Legerdemain: Exploring Tessellation with CatsEye

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Abstract

In this workshop participants will explore the use of CatsEye software for transfiguring hand-drawn sketches into tessellations. CatsEye is a Web-based application that features: an easy to use interface, five polygon tessellation structures (three regular and two irregular), high resolution image export, and a host of customizable settings. CatsEye may enhance the studio workflow for a great variety of art and design practices, including: fashion, interior design, graphic design and visual art. A preliminary exercise will examine and discuss the historical tools for the artist and mathematician, such as the compass and straight edge, and how these tools, fueled by geometry, translate into a software environment.

Introduction to Tessellation Techniques

The mathematical proofs for the 17 plane symmetry groups (or wallpaper groups) were first established in the late 19th century [1]. But the practical, intuitive use of these groups was developed by the artisanal vernacular of the ancient world: Egyptian, Greek, Roman and numerous others. Most celebrated for the extensive and creative evolution of these wallpaper groups were the traditional Islamic artists spanning the 12th to 16th centuries. Their tiled architecture not only utilize all 17 groups, they exhibit a profound mastery of the subject – choreographed compositions in form, pattern, colour and cultural context [2].

Today, we enjoy a vareity of digital tools to aid our creative processes. Adobe Illustrator is one of the most popular applications for designing patterns, and while its new Pattern Options tool is indeed powerful, it is a bit unwieldy and hard to rapidly sketch patterns. From a geometrical standpoint, a better option is the opensource software Taprats, developed by Craig Kaplan and Pierre Baillargeon at the Univeristy of Waterloo. While loaded with numerous control features, Taprats is specifically focused on lending computational power to Islamic-style designs [3]. A more recent tool, CatsEye is a software program developed in JavaScript at Victoria Univeristy of Wellington [4]. It is less mathematically rigrorous than Taprats, but lends an easy to use interface, runs within a Web browser, and unique in that pattern tiles act as clipping masks: the software lends itself to patterns that balance abstration/pictorial imagery.

Warm Up: From Compass to Code

The workshop will begin with a warm up exercise that pays homage to the mathematical techniques developed by master artisans dating back to the early last millennium, particularly in the Islamic world. While the exact techniques of these artists are not clear, they most likely employed the compass,

straightedge and some knowledge of Euclidian geometry. [5] The warm up will conclude with a demonstration of how these techniques can be translated into computer programming.

1. Constructing p6m by hand – 30 minutes. One of the most widely utilized plane symmetry groups in the Islamic arts (and in our CatsEye software) is p6m. We will sketch out a p6m pattern using a compass, straightedge and paper by (see Figure 1): a) constructing a hexagon, b) constructing a hexagon grid, c) identifying the p6m unit cell, and d) identifying the template motif. From there we will discuss unit motifs and how these could be tessellated across the hexagon grid.

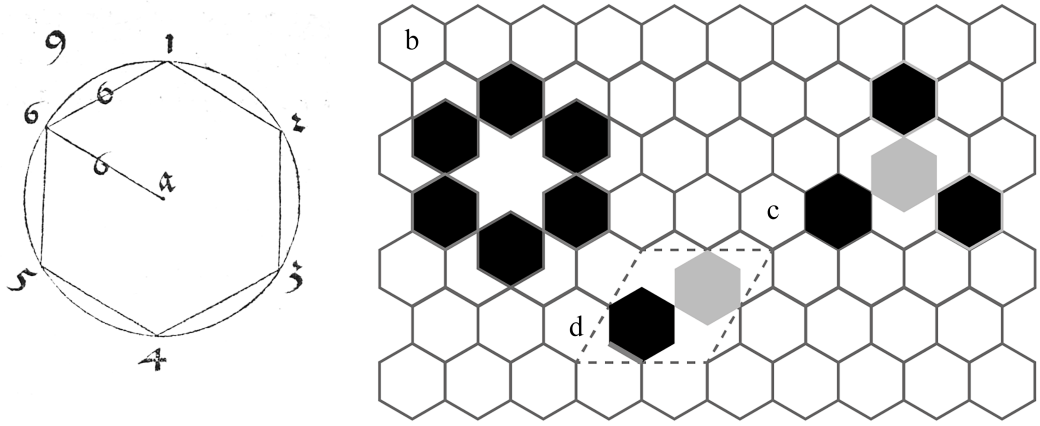

Figure 1: *constructing a hexagon (from Dürer) [6], constructing p6m (from Abas et al) [2].*

2. Constructing p6m with code – 30 minutes. A sample file will be provided that translates the previous steps into JavaScript. After highlighting the primary elements there will be some time for experimentation.

Creating Patterns with CatsEye

Creating patterns with CatsEye can be broken down into three steps that will be covered in the workshop: **Import** – constructing and importing images into CatsEye; **Patterning** – using the CatsEye interface to develop patterns; **Export –** final images from CatsEye are exported into other workflows. Participants will need black ink pens or markers, paper, a cell phone or camera and a laptop with Internet access (Photoshop, Illustrator, GIMP or Inkscape will be useful, but not required).

1. Import – 20 minutes. While any image digitized into a JPEG format can be used to create patterns in CatsEye, ink drawings and vector graphics work the best; the reductive information tends to create a more seamless visual logic as the cropped images reconnect along reflected axes. Participants will work with ink on paper, then scan or photograph their work to their laptops.

Figure 2: *source drawing [7], and source drawing imported into CatsEye.*

2. Patterning – 20 minutes. Once the source image is available, participants may load it into the *CatsEye* website (see Figure 2). Use of the software will be demonstrated during the workshop.

3. Export – 30 minutes. A final demonstration will show how these patterns can be incorporated within a few different art/design studio techniques using Adobe Photoshop and Illustrator (see Figure 3 and Figure 4). CatsEye has been used for graphic design, painting, wall-stencils, laser-cut projects and more.

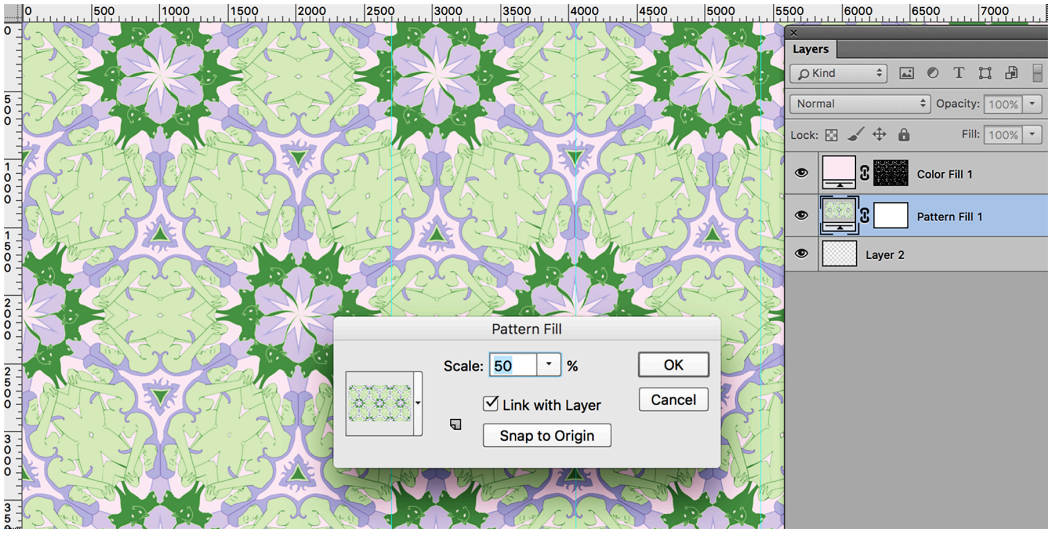

Figure 3: *CatsEye export converted into a Photoshop pattern.*

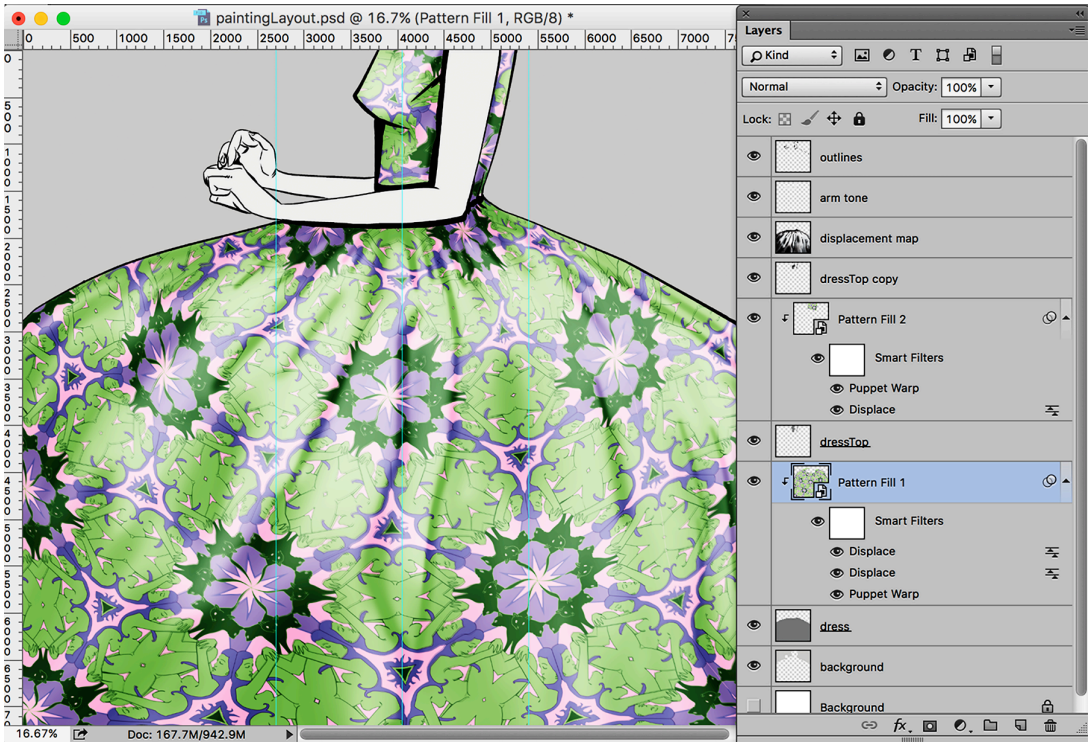

Figure 4: *The pattern converted into a clipping mask.*

Conclusion

In conclusion, the tiling types central to CatsEye (three regular polygon tilings, p6m, P3m1, p4m and two irregular polygon tilings, Voronoi and Delaunay) will be discussed. Upcoming plans for CatsEye will be presented and the participants are welcome to make suggestions as to how this software may be extended in the future.

References

[1] Fisher, Gwen, *A Method for Illustrating Border and Wallpaper Patterns*, in Renaissance Banff: Mathematics, Music, Art, Culture, pp. 511-518. 2005.

[2] Syed Jan Abas and Amer Shaker Salman, *Symmetries of Islamic Geometrical Patterns*, World Scientific, Singapore, 1995.

[3] Kaplan, Craig and Baillargeon, Pierre. *Taprats* website. https://sourceforge.net/projects/taprats/ (as of February 28, 2016).

[4] Easterly, Douglas and Jack, Ben. *CatsEye* website. http://catseye.graphics (as of February 28, 2016).

[5] Kaplan, Craig, and Salesin, David, *Islamic star patterns in absolute geometry*, ACM Transactions on Graphics (TOG), Vol. 23, pp. 97-119. 2004.

[6] Dürer, Albrecht, *Underweysung der Messung mit dem Zirckel und Richtscheyt*, Linean, Nuremberg, 1525.

[7] A Page from Hokusai Manga (1760 – 1849). Source: https://commons.wikimedia.org/wiki/File:Hokusai_Manga_02.jpg (as of February 28, 2016).