Color Symmetry in the Hand Woven Mats of the Jama Mapun

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Abstract

The Jama Mapun is an indigenous Filipino community known for their hand-woven mats. Their technique is impressive given that their designs are directly woven into the mat, and are not produced by simply painting or inserting colored leaves in completed mats. In this paper, we highlight concepts in color symmetry evident in the Jama Mapun mats. We discuss perfect and non-perfect colored designs including a finite, frieze and wallpaper pattern.

Jama Mapun Mats

The beauty and quality of Jama Mapun mats is well known [2]. This Filipino community primarily lives in the Sulu archipelago and in Southern Palawan. The intricate designs of a *tepo* (mat) attest to the artistry as well as the geometric skill of the weavers, a skill that has been passed over several generations. Their preference for colorful patterns is inherent in their culture. As described in [2], quarrelling families may display a number of colorful mats to cool off and appease each other.

The Jama Mapun use a variety of pandan (*Pandanus tectorius* or screw pine) for the mats, and these leaves are boiled and dyed. Their weaving technique is unique. While it is customary for mat weavers to begin at the edge or at the corners, the Jama Mapun weave along the center of the mat, continuing downward along a line or axis, until the central panel is completed (see Figure 1). Once this central panel is completed, the leftover portions of the leaves on either side of the panel are woven to complete the entire mat. No additional straws are inserted at this point.

Figure 1: *The mat's central panel*

Figure 2: *A tupi or fold*

One impressive feature of a Jama Mapun mat is that the design is directly woven into the mat. That is, the designs do not arise from simply painting or inserting colored leaves in completed mats. To facilitate the creation of colored patterns, the Jama Mapun employ a mat-weaving technique called the *tupi*, or fold. Without a *tupi*, each leaf necessarily follows a single direction, so that color changes would not be possible along that direction. However, the *tupi* or folding technique allows the weaver to change the direction of a colored leaf and create a wider range of designs. These *tupi* can be seen along borders where leaves of different colors meet (Figure 2).

Because designs are directly woven into the mat, a Jama Mapun weaver should have a mental picture of the mat's overall design, including the motifs and the interplay of the colors within the mat when they start weaving the central panel [4]. For example, Figure 3a shows how the leaves within the mat are cleverly organized and laid out. Each colored line drawn in the figure shows the path of one pandan leaf from the central panel. Clearly, weavers must have foresight. They must determine beforehand how many leaves of a certain color are needed. They also need to know when to utilize a *tupi* so that their planned design is realized, while at the same time ensuring that the weaving still results in a rectangular mat.

(a) (b)

Figure 3: *(a) A Jama Mapun mat (arrows signifying the paths of some pandan leaves); (b) a larger view of a portion of the mat*

This paper highlights color symmetry concepts [3,5] found in Jama Mapun mats, and demonstrates the mathematical insight necessary for weaving complex geometric patterns directly into these mats.

Color Symmetry Theory

Colored handwoven Jama Mapun mats are a physical manifestation of color symmetry theory [3], where a basic problem addressed is the assignment of colors to designs or patterns to arrive at a colored symmetrical pattern. In the construction and analysis of such a pattern, there are two groups that are usually taken into consideration: the group G consisting of symmetries of the uncolored pattern [1]; and the group H consisting of elements in G that effect a permutation of the colors. The elements of H are called the color symmetries of the pattern. If all symmetries in G are color symmetries, that is, $H = G$, then we say the pattern is *perfectly colored*.

Perfectly colored patterns and designs can be found in Jama Mapun mats. An example is the mat shown in Figure 3a exhibiting one of their typical designs: the *katam* (crab), which consists of five colors. The central panel in this case is along a vertical line passing through the center of the mat. There is a 180° rotational symmetry, which is a natural consequence of standard Jama Mapun weaving, which is to weave the design on one side of the central panel and turning it around to weave the same design in other side (this is referred to as *limbang*). Although there seems to be a reflection along a horizontal line passing through the center of the mat, the direction of the weaves (Figure 3b) shows otherwise. A similar analysis will show that there is also no reflection along a vertical line through the center of the mat. The 180°

rotation is the only non-trivial symmetry of this finite pattern (with colors disregarded). The symmetry group of the pattern is a cyclic group C_2 of order 2. This rotation is a color symmetry of the pattern and fixes the given colors.

A mat consisting of a repeating pattern of five colors is cut and created into a lady's handbag shown in Figure 4. If we consider this as a planar repeating pattern, its symmetry group (disregarding colors) is a plane crystallographic group of type $p2$ (2222 in orbifold notation), generated by three distinct 180° rotations with centers that are not collinear as labeled in the figure. This is also a perfectly colored pattern. Observe that the 180° rotation with center located at the pink square motif fixes the colors pink, purple and white and interchanges the colors blue and red. On the other hand, the 180° rotation with center located at the center of the white parallelogram interchanges blue and pink; purple and red, and fixes white. Finally, the 180° rotation about the point where four parallelograms meet fixes white and interchanges blue and pink, and purple and red.

Aside from perfectly colored patterns, we have also found non-perfectly colored patterns in the Jama Mapun mats. The mat in Figure 5 shows the weaver's rendering of five pairs of leaves (*gumamela*). In weaving this mat, the intention was to balance the vibrant colors (blue, pink, orange, green), with white and this color is used more dominantly than the other colors to arrive at the colored pattern. The total area of all the white regions exceeds the area of each of the regions of another color. Assuming that the pattern repeats indefinitely to the right or left, the symmetry group of the pattern with colors disregarded is a frieze group of type $p112$ (22∞ in orbifold notation) which is generated by two distinct 180° rotations with centers spaced at half a translation distance. Note that if we consider the 180° rotation at the center of the mat, a white triangle is brought to a pink triangle and a green triangle, so that this rotation does not effect a permutation of the colors. Thus the pattern is not perfectly colored.

Figure 4: *A perfectly colored pattern*

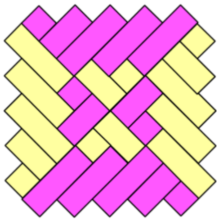
Figure 5: *A non-perfectly colored mat*

The symmetry group of the uncolored pattern found in Figure 6(a) is a plane crystallographic group of type $p2$ (2222), with generators three distinct 180° rotations with centers (black, white, and ringed dots) shown. Note that, the 180° rotation centered at the white dot does not effect a permutation of the colors. The white triangular regions are sent to pink, blue, green and orange regions. This is a non-perfectly colored pattern. Just like the pattern in Figure 4, here the white leaves are used more often than the other colored leaves.

The Jama Mapun use motifs that form an integral part of the mat's design. These motifs may possess local symmetry that is not a symmetry of the overall design. Consider for instance the motif in Figure 6(b), consisting of two colors coming from the mat in Figure 6(a). Here, we see that the symmetry group of the uncolored motif is a cyclic group of order 4 generated by a 90° rotation. This rotation is not a global symmetry of the mat; that is, it does not send the overall pattern to itself. However, the 180°

rotation on this motif is a local symmetry that is also a global symmetry. In Figure 6(a), we identify the center of this rotation to be at the ringed dot. This rotation fixes the colors pink and white in the motif. Although the mat is not properly stretched out, we can see that this rotation also fixes the other regions colored pink and white in the overall design. In color symmetry theory, this symmetry is called both a local and global color symmetry. Interestingly, this coordination between the colors of the motif and that of the overall pattern is a taken into consideration by the Jama Mapun in their weaving.

(a)



(b)

Figure 6: *(a) A non-perfectly colored pattern; (b) a motif taken from (a)*

Conclusion

What we have discussed in this short note is a glimpse of the variety of colored symmetrical patterns found in the mats created by the Jama Mapun. Without formal or advanced training in mathematics, it is impressive how they can organize and arrive at these colored designs in the mat that are concrete realizations of ideas from color symmetry theory, without use of template, pencil or paper. We have shown that the patterns and motifs have inherent symmetries and color symmetries as a result of their weaving technique (e.g. the existence of 180° rotation due to *limbang*). The manner in which the leaves are woven in place such as that shown in Figure 6(b) disqualifies some symmetries. There is no vertical reflection with axis passing through the center of the motif that is a symmetry of the given motif. A future direction in our research is to discuss the existence or non-existence of symmetries or color symmetries in these mats while also considering particular combinations of weaving strokes.

References

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