

# DESIGN: When it comes to patterns, it's okay to repeat yourself

From Islamic art to ancient architecture, patterns play a key role. Create your own mathematical designs using translation, reflection and rotation.

**W**e're pattern-seeking creatures. Whether you put this down to evolutionary defensive instinct or a higher-sourced aesthetic appreciation, we can't help seeing structure and repetition. This happens even where it doesn't exist, as shown by lottery-playing numerologists. More positively, patterns play an important part in art in practically every culture and age. In 1943 Alfred Whitehead, an English philosopher and mathematician, said: 'Art is the imposing of a pattern on experience, and our aesthetic enjoyment is recognition of the pattern.' This holds true from the monumental architectural designs of ancient Greece (Doric, Ionic and Corinthian) to the personal decorative designs of Aboriginal tattoos, and the visually and mathematically beautiful designs of Moorish and Islamic art.

We looked at patterns in camouflage a while back (see MacUser, 10 September 2010, p74), but repeat patterns is another part of this area of design and it's worth a closer look. Creating complex, detailed graphics that work across repeats can take time, but it's time well spent. The field of

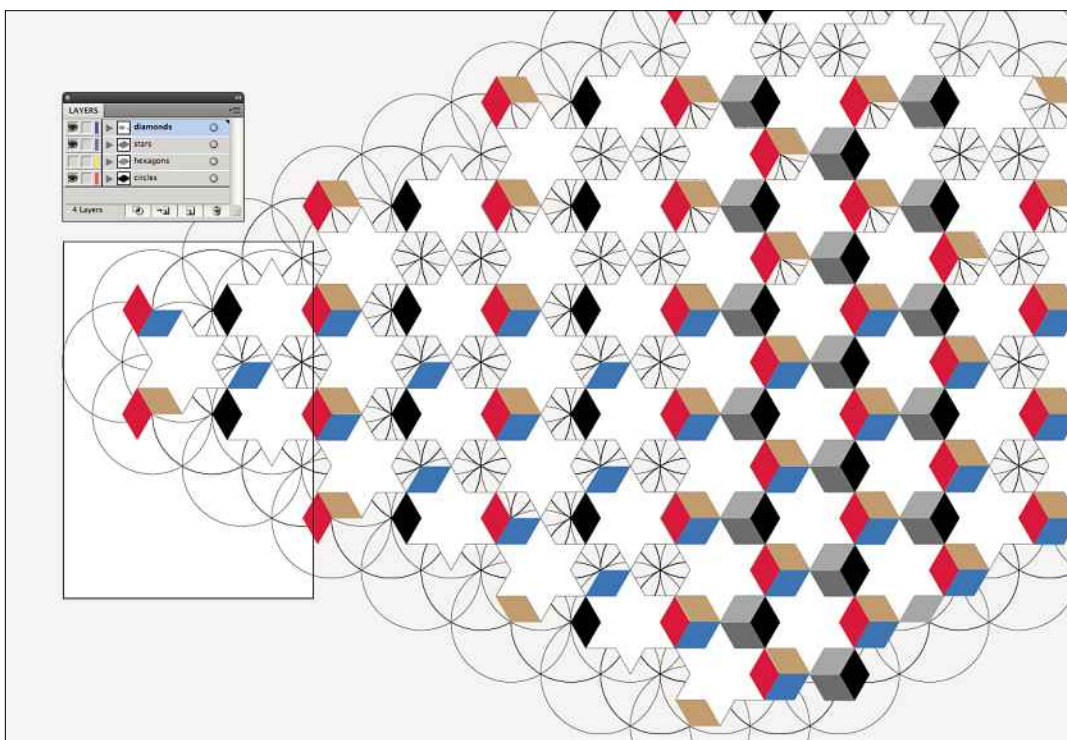
surface design in particular relies strongly on generating and manipulating repeating patterns, and the key techniques to practise for this kind of work are translation, reflection and rotation.

Here, translation isn't anything to do with linguistics. In this discipline, it means repeating by moving – in other words, sliding and copying. At the most basic, think of potato-stamp printing; anything that simply repeats a design over and over across a surface. Alt-dragging does this in most applications, as do the better Duplicate commands. As a graphic manipulation operation, this is fairly simple, but it can be highly effective. Create elements that straddle the adjacent sides of repeating design units and the edges of the actual repeats will start to be hidden in the array of design elements.

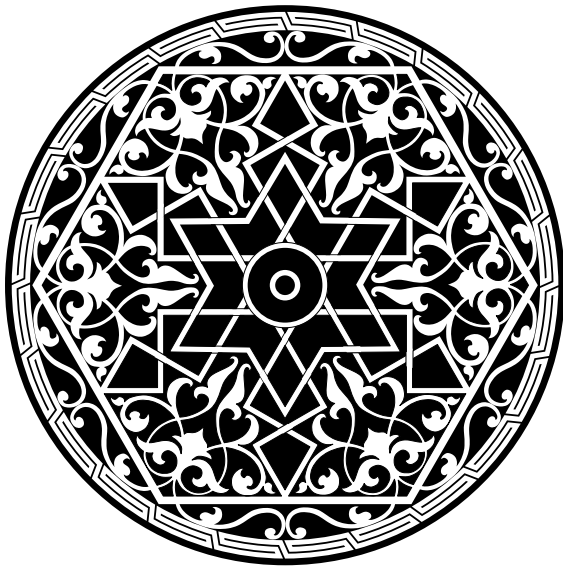
Reflection adds some spice to pattern-generation recipes. Rather than simply replicating something and letting the elements inside the design units do all the work, the shapes are flipped, mirroring the core artwork along a line of symmetry, the reflection axis. This is found in a lot



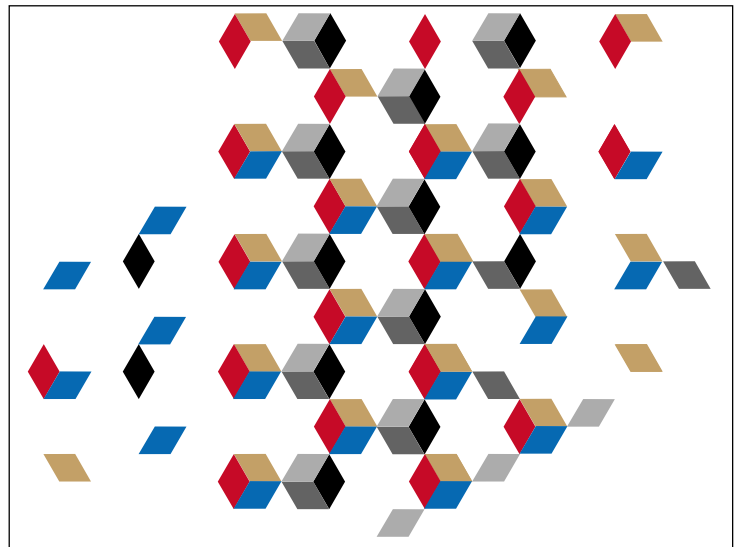
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◀ *With the methods discussed here, use Illustrator to create a repeat pattern structure. Use selection techniques and layers to deal with similar objects across the tessellated design.*



▲ Here's a classic illustrative Islamic geometric design that uses reflection and rotation pattern-generating techniques.



▲ Once a pattern has been created, consider how you can take things further by removing parts. Here, the star shapes created early on are now just implied by the diamond elements.

of classical designs, where symmetry and balance were held in high regard.

Finally, rotation simply defines a point relative to the original and rotates a copy around that point. If you're using Illustrator, click and drag with the Rotate tool, holding down the Alt key to duplicate rather than just move the original. Use this tool to reposition the centre point first. In pattern generation, rotation is often done stepped at some clean division of 360°: 60° for six steps around, 45° for eight around, 36° for 10 around, 30° for 12 around and so on. Other values are possible, although you'll have to use decimal fractions to get things spaced evenly. Rotating a copy every 51.4285714285714° will give you seven instances in a circle; to be honest, though, you only really need a precision level of two decimals for most work.

These three manipulation methods are quite simple, but with a little thought and practice, the end results can be extraordinarily rich and complex.

Sophisticated pattern repeats are a core part of Islamic art and one of the key motifs there is the star pattern, which is a combination of rotation and translation. This is an ancient graphic development that reached a zenith 500 or so years ago and can be found as far apart as Spain and Morocco in the west and Uzbekistan in the east. This star pattern is a mathematically and geometrically based structure, but one of the curious things about these designs is that we know next to nothing about how they were actually developed – at least not much beyond what we can surmise through logic and applied geometry. The craftsmen who produced the patterns considered the process to be secret knowledge, restricted information like the recipes for Coca-Cola and KFC today. We know the work is based on a thorough and widespread understanding of Euclidian planar geometry, and there are countless designs available to study, but we don't know the specific detailed planning that went on behind the results.

Developing new forms based on these artworks is a great exercise in geometric explorative design. I'm not suggesting anything as crass as trying to recreate the intricacies of the work in Cairo's Ibn Tulun Mosque in five minutes, but it's a useful way to develop some graphic insights and get some inspiration. To begin with, use Illustrator to draw a circle that's 100mm in diameter with a plain 1pt stroke and no fill. Duplicate it and place the copy with its centre aligned on the first circle's edge. Create another copy of the circle and

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place the centre where the lines of the original and the previous copy cross. Repeat around the first circle until you have six arranged equally around the circumference. There are various ways to do this, including using the Rotate tool with the point on the original's centre and turning 60° each time.

Use the Pen tool to draw a path from one junction of circle paths to the next and you'll end up with a regular hexagon. Next, draw a path from the midpoint of one of the hexagon segments to the midpoint of the segment two sides around. In case that wasn't clear, you're aiming to have an equilateral triangle that sits with its points midway along lines of the hexagon. Duplicate, rotate 180° and slide it down to form a six-pointed star. Use the Pathfinder palette to unite the triangles into a six-pointed star. Give the hexagon a grey fill and fill the star with white; this will make it easier to see the structures as they form and it will also help with selecting things later.

Yes, we could have made these shapes in a slightly more direct method, but starting with circles, using them to build hexagons and then stars, and progressing through rotation and translation techniques is a good

way to build up a strong feel for the geometric relationships and underlying structural base.

Select everything and Alt-drag across and down to place the new hexagon against the old and line up points of the stars. With Snap To Point selected in the View menu, it should line up relatively cleanly and easily in one go. Next, choose Object > Transform Again. And again, and again. Once you have half a dozen or so instances, select everything, and Alt-drag upward and across to align a copy of it all as before. Repeat the operation with Transform Again a few times and you'll have a tessellated pattern covering part of your page and far into the pasteboard as well.

This is really a starting point, the stage where you can draw paths along routes through the design, slicing it up to get over and under effects, draw diamonds over the implied shapes made by the stars and hexagons, or whatever else takes your fancy. But first, select one of the circles and choose Select > Same > Appearance. Because only those will be selected. Now you can move them safely to a new layer or delete them.

How you develop this is up to you, but spend some time researching the geometric developments of Islamic design and compare this to the illustrative genius of MC Escher. The pattern-generating possibilities of translation, rotation and reflection are endless.

