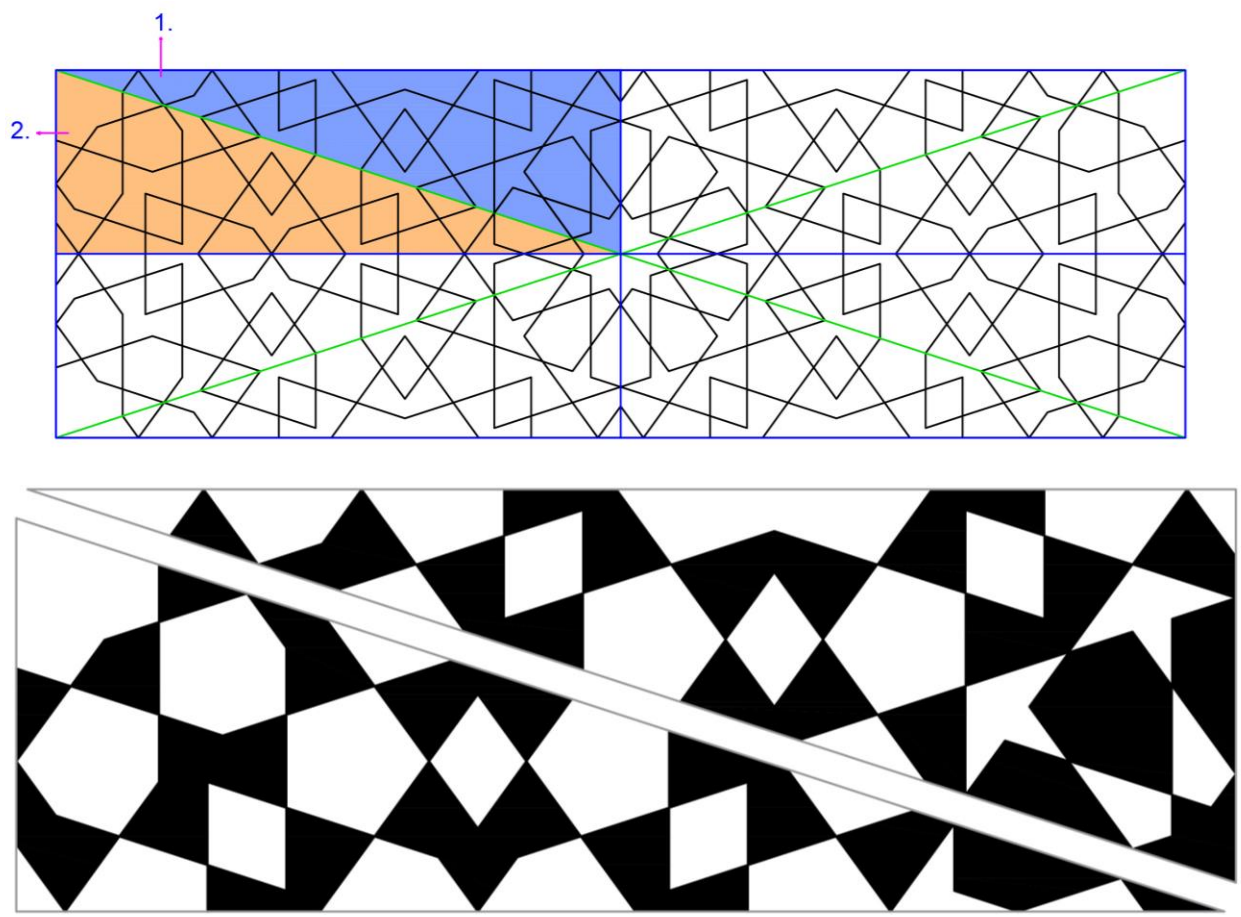
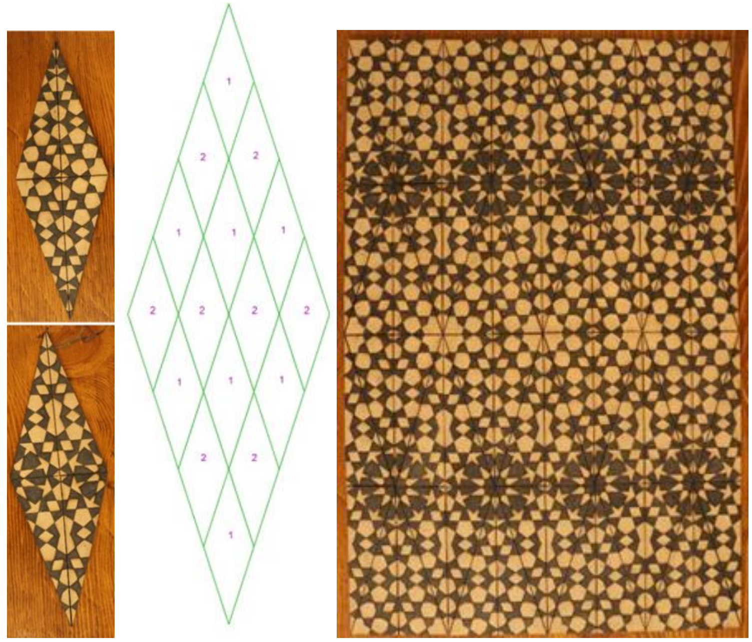


Figure 2: *The smallest units of the design.*

Now let us create new designs by only using the two pieces from this wing. First of all, when we apply a mirror symmetry to these pieces in horizontal and vertical axis individually, we will end up having two different rhombi with 36° and 144°. By applying glide symmetry to both of the rhombi together, we can create a surface tessellation (Figure 4).

Figure 3: *Other window wing designs.*



(a) (b) (c)

Figure 4: *The first and the second rhombi (a), the way it is tessellated with glide symmetry (b), the design with the tessellation (c).*

Furthermore, if we apply rotational symmetry ten times to each rhombus separately we will have two more different designs (Figure 5). These two designs are same size stars with different interior configurations.

(a) (b)

Figure 5: *The two different designs produced by applying rotational symmetry to the first (a), and the second piece (b).*

Things get even more interesting if we want to extend the design at this point. In kundekarı examples, where the center and the corner stars are the same, the rhombus produced by the smallest unit of such design can expand toward infinity if they are tessellated in a rotational fashion outwards from the center [5]. However, as the unique design on the window wing produces two different rhombi, we need a different solution to expand the design. Similar to the way we expanded the first design by the translation of two different rhombi, the system here, also, will run in two ways by systematically alternating between the different pieces. If we have the first rhombus at the center, we can extend the design towards infinity in the order of 1-2-1, and, if the second rhombus is at the center we will follow the order of 2-1-2 (Figure 6).

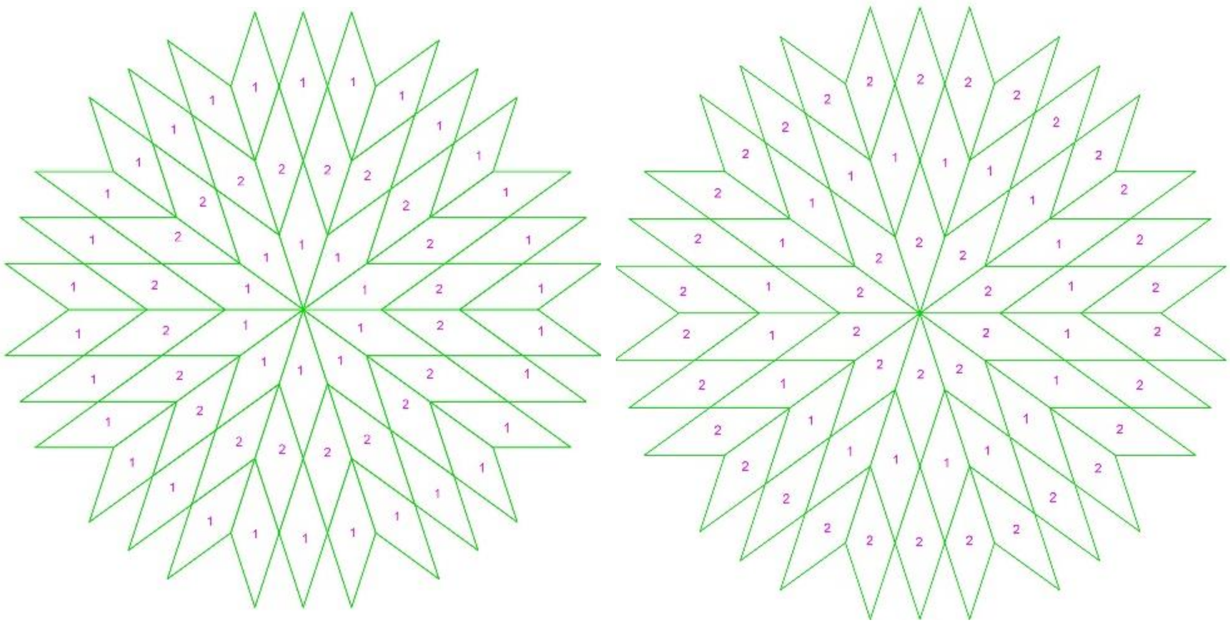


Figure 6: *The sequencing of the rhombi to expand the design toward infinity.*

Figure 7: *Expanding towards infinity when the first piece is at the center.*

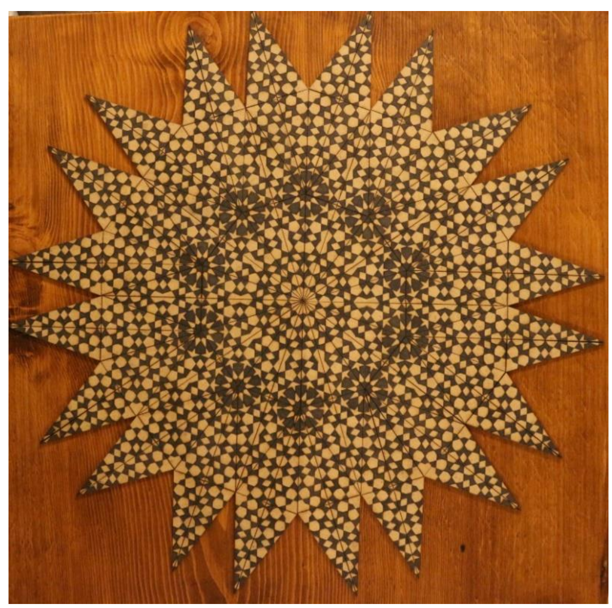
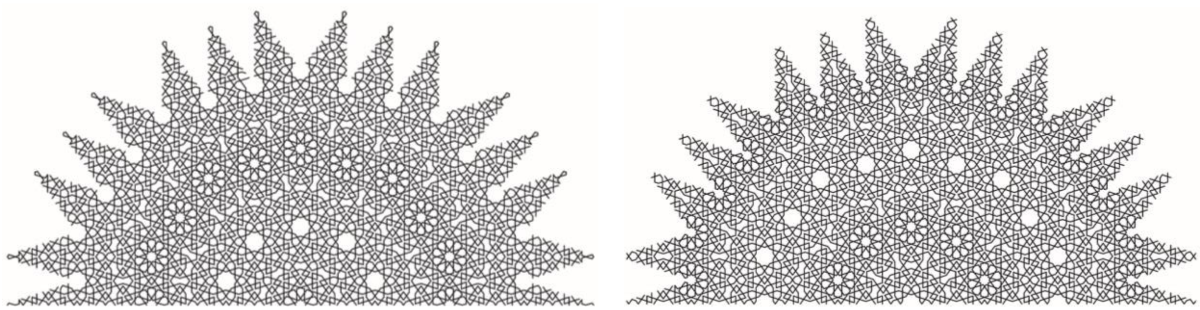


Figure 8: *Expanding towards infinity when the second piece is at the center.*

Figures 7 and 8 respectively illustrate the effects of repetition in each case. Figure 9 illustrates the two different patterns which further extend towards infinity: on the left, the first piece is at the center, and on the right, the second piece is at the center. The sequencing of the rhombi determines the outcome of the design. Finally, by using the rectangular and circular designs drawn or printed on a cardboard, we can produce two different decagonal prisms (Figure 10).



(a) (b)

Figure 9: *Further expansion of the design: (a) when the first piece is at the center, (b) the second piece is at the center.*

Figure 10: The two three-dimensional designs.

Workshop Objectives and Modus Operandi

- The materials that are used in this workshop are the wooden pieces of triangles (sized 13.5cm x 4.1cm x 12.9cm), cardboards with printed designs, glue, instructional handouts and a power point presentation. We will be preparing and providing these materials for the workshop.

- The workshop will begin with a ten minutes long introduction about the designs and their historical development. It takes an individual approximately thirty minutes to make all the designs. In a group work this time would be shorter. After the introduction, the participants will be given a handout with all of the designs and be asked to recreate these designs by assembling the wooden triangles on a surface. The surface will be covered with different designs composed of hundreds of triangles. This way, the participants will be able to easily understand how the methods of mirror symmetry, glide symmetry and rotational symmetry works and they will observe the role of these methods in creating the designs. It takes an individual approximately thirty minutes to make all the designs. In a group work this time would be shorter. Lastly, the participants will be instructed to make a three-dimensional craft project by using two-dimensional prints of the designs. After optionally colouring the parts, they will be asked to glue them together and complete their decagonal prisms which they can take home.

- In the previous workshops, the participants found it challenging to identify the horizontal and vertical mirror symmetries of the parts to create the rhombi. We observed how this challenge made it a very entertaining experience especially for young learners. They also find it very rewarding to see the final design. Since all the designs can extend toward infinity they get to decide where they would like to finalize their designs.

- This workshop aims at gaining the participants (1) knowledge about the nature of historical kundekari designs in general and what makes this design special which entails familiarization with the five-fold systems and kinds of historical pattern families; and (2) the ability to identify the smallest unit of such designs and produce new designs from these units which is a skill set that they can utilise to experiment with any geometrical composition.

Conclusion

In this article, we analyzed the design of a wooden window wing that at first glance appears to be random but with careful investigation we have shown it to be otherwise. We have seen how this pattern located inside an idle piece of a rectangular panel amongst many other much larger doors containing many more designs has an exceptional system with a remarkable potential for producing novel designs. From a single pattern located within a narrow frame, we may produce designs that can expand toward infinity with simple applications such as symmetrical translation and rotational symmetry. In summary, we tackled the analysis of a historical geometrical design and the methodology of creating new ones from it. We hearkened to the sound of a wooden window wing, which has been waiting for hundreds of years in serenity and quietness.

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