Creating Non-Systematic Islamic Geometric Patterns With Complex Combinations of Star Forms

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Abstract

This Workshop will demonstrate the design methodology employed in the creation of particularly complex Islamic non-systematic geometric patterns with differentiated regions of compound local symmetry. This variety of Islamic geometric pattern is characterized by combinations of star forms that range from the more compatible (such as 9s and 12s) to the seemingly incompatible (such as 9s and 11s, and 11s and 13s). A series of historical pattern examples, ranging in complexity, will be used to demonstrate the non-systematic use of the *Polygonal Technique* of geometric pattern generation; and corroborating historical evidence will be provided that confirms that the techniques being taught in this Workshop were used by Muslim artists of the past. Along with self-similar designs, this variety of geometric pattern represents the pinnacle of Islamic geometric art; yet very little has been published on this all-but-lost design methodology. The objective of this Workshop is to assist in the rekindling of this design tradition: opening the door to working with, and teaching, the more complex aspects of this ancient design discipline.

Introduction

The subject of this Workshop is a class of particularly complex Islamic geometric designs, referred to as *compound patterns*, that are characterized by two or more regions of localized symmetry, and associated star-forms [1]. Such patterns are very beautiful and geometrically intriguing. The vast majority of traditional Islamic geometric star patterns were created using the *polygonal technique* [2]. Patterns created from the polygonal technique can be divided into two general categories: (1) those that are created from a *systematic* methodology employing a finite number of decorated polygonal modules with *n*-fold symmetry that are easily able to tessellate together in different edge-to-edge combinations to

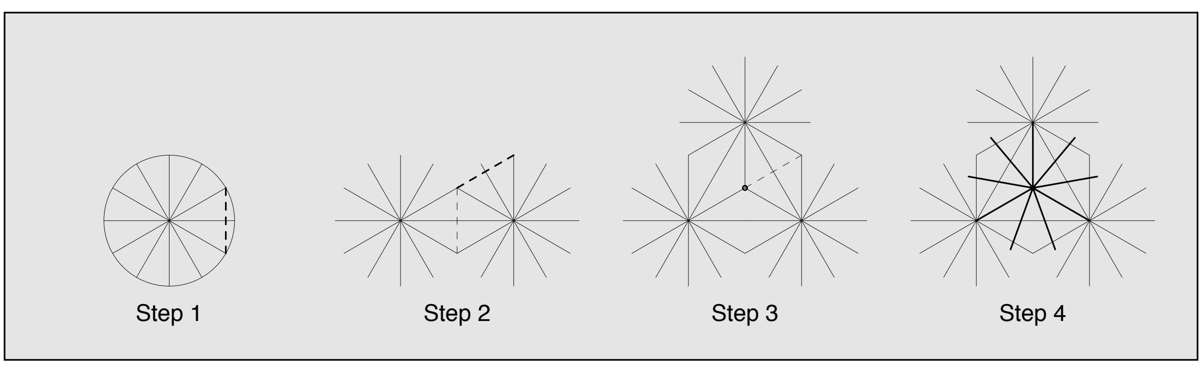

Figure 1: *Development of a representative radii matrix with compound symmetry: 12-fold at the vertices of the isometric grid, and 9-fold at the centers of each triangle.*

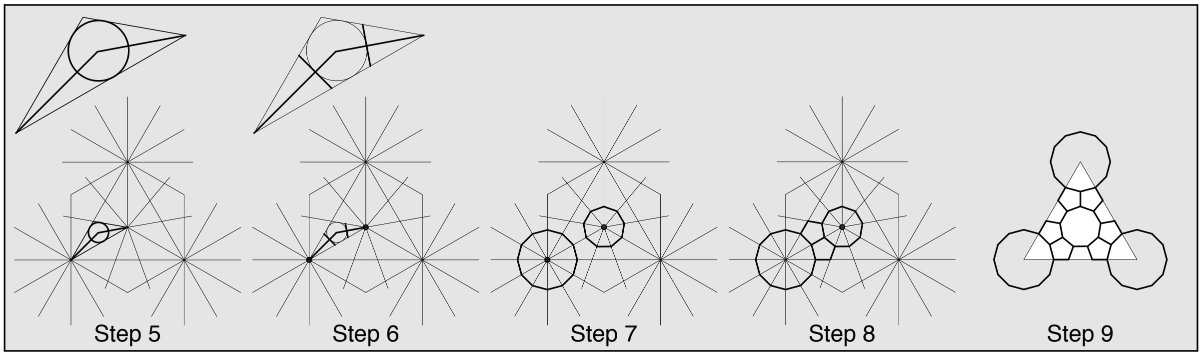

Figure 2: *Development of a representative underlying generative polygonal sub-grid from a radii matrix: dodecagons at the vertices of the isometric grid, and nonagons at the centers of the triangular repetitive unit, separated by a ring of irregular pentagons.*

construct an unlimited number of generative tessellations [3]; and (2) patterns that are created from an underlying generative polygonal tessellation whose individual sub-grid elements include polygons that are unique to the given pattern, and hence qualify as *non-systematic*. This design methodology utilizes underlying polygonal tessellations (sub-grids) as scaffolding upon which geometric pattern lines are strategically placed. Following the creation of the pattern the sub-grid is discarded, leaving no discernable trace of the method by which the pattern was constructed. The placements of the pattern lines onto the underlying generative sub-grids are generally arranged so that two crossing pattern lines are located upon (or near) the midpoints of each polygonal edge. The specific contact angle of these crossing pattern lines determines the character of the completed pattern. By varying the angle of the crossing pattern lines Muslim artists developed three historical families of Islamic geometric pattern: the *acute*, *median*, and *obtuse*. A fourth family, referred to as *2-point*, places pattern lines upon two points of each underlying polygonal edge [3]. Since the identification of the various historical generative systems that were employed by Muslim artists of the past [3], considerable attention has been given to this more formal and systematic design methodology [4]. By contrast, the historical, and far more intricate, techniques for creating non-systematic geometric patterns have remained obscure.

Workshop Objective

The objective of this Workshop is to provide the participants with the necessary design skills for creating original geometric patterns in this specialized design discipline. This non-systematic methodology is all but lost, yet the skills required to create original patterns of this variety are easily learned by those with the patience and interest to learn this very specific practice. As a means to assist in the rekindling of this design tradition, it is intended that this Workshop should encourage the participants to learn and practice these design techniques, as well as, one hopes, teach others.

Design Methodology

This Workshop will provide historical evidence demonstrating the primacy of the polygonal technique in creating compound patterns. The design methodology will be

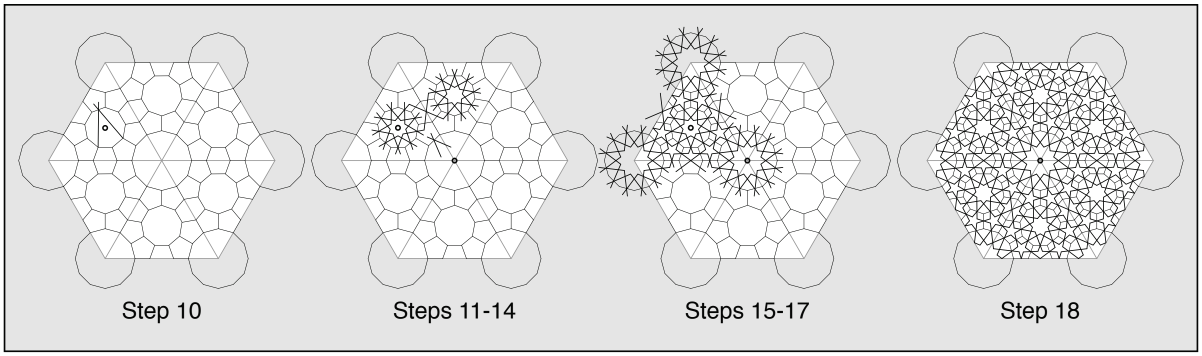

Figure 3: *Development of a representative geometric pattern from an underlying polygonal sub-grid with compound symmetry: 12-pointed stars at the vertices of the isometric grid, and 9-pointed stars at the centers of each triangle. (Note: the representation of this design sequence has been condensed due to limitations in space.)*

approached as a step-by-step sequential process beginning with the construction of radii matrices (**Figure 1**); followed by the creation of the underlying polygonal sub-grids (**Figure 2**); followed by the methods employed in the strategic placement of the pattern lines upon underlying sub-grids (**Figure 3**).

Each participant will be provided an instructional workbook detailing these three design processes, and will keep the workbook as an aide-mémoire for further design exploration and subsequent teaching.

Examination and Analysis of Historical Examples

The above-mentioned triadic design process will be applied to the examination and analysis of several non-systematic historical Islamic geometric patterns, each employing different star combinations and diverse repetitive stratagems. These historical examples are representative of the variety of complex compound geometric patterns found within this tradition. The

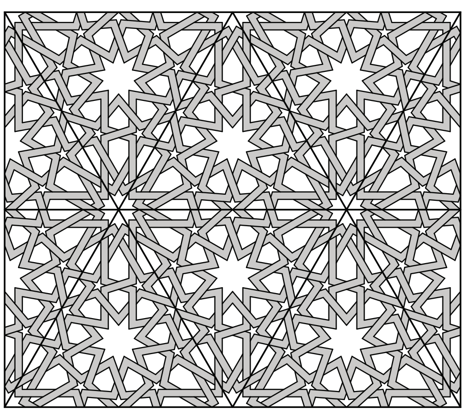

Figure 4: *Compound* acute *pattern with 12-pointed stars at the vertices of the isometric grid, and 9-pointed stars at the centers of each triangular repetitive unit.*

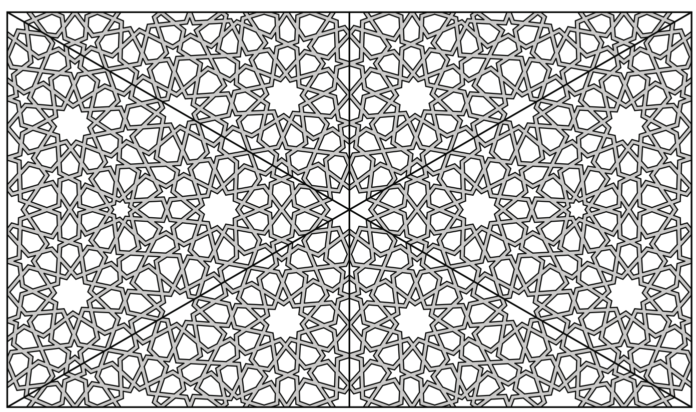

Figure 5: *Compound* acute *pattern with12-pointed stars at the vertices of the isometric grid, 9-pointed stars at the centers of each repetitive triangle, 10-pointed stars at the midpoint of each triangular edge, and 11-pointed stars within the field.*

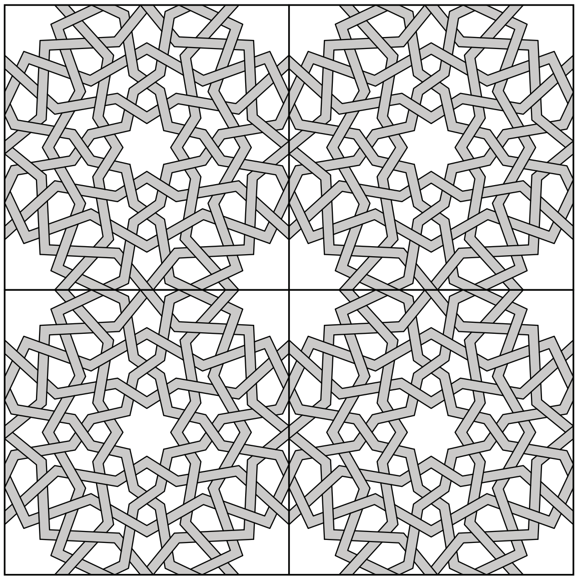

Figure 6: *Compound* obtuse *pattern with 16-pointed stars at the vertices of the orthogonal grid, and 8-pointed stars at the centers of each repeat unit. The sub-grid for this pattern was also used historically to create an* acute *pattern*.

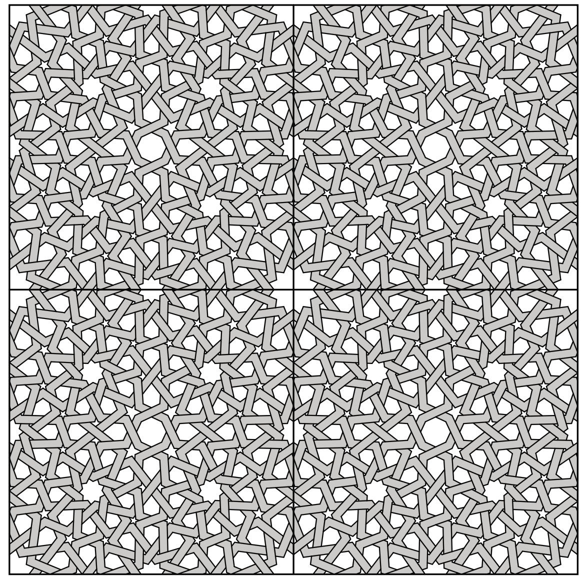

Figure 7: *Compound* acute *pattern with 12-pointed stars at the vertices of the orthogonal grid, octagons at the centers of each repeat unit, 10-pointed stars at the midpoint of each repetitive edge, and 9-pointed stars within the field*.

patterns selected for examination and analysis in this Workshop include: an *acute* pattern comprised of 9 and 12-pointed stars that repeats upon the isometric grid. This pattern was employed frequently throughout the Islamic world (**Figure 4**); a particularly complex Seljuk *acute* pattern from the Karatay-Han in Turkey (1230-40) that repeats upon the isometric grid with 12-pointed stars at the grid vertices; 9-pointed stars at the center of each repetitive unit; 10-pointed stars at the midpoint of each repetitive edge; and 11-pointed stars within the repetitive field (**Figure 5**); a very well balanced Timurid *median* pattern from the Madrasa of

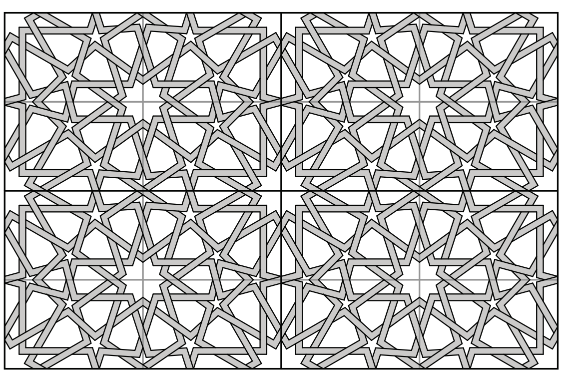

Figure 8: *Compound* acute *pattern with 12-pointed stars at the vertices of the rectangular repetitive grid, and 10-pointed stars at the vertices of the repetitive rectangular dual grid*.

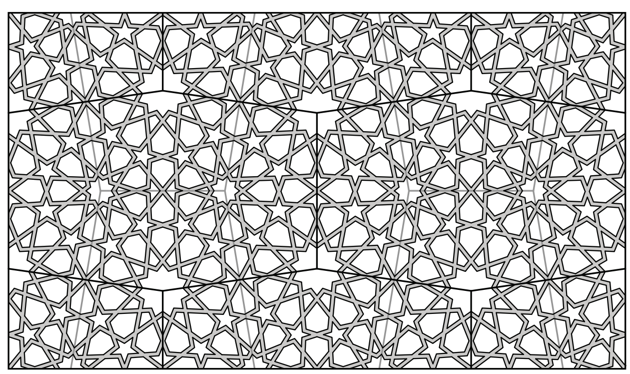

Figure 9: *Compound* acute *pattern with 11-pointed stars at the vertices of the elongated hexagonal repetitive grid, and 9-pointed stars at the vertices of the perpendicular elongated hexagonal repetitive grid*.

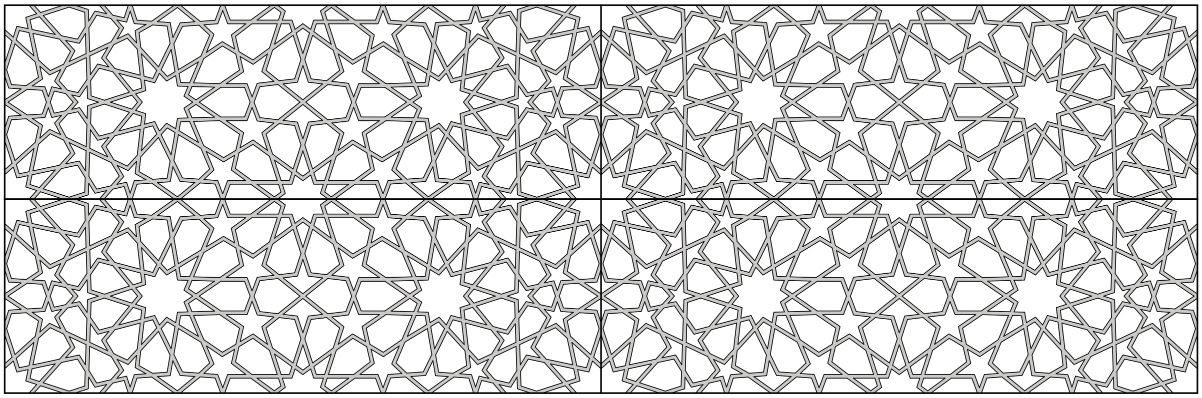

Figure 10: *Compound* acute *pattern with 12-pointed stars at the vertices of the unusually long rectangular repeat unit, 10-pointed stars at the centers of the long edge of the repetitive unit, and 11-pointed stars within the field of the repeat unit.*

Ulugh Beg in the Registan in Samarkand (1417-21) that repeats upon the orthogonal grid and places 16-pointed stars at the vertices of this grid, and 8-pointed stars at the centers of each repeat unit (**Figure 6**); a more complex orthogonal *acute* pattern from the Agzikara Han of Seljuk Turkey (1236-46) that places 12-pointed stars at the vertices of the square repeat units; 10-pointed stars at the midpoints of the edges of the repeat units; and 9-pointed stars within the repetitive field (**Figure 7**); a Seljuk *acute* pattern that repeats on a rectangular grid from the Great Mosque of Aksaray in Turkey (1150-53) that places 12-pointed stars at the vertices of the grid, and 10-pointed stars at the vertices of the rectangular dual grid (**Figure 8**); an *acute* pattern from the Topkapi scroll that employs an elongated hexagon as its repeat, with 11-pointed stars at each vertex of the repeat unit, and 9-pointed stars at the vertices of the perpendicular dual repeat unit that is also comprised of elongated hexagons, but of a different proportion (**Figure 9**); and a Seljuk *acute* pattern from the Hizr Ilyas Kiosk in Erkilet in Turkey (1241) that employs an especially long rectangular repeat unit with 12, 11, and 10-pointed stars (**Figure 10**). This pattern is characterized by a series of linear bands of identical star forms that alternate in a 12-11-10-11-12 assembly. This pattern has an identical layout of the star forms to the celebrated design [6] from the Maqam Ibrahim at the Citadel of Aleppo in Syria (c. 1212). However this Turkish example is considerably more successful in its overall aesthetics.

Due to time constraints, only a selection of these historical examples will be fully examined within the presentation. However, the step-by-step design process for each will be included within the accompanying workbook.

Workshop Structure

The first half of the 60-75 minute Workshop will be a PowerPoint presentation that details the sequential design process used in creating the initial radii matrices, the subsequent underlying polygonal sub-grids, and culminating in the application of the pattern lines. The provided workbook will correspond with material in the PowerPoint presentation and will include explanatory imagery for each of the historical examples mentioned above. The second half of the Workshop will involve putting into practice several of the techniques that have been covered in the first half of the Workshop. To this end, exercise sheets will be provided to each attendee, and the presenter and his assistant will circulate among the participants to assist in the learning process, provide critiques, and answer questions. Following the Bridges 2012 Conference, the handout booklet and exercise sheets will be available for download from Jay Bonner's website (see above for web address).

Attendee Information

The construction methods employed in creating non-systematic Islamic geometric patterns are not especially difficult, but require discipline and patience. Attendees should have a working knowledge of basic geometry. Consequently, this Workshop is not suitable for young children. In addition to a keen interest in the subject, each attendee should bring the following items:

- Automatic pencil, or a pencil and sharpener.
- Eraser.
- Straightedge.
- Pad of tracing paper.

Presenter Biography

Jay Bonner is a consulting specialist in Islamic architectural ornament and has worked in the field of Islamic geometric design methodology for some 38 years. His forthcoming book *Islamic Geometric Patterns: Their Historical Development and Traditional Methods of Derivation* (Springer, 2013) is dedicated to the revitalization of this design tradition. The material covered within this Workshop is a selection from the far more extensive design exposition in his forthcoming book.

References

[1] J. Bonner. *Islamic Geometric Pattern: Their Historical Development and Traditional Methods of Derivation* (Library of Congress copyright TXu000981014 / 2000-08-21).
-Craig Kaplan; *Islamic Star Patterns from Polygons in Contact*, Proceedings of the 2005 Conference on Graphics Interface, Victoria, British Columbia, Canada, pp. 177-186.
-Peter Cromwell; *Islamic Geometric Designs from the Topkapi Scroll I: Unusual Arrangements of Stars*, Journal of Mathematics and the Arts, Vol. 4, Issue 2, 2010.

[2] E. H. Hankin in *The Drawing of Geometric Patterns in Saracenic Art*; Memoirs of the Archeological Survey of India, No. 15, 1925.

[3] J. Bonner; *Three Traditions of Self-Similarity in Fourteenth and Fifteenth Century Islamic Geometric Ornament*; Bridges Conference Proceedings, 2003.

[4] Peter Lu & Paul Steinhardt; *Decagonal and Quasi-Crystalline Tilings in Medieval Islamic Architecture*, Science 315: 2007; 1106-1110.
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[5] E. Herzfeld; *MCIA. Troisième partie: Syrie du Nord. Inscription et monuments d'Alep*, 1954-6, vol. 1, MIFAO, fig. 56.