Triaxial Weaving for Complex Repeat Patterns and Tessellations

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Abstract

Algorithmic color placements in triaxial weaving generate surprising repeat patterns. Periodic arrangements of complex tilings (multiple shape p3 and p6 symmetries) unfold. Tessellations, radial, threefold and sixfold symmetries and directional patterns variously appear. Two-color examples with identical sequencing on each axis are emphasized here, along with simple shifts in color placement which produce inverse colorways, rotations, or distinct pattern variations.

Introduction

Triaxial weaving originates in basketry, where it appears either as an open structure resembling honeycombs, or a solidly woven field of rhombuses in three orientations, resembling the pieced quilt pattern "tumbling blocks". Each element runs from edge to edge, interlacing with two other sets of strips at 60° angles. This interlacement, combined with rhythmic color placement, produces intriguing surface designs. I think of each parallel set of strips as a layer (which is exactly how I handle them in digital graphic design files). Every strip is visible equally: 1/3 on the front , 1/3 on the back, 1/3 enclosed between the two faces.

Triaxial Weave

Triaxial weaving can be developed from the center outward, useful with stiff or very delicate materials and when using an image that must be kept in sequence, such as strips from a map: Figure 1. This approach is extensively illustrated in [1]. I prefer a method addressing one axis (or layer) at a time, which may be the easier way to learn, and helpful when color patterning is involved (Figure 2). Another option is to begin with an open weave (Figure 3), then fill in the spaces.

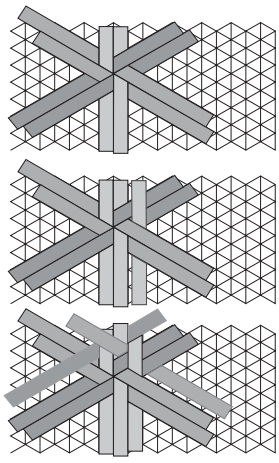


Figure 1:
Working outward from center

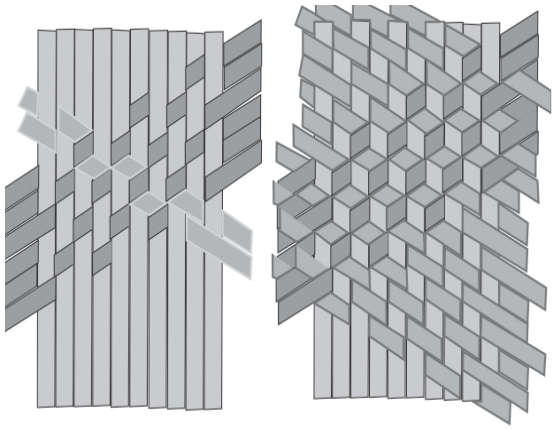


Figure 2: *Layer by layer. The entire vertical set is placed. Elements running from lower left to upper right are woven in (under two, over one, as shown), followed by the elements running from lower right to upper left, interlacing to result in all-over blocks (cube figures) on both front and back faces.*

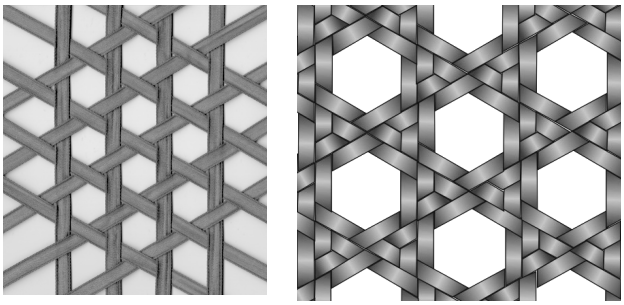


Figure 3: *open "cheesebasket" or "embankment" weaves use 1/3 the material of fully woven work. Left: single strand (the A elements of Figure 14); two strips will fill the space. One strategy well illustrated in [5]. Right: double strands (the A elements of Figure 15). Four strands will fill the space.*

Color and Pattern

Colors and repeat sequences are designated here by letters. Figure (4): color sequence ABAB repeats throughout, in all three layers. Juxtaposition of layers two and three relative to layer one (or to one another) does not affect the motif resulting. Figures 5 and 6, however, illustrate that as repeat sequences become longer, the point of color interplay between layers affects the resulting design. Using AABB in all three layers, a shift in the positioning of layer 3 relative to the other layers yields two different patterns.

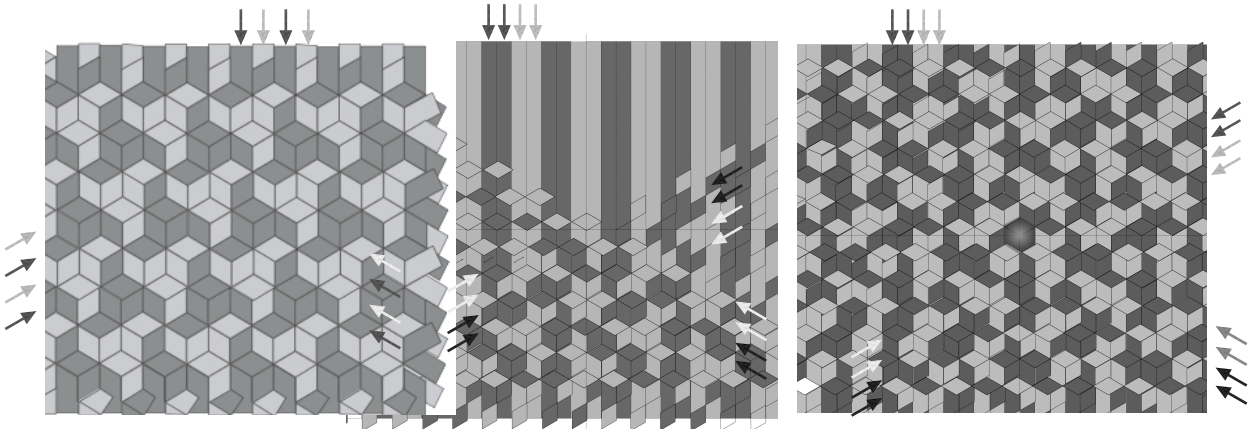


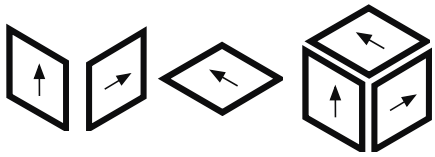
Figure 4: *AB in all layers. "Simple Pinwheels"*

Figure 5: *AABB in progress "Stars and Tadpoles*

Figure 6: *AABB; layer 3 shifted "Dots and Triceratops"*

An accurate model and careful observation are necessary to reproduce a pattern. It helps to determine which rhombus orientation signifies which strip set (Figure 7). I use graphic design software to diagram entire sets of strips as layers, designate color sequences, and digitally shift and stack them to discover the resulting patterns. I weave selected patterns by hand with a blunt needle, often with silk ribbon. Strip thickness and flexibility affect the spacing needed between them: heavier or stiffer materials need a more open sett. Contrast and scale affect how the pattern reads. If the weaving materials are not fully opaque, backlighting reveals additional patterns. The back face often mirrors or transposes the colors of the front.

Figure 7: *Rhombus orientation matching the diagrams here: Layer one (vertical), layer two (angled from lower left to upper right), layer three (angled lower right to upper left).*



Figures 8-10 are woven using color sequence AAABBB in all three layers. In Figures 8 and 9, shifting the placement of layer three results in the same "Dots and Blossoms" motif, but with a reversal of figure and ground colors. Figure 10 is also AAABBB, but this "Windmills and Spirals" motif requires shifting layer two; it is not possible to achieve this motif with layers 1 and 2 placed as in the previous two examples. Other motifs can be generated with this sequencing, applying different shifts.

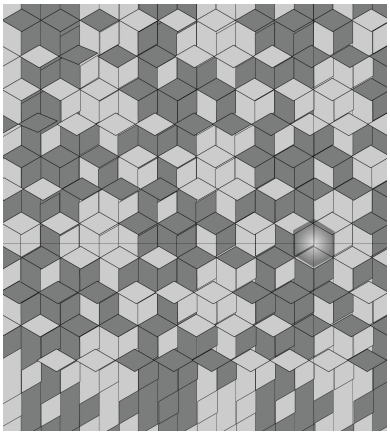


Figure 8

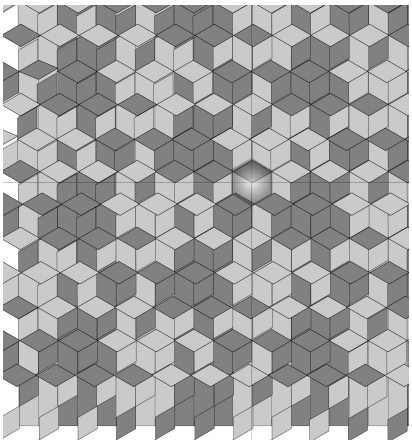


Figure 9:
AAABBB in all three layers.

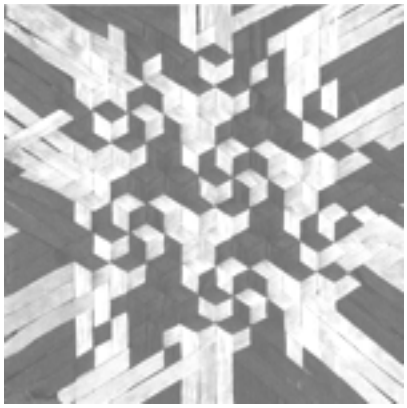


Figure 10
edges visible

Figures 11-13 show a trio of pieces woven AAAABBBB in all three layers, with simple shifts of placement distinguishing them. In Figure 11, there are four repeating motifs. The lighter motif is not symmetrical, and it rotates. In Figure 12 a large motif, center dot surrounded by a spiral within a triangle, appears in two iterations (figure inverts with colors transposed). Light and dark centers appear and the figures tesselate, with rotations of the asymmetrical elements. Colors reverse on the back face. Figure 13: diagonal rhombus strings emphasize the triaxial angles, and connect two repeating motifs. (Dropping your eyelids halfway can make it easier to pick out the motifs.)

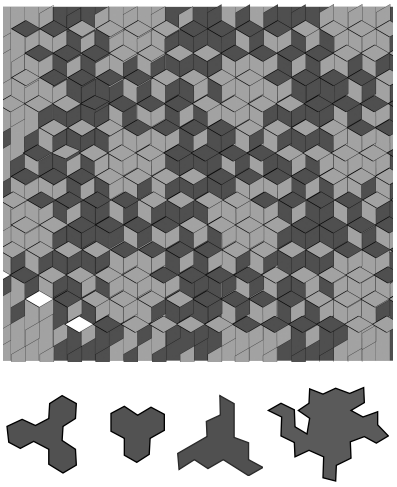


Figure 11: "*Four Motifs"*

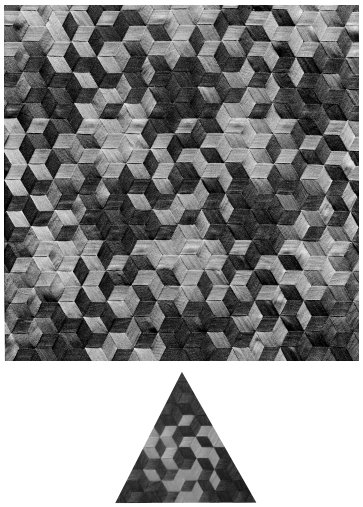


Figure 12: *"Whirlpool Spiral"*

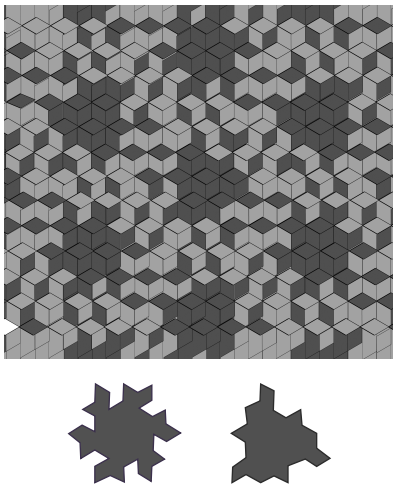


Figure 13: "*Inkblots"*

Light and dark elements do not have to be balanced – repeats can be, for example, ABB or AABBB (Figures 15 – 17). (Note: Figure 15 is a filled in version of Figure 3. Figure 16 is Figure 4, filled.)

The three layers do not have to all use the same sequences; see Figure 17. Patterns can be generated by using different sequences in the layers. Other variations: weaving with strips which change color along their lengths, or with ombre strips as in Figure 18 (color is modulated from edge to edge across the strip's width). Images and materials such as documents can be cut into strips and interlaced, pattern repeats optional (Figure 19).

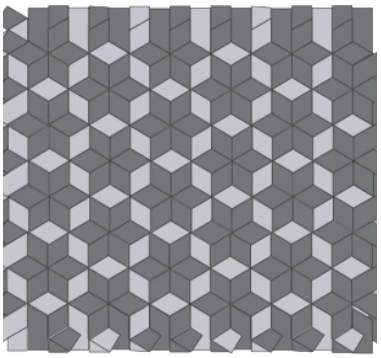


Figure 14: ABB

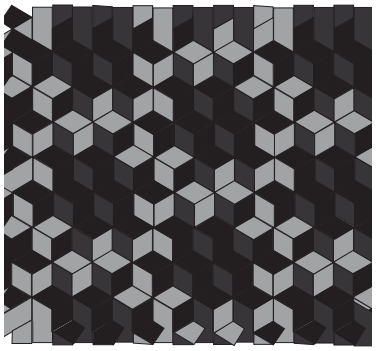


Figure 15: AABBBB

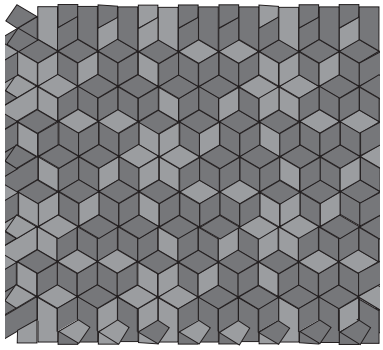


Figure 16: AABBBB

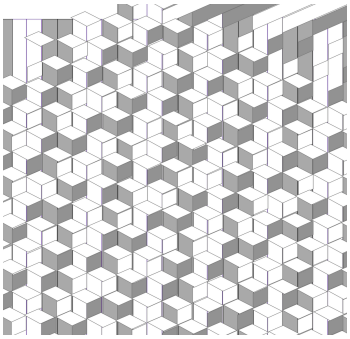


Figure 17: *Layers one and two: AABB, layer three: all A*

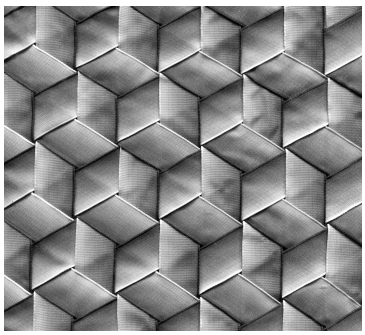


Figure 18: *ombre strips*

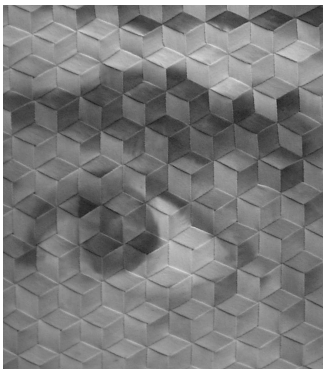


Figure 19: *images dyed into each layer before interlacing "Connection" 30"W x 50"H*

Conclusion

This strategy offers a route to discovering and building complex p3 and p6 tiling patterns. Enjoy!

References

[1] Virginia Harvey *The Techniques of Basketry*. University of Washington Press 1986.

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[5] Elizabeth Lang-Harris, Charlene St. John *Hex Weave and Mad Weave, An Introduction to Triaxial Weaving* Schiffer 2013