

Symmetric Characteristics of Traditional Hawaiian Patterns: a Computer Model

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Abstract

Most of Hawaiian quilts, fabrics and traditional handicrafts are lavishly decorated with patterns. Reflecting the culture of Hawaii, Hawaiian flora and fauna find their creation in a fabric of symmetrical patterns. Although this exotic and highly balanced symmetry is an essential component of many traditional handicrafts in Hawaiian patterns, the symmetric principles of Hawaiian patterns have rarely been discussed. To provide insight into the creation of Hawaiian patterns, this article analyzes the symmetric characteristics of the traditional Hawaiian patterns. In addition, the article presents a computer model using a java applet that has been developed to generate an exponential number of different Hawaiian patterns.

1. Introduction

Traditional Hawaiian patterns appearing on quilt and bark cloth, known as *kapa and tapa*, have long been appreciated for their beauty, due to their unique design patterns. Hawaiians began to decorate their fabrics not only to represent Hawaii's natural beauty, but also Hawaii's culture. Little is known about the actual emergence of the patterns and about the thought process behind the patterns. The original designers of these patterns kept the techniques and their meanings a guarded secret. Little or no access to the design was allowed until the quilt was completed. In addition, Hawaiians did not have written language until the missionaries from New England arrived in 1820 to record the techniques. Nevertheless, as the centuries passed, this practice has been developed into a system of sophisticated ornamentation that spread into other areas of Polynesia.

Many attempts have been made to explain how Hawaiian patterns were designed. One such attempt was to decipher the traditional Hawaiian patterns using the "snowflake". For example, Poakalani and John Serrao (1997), Stewart (1986) analyzed the Hawaiian quilt with the paper folding and cutting technique. They dissected the Hawaiian patterns, and then used the process to create a larger collection of traditional Hawaiian quilt patterns. In doing so, they found that the pivotal part of the pattern was its center, for it was the center that allowed creativity to branch out within the borders. Similarly, the Hawaiians believed that a spiritual and physical center provided the foundation for growth. This snowflake method closely resembles the method for creating the appliquéd designs.

Although a variety of explanations is possible in analyzing Hawaiian patterns, fundamental to all these designs is the principle of symmetry. Yet, little attention has been given to the principles of symmetry in the traditional Hawaiian patterns. Moreover, a systematic analysis of Hawaiian patterns with regard to symmetry principles is almost nonexistent, even when literature suggests that, interesting enough, most of the Hawaiian patterns are based on what we call "point group symmetry", and the "frieze and wallpaper group symmetry". It is compelling, then to discuss the patterns with regard to symmetry principles.

In this article, the historic backgrounds and evolutions of Hawaiian patterns are discussed first. Second, the characteristics of Hawaiian quilts are described. Third, a procedural traditional technique for constructing the patterns is explained. Fourth, the patterns with regard to symmetry principles that underlie composing the patterns are detailed. Finally, given the symmetric principles and Hawaiian motifs, an interactive computer model using a Java applet to generate a number of variations of Hawaiian patterns is presented. The computer model is a procedure for constructing a myriad of new Hawaiian patterns. Examples of patterns generated with a software implementation of the technique are provided.

2. History and Evolutions of Hawaiian Patterns

Even before the missionaries arrived on the islands, Hawaiian women used beautifully textured bark cloth (*tapa*) made from the inner bark of the paper mulberry tree (*wauke*) for clothing and other utilitarian and ceremonial purposes (Titcomb, 1975).

The making of *tapa* was a time-consuming and labor intensive process. The outer bark was stripped away and the inner bark was soaked in water to make it soft. Artistically carved round wooden mallets were used to pound the strips of the inner bark into meshed fiber to form sheets of various sizes, thicknesses, and textures. Then, the *tapa* was colored by native dyes and decorated with block prints (Arthur, 2002). The beauty of the *tapa* creations were found in fine bedding, consisting of six sheets of *tapa*: four white sheets, a dyed sheet, and a decorated top sheet (Schleck, 1986). Women took pride and care in developing their own designs in the mallets, and *tapa* stamps.

New England missionaries arrived in 1820 and taught high-ranking Hawaiian women to make American-style patchwork quilts. On April 3, 1820, seven young New England missionary women held the first “Sewing Circle” aboard the brig *Thaddeus*. The high-ranking Hawaiian women were Kalakua, mother of King Liholiho, her sister Namahan, and two wives of Chief Kalanimoku. The missionary wives were Lucy Thurston, Lucia Holman, Sybil Bingham, Nancy Ruggles, Mercy Whitney, Jerusha Chamberlin, and Elisha Loomis. The missionaries supplied the scissors and furnished the native women with calico patchwork to sew. Sewing calico piecework was new to the ranked Hawaiian women, but the geometric and symmetrical patterns associated with quilting were not (Stewart, 1986). The Hawaiian women were taught both types of quilt making. The pieced variety technique was used to make geometric repeated blocks, and the appliqué style used the “snowflakes” method (Stewart, 1986).

While the missionaries had fabric scraps left over after cutting out their garment making, Hawaiian’s garments left few scraps of fabric. The Hawaiians saw no point in cutting up the whole piece of fabric into small pieces only to be sewn back together again. Quilting began to change as the Hawaiian women created their own methods of constructing and designing a quilt, which is known today as the traditional Hawaiian quilt. The patterns on the quilts reflected their culture, heritage, and beliefs; the beauty of the islands; and historical events (Poakalani and J. Serrao, 1997).



Figure 1: Historic quilts used in a room decoration (Courtesy from the Mission Houses Museum, Honolulu, Hawaii)

By late 1970, while the traditional Hawaiian quilts still existed, a new form of quilting known as the contemporary Hawaiian quilt began to emerge. Contemporary Hawaiian quilt designs had no rules. The designs were often visual representations of Hawaii, often realistic and pictorial, and easily understood by the viewer. This new quilt evolution was possibly due to rapid changes society and the integration of different cultures in Hawaii (Arthur, 2002).

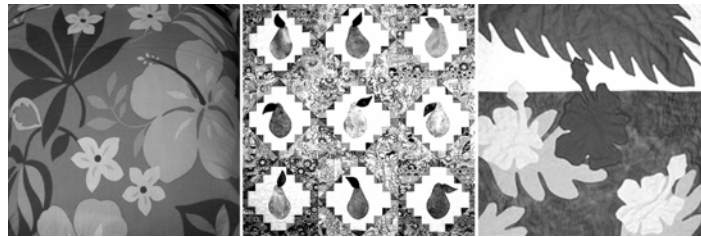


Figure 2: Three examples of contemporary Hawaiian quilts

3. The Symmetry of the Hawaiian Quilt Designs

This paper focuses on the symmetry of the Hawaiian quilt designs. Since ancient times, designs on Hawaiian quilts were created by using techniques of symmetry. Early designs were produced by carving designs onto bamboo strips called ‘ohe kapala strips” (Figure 3a). These bamboo strips could be arranged into groups side by side, end to end, or in other unique patterns. Multiple groups of bamboo strips could also be formed to create motifs (Kaepler, 1980). Examples of these patterns are shown in Figure 2b & 2c. These patterns were then used to make impressions on tapa, or cloth made of tree bark.



Figure 3: a. Different types of ‘ohe kapala strips; b. Beating Kapa; c. Repetative Kapa pattern

Tapa can be characterized by its texture and thickness. The thin and soft-textured tapa had lighter and smaller designs created by pressing it onto carved patterns on the surface of bamboo strips. Thick tapa had bold designs created by pressing it into the grooves of the narrow channels in the patterns of the bamboo strips (Kaepler, 1980).

Over time, one technique that dominated Hawaiian quilt designs was the symmetrical design in the square. This popular design utilizes the “snowflake” method to create a symmetrical pattern in a square. The use of the square finds its roots in Hawaiian religious beliefs (Poakalani and John Serrao, 1997).

The “snowflake” method begins with a square paper of the size that will be appliquéd to produce the quilt. The square paper can be folded into halves, fourths, sixths, or eighths. This produces perfect symmetry in both simple and complex designs (Root, 1989). For example, folding a square in sixths can create a circular symmetrical configuration. Folding a square into eighths, the most common technique,

extended designs to the corners of the square (Figure 4). Because the folds are either on a bias (diagonal), horizontal, or vertical, the patterns can be aligned with the grain of the fabric. The “snowflake” design is cut from a single piece of fabric, then appliquéd onto a background (top) square of fabric, and finally quilted with the batting and the bottom fabric backing.

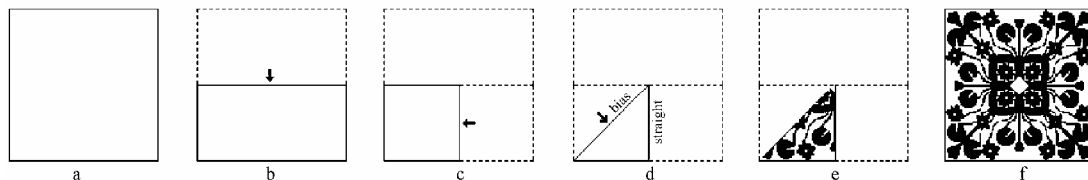


Figure 4: Paper folding technique with a square: a. Square flat material; b. Folding the material in half; c. Folding the material in half again; d. Folding the material diagonally; e. Asymmetric motif to folded square and cut out design; f. final pattern unfolded



Figure 5: a: Typical Hawaiian quilt pattern; b: Contemporary asymmetric quilt pattern (Redrawn by the authors)

The symmetry of the quilt patterns captured the interest of the authors of this article because they were intrigued with the possibility that the designs could be replicated using computer technology. The symmetrical techniques of the designs were, thus, analyzed. The findings of this analysis are presented next.

4. Analysis of the Symmetrical Techniques Used in the Quilt Designs

Two dimensional plane symmetry designs can be categorized into two groups: finite (or point symmetry) and infinite. Spatial transformations take place in a fixed point or line. The transformations involve rotation about the point and reflection along the lines, or the combination of both. In the point symmetry group, no translation takes place.

In the infinite symmetry group, spatial transformations occur where the basic movement is either a translation or a glide reflection. In this group, designs which are invariant under one directional translation are called the frieze group, and designs under two directional translations are called the wallpaper group (March and Steadman, 1971; Park, 2004).

Finite or Point Symmetry: Many variations of the symmetrical designs in the square can be found (Hammond, 1986). See Figure 6. The typical “snowflake” eight-fold design is shown in Figure 6a. Figure 6b illustrates a vertical reflective symmetry. Figure 6c, “My Beloved Flag,” is a renowned emblem of an overthrown monarchy. Although the central symbol is asymmetrical, the flags that surround the symbol are produced by four quarter-turn cyclical symmetry. Figure 6d represents a quilt pattern based on four quarter-turns without reflections. Figure 6e illustrates a motif in which four quarter-turns, 10-fold, and 18-fold rotations are respectively superimposed. Stewart (1986) provides other

designs that rely on symmetry for their creation (Figure 7). Interestingly enough, a half turn rotation design could not be found in the research conducted for this paper.

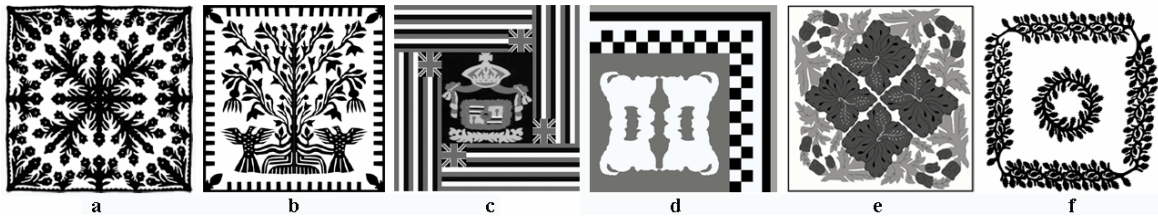


Figure 6: Six Hawaiian Quilts examples (Redrawn by the authors)

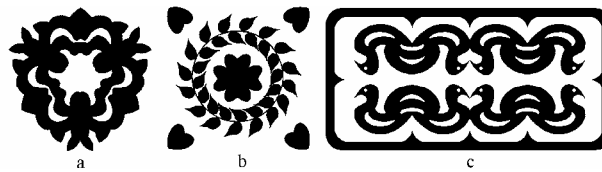


Figure 7: Three Hawaiian Quilts that show different symmetry: a, triangular symmetry; b, superimposition of the symmetry of a square and a 16-fold rotation; c, rectangular symmetry (Redrawn by the authors)

Infinite Symmetry: Frieze and wallpaper symmetry reflect the use of bamboo stamps (Figure 8) used long ago to create designs. Geometric designs such as lines, triangles, circles, and other symbolic motifs carved into bamboo were used to repeat patterns. Symmetrical patterns created by the repetitions show patterns that were reflected, rotated, and translated along a line (Figure 9). The prolific repetition of the patterns on a single item created rich designs. Opportunities to use each design to produce other designs are infinite.

Wallpaper patterns (Figure 10) are similar to frieze patterns. Distributions of patterns are of equal distance horizontally and/or vertically.

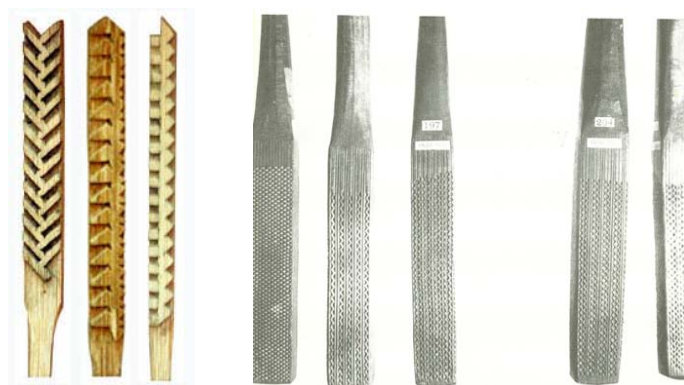


Figure 8: Contemporary (a) and traditional (b) examples of various bamboo stamps

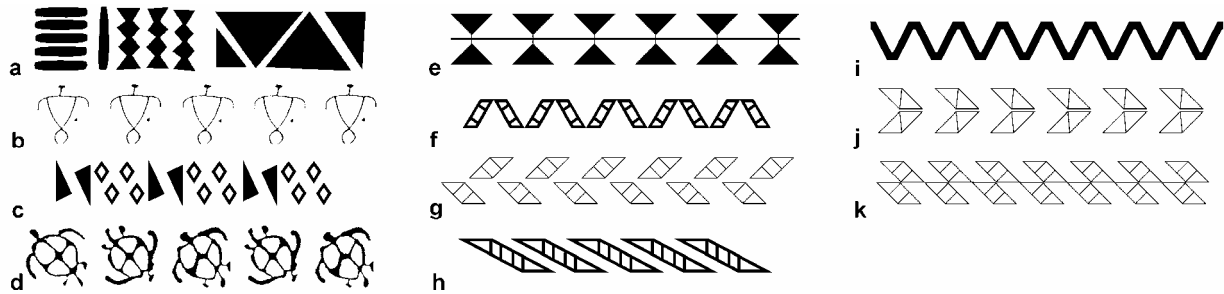


Figure 9: Left. Various Frieze patterns found in Hawaiian ornamentation

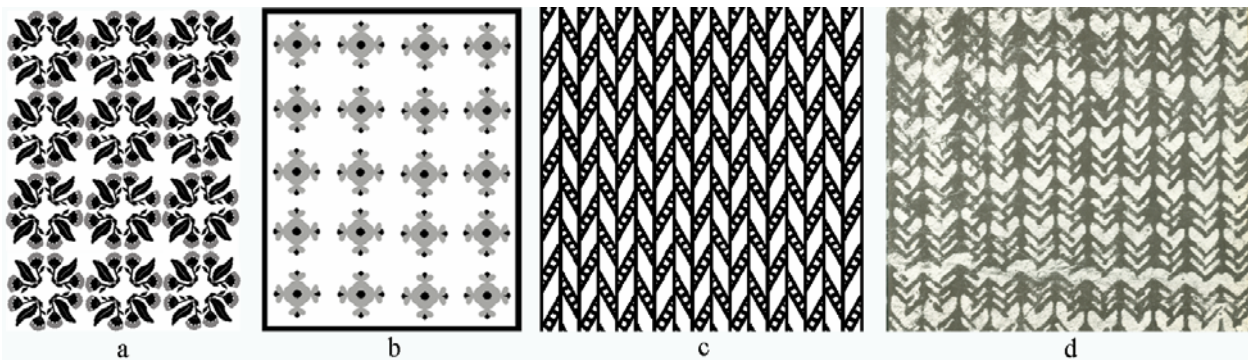


Figure 10: Four Wallpaper patterns found in Hawaiian patchwork (a and b) and *kapa* (c and d). The way that symmetry was used is simple and straightforward.

5. Creating Hawaiian Design Symmetry on the Computer

Computer technology can not only be used to copy Hawaiian design symmetry, but to create an infinite number of patterns by duplicating, reflecting, rotating, superimposing, attaching, and shrinking or reducing single designs. The authors saw this potential and developed a Java applet model that includes point, line, and plane group symmetry.

Using the Java applet application, motifs are viewed as lines and/or curves that can be created by plotting points (x and y coordinates) with mathematical lines and third cubical Spline equations. X and y coordinates of points in rows represent a line or a curve segment of the motif. The Java program then generates a motif path that can be filled with color when displayed on the computer screen.

To create a motif, a Java input file must be created. First, the motif image is scanned into a digital format. Second, the digital image application is used to read the scanned digital file. Third, the x and y coordinates of point in the motif are recorded. Fourth, the coordinates of the points for each line or curve segment are entered. Then, the process is repeated until the entire motif is completed. Line and curve segments can be made continuous from their end points.

Figure 11 shows snapshots of the implementation of a Java-based interface for dynamic retrieval of a set of pattern designs. Initially, the simplest common denominator of a design is created using x and y coordinates. The reason for using the simplest possible motif is that, on one hand, the hierarchical structure of the whole pattern is clearly revealed; on the other hand, developments in complexity can occur rapidly by adding other symmetric motifs, one-by-one (Budden, 1972).

One can design a quilt by clicking on buttons in the design where motif transformation is desired. The Java program ensures that the design is always transformed according to symmetry principles.

Applying the Java motif files created for this paper, the user can create various patterns by selecting a basic motif from three categories of motifs. Then, the user who wishes to create a design according to the point group symmetry can choose the reflect or rotate button. Otherwise, if the user wants to create a design based on the line or plan group symmetry, the user can select from 7 to 17 different types of symmetry patterns. In essence, this powerful applet model can generate a myriad of Hawaiian designs using point, line, and plane group symmetry with the chosen motif that is limited only by one's imagination.



Figure 11: Java applet design examples of the point, line, and plane group symmetry

Conclusion

This paper has surveyed and analyzed traditional Hawaiian patterns with regard to symmetry. At a glance, Hawaiian quilt patterns seem to vary greatly as if disengaged from a systematized design. However, this study identifies an underlying carefully ordered and balanced symmetry in the Hawaiian patterns. Without the help of mathematical models, Hawaiians seemed to have understood the notion of geometric order as they intuitively constructed patterns base on countless experiences.

With the Java applet model, however, the possibilities of creating symmetrical Hawaiian patterns are endless. The most striking implication of this Java model is that it can generate bountiful numbers of new Hawaiian patterns based on existing motifs, thus enriching Hawaiian designs on various products.

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