Patterns for Practical Madweave Baskets

Paul Gailiunas

Newcastle, UK; paulgailiunas@yahoo.co.uk

Abstract

With few exceptions traditional madweave basketry does not incorporate colour. Occasionally it is introduced by using ink, dye, or adding overlays or additional strands, an idea that has been developed recently by using substitution to control a repeating pattern that covers the whole basket. Another modern approach simply starts with an arrangement of different colours and sees what happens, retaining the result if it is appealing. Yet another is restricted to flat structures, avoiding the usual complications. Analyzing symmetry identifies a limited range of consistent repeating patterns that cover the sides of typical madweave baskets without requiring substitution.

Madweave

Madweave is a dense triaxial basket structure used in many South East Asian cultures. Lontar or Pandanus [10, 5] is often used, usually for boxes, often for betel nuts, but other materials can be found. Figure 1(a) shows a typical box made using Lontar [3]. If there is any colouring it is usually applied using some kind of staining. Figure 1(b) shows an example in the Museum of Ethnology in Vienna with traces of colour remaining (most obvious around the central region where it is being worn away) [12].

Corners are produced in the otherwise flat structure by omitting one or more strands, most usually only one, creating a point of local five-fold symmetry instead of the usual six-pointed stars. There is a clear example in Figure 1(b) at the near right-hand vertex of the top hexagon. A consequence is that any pattern made in the flat structure by using coloured strands is disrupted.

Figure 1: *Typical traditional madweave boxes. (a) A fairly recent example from Palu'e. (b) An old example from Aru Island showing traces of colour.*

Tudung saji are conical dish covers that originated in Malaysia. They have been the topic of research using a methodology known as "mutual interrogation" [11], where a team of mathematicians engaged in dialogue with traditional basket-makers in three cycles of fieldwork over eighteen months. These covers are unusual among traditional madweave constructions because different coloured strands are introduced to produce characteristic patterns.

Figure 2: *Some tudung saji patterns.*

Figure 2 shows examples from the quoted paper. The patterns are created around the centre of five-fold symmetry, which is integral to the design, so there is no disruption.

Modern Use of Coloured Strands

There has been an increasing interest in madweave among craftspeople over the last few decades, with the creation of pattern engaging many people's attention. At its most straightforward flat pieces of fabric with no corners are created as works of art that stand on their own [6, 8].

The only pattern that can uniformly cover madweave that includes five-fold corners (in fact any kind of corner) arises naturally if Richard Ahrens's method of construction is used [1]. He begins by making a kagome (open hex-weave) version of the basket he aims to create and then fills in with more strands to complete the madweave. If different colours are used at the two stages then the "star" pattern results, visible in the central section of the second image in Figure 2.

Shereen LaPLantz developed an entirely different construction technique, probably based on her experience of biaxial twill structures [9]. Her approach to patterns is to find a design for the base and then let the sides take care of themselves. She accepts the disruption caused by the corners since it can add more interest to the final result.

Recently Susan Brunton [2] has described how to avoid the disruption caused by corners (of any type) by replacing the strands with others of a suitable colour on passing from the base to the sides, so that the same pattern continues.

A Different Approach

Constructing a basket begins with the base, and it is natural to want to create a pattern at the start. In fact the sides are generally the most obvious visually, and it makes more sense to think about how to create a consistent repeating pattern there, not on the base. Assuming that the base is hexagonal, a necessary condition is that it has a centre of six-fold colour symmetry, which will automatically introduce some visual appeal.

An immediate consequence is that the six middle strands (two in each of the three weave directions) must all be the same colour. This condition is automatically satisfied in the star pattern, and trivially if the base is monochrome.

Bias

The implications of the symmetry condition depend on a consideration known as "bias" in fibre crafts. The middle strands can pass either through the corners, where they become oblique strands in the sides, or between the corners, where they become vertical strands in the sides. In both cases there are two oblique directions; in one horizontal strands are added in the third direction, in the other vertical strands from the base provide the third direction (Figure 3). I will call the two cases *horizontal bias* and *vertical bias*. In both cases any oblique strand passes through the base then back into the sides in the other oblique direction. The result is that the colour sequence in one oblique direction is the mirror image of the sequence in the other direction. This is the main constraint on any consistent repeating pattern on the sides. There is a further constraint in cases with vertical bias: the middle strands in the base have the same colour, so the sequence in the vertical direction must include neighbouring strands of the same colour.

In principle there need be no limit on the length of the repeat sequence of colours in any direction, but it must be monochrome or a multiple of three, since there are three types of strand in any direction of the madweave structure [4]. This discussion will mainly consider sequences of three strands in each direction since the emphasis is on periodicity rather than visual complexity. Mary Klotz has exhibited some examples with longer repeats [7]. In turn this determines the possible sizes of baskets since the sequence of colours in the oblique strands must continue after a corner. One of Shereen LaPlantz's examples has the star pattern on the base but locates the corners in positions that lead to disrupted pattern on the sides.

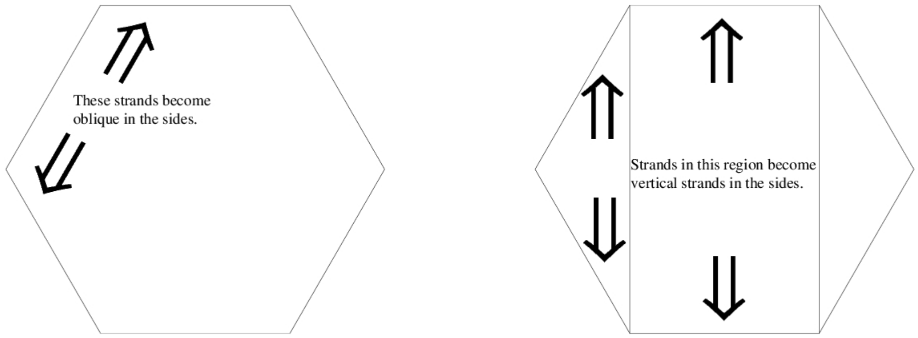


Figure 3: *(a) Base strands leading to horizontal bias. (b) Base strands leading to vertical bias.*

Two Colours

The star pattern is the obvious two-colour possibility, but there are others. Figure 4(a) shows my first attempt at creating madweave. Actually there were many mistakes and I had to largely rebuild it when I looked at it in detail again. (This structure is called madweave for a reason.) The pattern was unplanned but it was a major stimulus to write this paper because it demonstrated that there are possibilities beyond those described previously by others.

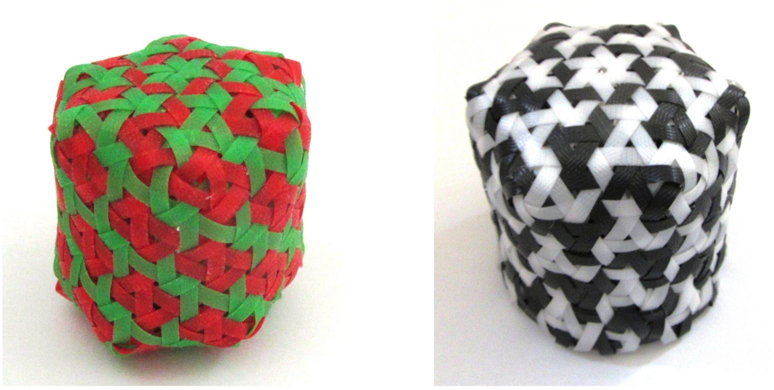


Figure 4: *(a) A pattern with vertical bias. (b) A pattern possible only with horizontal bias.*

It is a structure with vertical bias. Working outwards from the centre of the base the colour sequence is green, red, green, which become vertical strands in the sides as illustrated in Figure 3. The sequence then continues red, green, red providing the oblique strands. Since this sequence is mirror symmetric it is the same in both oblique directions.

There is another well-known two-colour pattern, generally called “pinwheel”, where the colours simply alternate. In effect this means that the repeat length is six, since it must be a multiple of three. As a consequence the edge of the base must be a multiple of six strands: exactly six in the example shown in Figure 4(b). At a corner some strands that are in different directions in the base become adjacent. If there were an odd number of strands this would result in adjacent strands having the same colour. This pattern with alternating colours can be created only with horizontal bias because baskets with vertical bias must include some adjacent strands with the same colour.

Careful inspection of Figure 4 shows that the pattern on the base is the same in both cases. This can happen because the baskets are small. In larger baskets the sequence in Figure 4(a) would change in the corner regions indicated in Figure 3(b): green, red, green, green, red, green … red, green, red, red, green, red …; in Figure 4(b) the sequence would simply continue alternating between white and black.

The base of a basket with vertical bias must be either the star pattern or monochrome if the repeat distance is three, since the middle six strands must be the same colour. There are no such constraints on the oblique strands so they could alternate as in the pinwheel pattern. This allows some more possibilities. Figure 5(a) shows the base of one: the vertical strands are all white and each of the six oblique sequences has three alternating white and black strands. Figure 5(b) shows the side, which I do not think is one of the standard patterns. Another possibility would be to use the star pattern for the base.

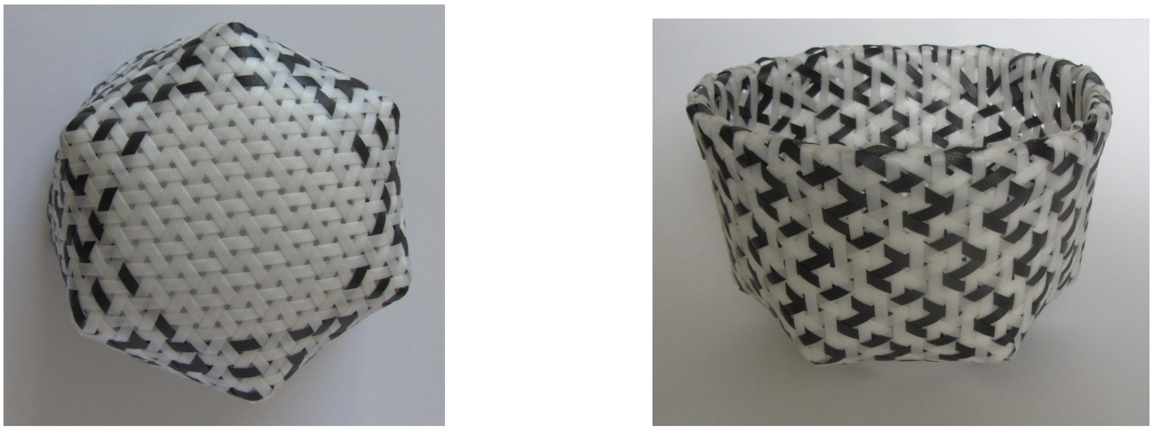


Figure 5: *(a) The base of a basket with alternating oblique strands. (b) The same basket from the side.*

Three Colours

As more colours are included the number of possibilities increases quite rapidly, even with the sequences limited to a length of three. In the interest of simplicity only three-colour patterns will be considered. A straightforward idea is to modify a two-colour pattern, by changing all the occurrences of one colour in a sequence. Figure 6(a) shows the result when the pattern in Figure 4(a) is modified to have the single colour in the vertical sequence different from the corresponding (repeating) colour in the oblique sequences, in this case white, blue, white for vertical strands and black, white, black for the oblique ones.

Figure 6: *Two three-colour patterns (a) with vertical bias (b) with horizontal bias.*

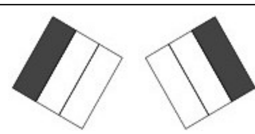
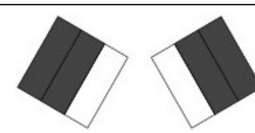
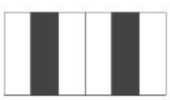
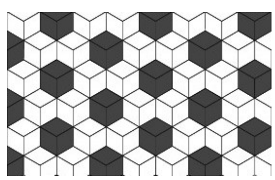
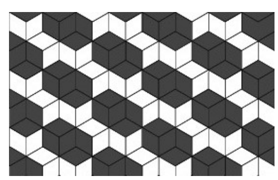
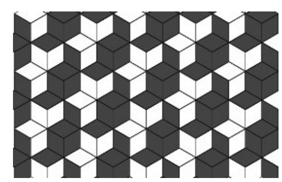
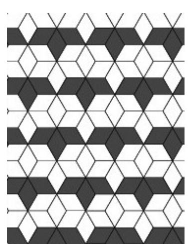
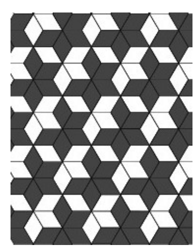
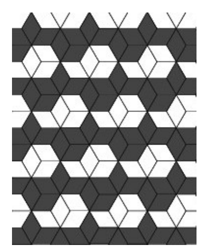
A consistent pattern with three colours in each direction is possible only in baskets with horizontal bias. Figure 6(b) shows one example, which again I have not seen before.

There is vertical mirror symmetry in the sequences with both types of bias. Mirror symmetry between the oblique colour sequences is a necessary result of the construction, and in vertical bias consistency of pattern requires mirror symmetry in the sequence of vertical strands; in horizontal bias the additional strands are horizontal so they automatically have vertical mirror symmetry. Nevertheless, apart from the patterns with threefold rotational symmetry (star and pinwheel), all of the examples considered are broadly helical in appearance. This happens because triaxial structures, both kagome and madweave, are intrinsically chiral, which introduces chirality into the patterns. A visually surprising consequence is that the handedness is the same on both sides of the madweave fabric. Figure 6(b) shows this particularly clearly.

Phase

A particular complication with madweave is that the sequence of colours in each direction does not fully determine the resulting pattern. The way they relate to each other must also be considered [4]. Table 1 summarizes the situation for two-colour patterns subject to the constraints needed to ensure a consistent repeat pattern on the sides of a basket. The first row shows variations that are possible with vertical bias. Obviously these patterns can also be achieved with horizontal bias, rotated by 90°. The second row shows additional possibilities that can be produced by shifting the horizontal colour sequence. They are not possible with vertical bias because the shift would break the hexagonal symmetry in the base, disrupting the consistency of the pattern on the sides.

Table 1: *The effect on two-colour patterns of changing the relative phases.*

	 Oblique sequence	 Oblique sequence	 Oblique sequence
 Vertical sequence			
 Horizontal sequence			

The first column shows what happens when the sequences match. The star pattern results when the phases correspond. Shifting the oblique sequence leads to the two-colour “spots” pattern. Shifting the sequence in the third direction leads to a pattern that does not have a name as far as I know.

The other two columns have the colours reversed in the oblique directions compared with the third, as in Figure 4(a). Again the colours are shifted only in the oblique directions in the first row, and also in the third (horizontal) direction in the second row.

The possibilities that are not shown do not produce any new patterns but simply change the orientation, or in the case of the “spots” pattern, the position of the hexagons.

Further Possibilities

Only the simplest patterns have been considered here, with occasional indications of other possibilities. Obviously patterns that repeat every six or nine strands are possible if larger baskets are constructed. Two-colour patterns with the smallest repeat distance of three have been explored exhaustively but those with three colours only briefly considered. Some are, in effect, modifications of two-colour patterns, like Figure 6(a), and table 1 provides a useful starting point to explore further. Horizontal bias three-colour patterns, like Figure 6(b), actually provide only a small number of new possibilities. Many variations simply change the orientation of an existing pattern. Clearly more colours could be used, leading essentially to modifications of the simpler patterns.

A half-way stage between LaPlantz's patterns and these consistent periodic patterns on the sides of a basket would be to break the colour symmetry of a simple pattern in some way. For example in Figure 6(a) replace the blue strands with, say red, in one direction and green in the third direction.

There are probably some exceptional situations when the repeat distance need not be a multiple of three. For example the pinwheel has an underlying repeat distance of two. The corners do not disturb the sequence in any of the three directions if the edge of the base has an even number of strands, and the hexagonal symmetry ensures that things will meet up going around the basket circumference, so some different sizes of basket are possible. The Ahrens method of construction cannot be used directly in these cases.

References

[1] R. Ahrens. https://static1.bridgesmathart.org/art-exhibits/bridges06/ahrens.html

[2] S. Brunton. *Triaxial Bias Plaited Basketry – Theory, Structure and Technique.* A thesis presented to OCAD University, Toronto, Ontario Canada, 2022. https://openresearch.ocadu.ca/id/eprint/3954/3/Brunton_Susan_2022_MFA_IAMD_thesis.pdf

[3] S. Danerek. "Palu'e basketry: design, usage, culture and linkages." *Fiber, Loom and Technique*. Tracing Patterns Foundation, 2022. https://fltjournal.libraryhost.com/index.php/flt/article/view/5

[4] P. Gailiunas. "Mad Weave." *Journal of Mathematics and the Arts*, vol. 11, no. 1, 2017, pp.40 – 58.

[5] Gerimis Art. https://www.gerimisart.com/wp-content/uploads/MadWeave.pdf

[6] M. T. Klotz. "Triaxial Weaving for Complex Repeat Patterns and Tessellations." *Bridges Conference Proceedings*, Waterloo, Ontario, Canada, July 2017, pp. 503 – 506. http://archive.bridgesmathart.org/2017/bridges2017-503.html

[7] M. T. Klotz. https://gallery.bridgesmathart.org/exhibitions/2017-joint-mathematics-meetings/mklotz

[8] E. Lang-Harris, C. St. John. *Hex Weave & Mad Weave*. Schiffer Publishing, 2013.

[9] S. LaPlantz. *The Mad Weave Book*. Press de LaPLantz, Bayside, 1984, reprinted Dover, 2016.

[10] O.T. Mason. "Anyam Gila (Mad Weave): A Malaysian Type of Basket Work." *Proceedings of the United States National Museum*, **36** (1909), Smithsonian Institution, Washington, pp.385 – 390. https://repository.si.edu/bitstream/handle/10088/14108/USNMP-36_1672_1909.pdf?sequence=1&isAllowed=y

[11] Noor Aishikin Adam. "Weaving Mathematics and Culture: Mutual Interrogation as a Methodological Approach." *Journal of Mathematics & Culture*, vol. 6, no. 1, 2012, pp. 88 – 103. https://journalofmathematicsandculture.wordpress.com/wp-content/uploads/2016/05/aishikin-final-paper.pdf

[12] Museum Siwalima. http://siwalima.atspace.com/virtual01.html