Eye-catching linear designs framing doorways or adorning buildings enrich architecture. Symmetrical swirls or the tease of near symmetry make borders a favorite device to entice our attention in magazines, newspapers and consumer packaging. Border motifs can evoke social or psychic overtones through their ethnic or personal associations. Attractive designs might occur spontaneously when our idle doodles are repeated as in a border.

Decorative borders are everywhere, an expression of the pleasure we find when surrounded by the beauty of symmetry.

We will use the term **border pattern** for a design which can naturally be continued indefinitely in both directions along a line. By their nature border patterns exhibit translational symmetry. Border patterns are also sometimes called **frieze patterns**.

Different cultural traditions are suggested by these examples.
Possibilities for border patterns are endless. Surprisingly, based on symmetry, any border naturally falls into one of seven possible types.

Before going into the classification scheme, a variety of borders are given below. First illustrations of each of the seven types are given followed by selections of representative African and Native American borders.
Border Patterns: The Seven Types

1m Centerline Reflectional Symmetry.

1g Glide Reflectional Symmetry

12 Half-turn Symmetry.

11 Translational Symmetry only.
Border Patterns: The Seven Types

**mm**
Centerline and Crossline Reflectional Symmetry.

**mg**
Crossline and Glide Reflectional Symmetry.

**m1**
Crossline Reflectional Symmetry
African Border Designs

Sources:

- Geoffrey Williams, *African Designs from Traditional Sources*, Dover.
- David Crow, *Symmetry, Rigid Motions, and Patterns*, COMAP
Southwestern Native American Designs

1. [Design Image] 2. [Design Image]
3. [Design Image] 4. [Design Image]
5. [Design Image] 6. [Design Image]
7. [Design Image] 8. [Design Image]
9. [Design Image] 10. [Design Image]
11. [Design Image] 12. [Design Image]

Source: Dorothy Smith Sides, *Decorative Art of the Southwestern Indians*, Dover.
Centerlines and Crosslines of Borders

Two terms, centerline and crossline, will be needed for our discussion below.

The center line of a border goes down the middle, the full length of the border. The centerline is drawn on this border:

A crossline is a line which crosses the border and is perpendicular to the centerline. Two crosslines are drawn in the next figure. Notice that one of these is a reflection line. The other is not.

How Do We Recognize the Code Type?

There are just 7 different symmetry combinations which are possible for border patterns. The code symbols used to identify these seven types are listed here.

\[
\begin{array}{ll}
1m & \text{mm} \\
1g & \text{mg} \\
m2 & \\
11 & \text{m1}
\end{array}
\]

The code consists of two characters. Notice that the first character is either the letter \( m \) or the number \( 1 \). We will first show how to determine the first character.

First Code Character: Crossline Reflectional Symmetry

The first character indicates the presence of a crossline reflection line: \( m \) indicates a crossline reflection line is present and \( 1 \) indicates no crosslines are reflection lines. Holding a mira across the border and then moving it around to see if the patterns lines up with itself can be very helpful for determining crossline reflectional symmetry.
Notice in the display below that the two patterns in the left column have crossline reflectional symmetry (and thus an m as the first code letter) and those on the right do not have a crossline which is a reflection line (and thus have a 1 as their first code character).

<table>
<thead>
<tr>
<th>Crossline Reflections</th>
<th>No Crossline Reflections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type mm</td>
<td>Type 1m</td>
</tr>
<tr>
<td>Type m1</td>
<td>Type 12</td>
</tr>
</tbody>
</table>

**Second Code Character**

The second code character is in indication of center line or other types of symmetry. There are four possible characters:

- m ↔ centerline is a line of reflection
- g ↔ center line is a line of glide reflection
- 2 ↔ there is half-turn symmetry
- 1 ↔ there is no additional symmetry

**Important Note:** Many times more than one of the symmetries is present. In this case, as you go down the list, assign the first letter which is appropriate. For example, if the centerline is a line of reflection and there is also half turn rotational symmetry, the correct code to assign is m since this letter appears first on the chart.

We will illustrate each of the four possibilities in the following. With each type we also indicate how to test for the symmetry.
Second Code Character m: Centerline a Reflection Line

If the center line is a line of reflection then the second code letter is an m. Placing a mira along the center of the border gives a quick check for this type of symmetry. Two examples are given in the next table.

<table>
<thead>
<tr>
<th>Centerline is a Line of Reflection:</th>
<th>Type _m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image1" alt="Type 1m" /></td>
</tr>
<tr>
<td></td>
<td><img src="image2" alt="Type mm" /></td>
</tr>
</tbody>
</table>

Second Code Letter g: Centerline a Glide Reflection Line

For the two examples in the next table, the centerline is not a line of reflection; however, it is a line of glide reflection. This can be checked with tracing paper by first marking a point along the center of the border, tracing the border and then flipping the trace along the centerline. If the trace does not line up when the mark corresponds with itself, but does line up after sliding along, then the border has glide reflectional symmetry. Thus, in this case the second letter of the code type is a g.

<table>
<thead>
<tr>
<th>Centerline is a Line of Glide Reflection</th>
<th>Type _g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image3" alt="Type 1g" /></td>
</tr>
<tr>
<td></td>
<td><img src="image4" alt="Type mg" /></td>
</tr>
</tbody>
</table>
Second Code Character 2: Half-Turn Symmetry

The next two examples do not have centerline reflectional or glide reflectional symmetry. However, they do exhibit rotational symmetry. To check this begin with a guess about where the center of the turn is located. Mark this center. Then trace the border and rotate the border around the center point. If the trace lines up, then half turn symmetry is present. In this case, the second code letter is a 2.

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Half-turn Symmetry is Present: Type _2

<table>
<thead>
<tr>
<th>Type 1g</th>
</tr>
</thead>
<tbody>
<tr>
<td>mg</td>
</tr>
</tbody>
</table>

---

Second Code Letter 1: No Additional Symmetry

Finally, if the border has none of the above symmetries (centerline reflectional, glide reflectional or half turn) then the second code letter is a 1. This means that no additional symmetry is present (except possible crossline reflectional symmetry indicated by an m as the first code character). Two examples are given in the next table.

---

No Additional Symmetry Present: Type _1

<table>
<thead>
<tr>
<th>Type 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>m1</td>
</tr>
</tbody>
</table>

---
Summary and Procedure

The following table can be helpful in deciding the two letters of the code for borders.

<table>
<thead>
<tr>
<th>First Character</th>
<th>Second Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>m – crossline reflectional symmetry</td>
<td>m – centerline reflectional symmetry</td>
</tr>
<tr>
<td>1 – no crossline symmetry</td>
<td>g – glide reflectional symmetry</td>
</tr>
<tr>
<td></td>
<td>2 – half-turn symmetry</td>
</tr>
<tr>
<td></td>
<td>1 – no additional symmetry</td>
</tr>
</tbody>
</table>

The following procedure, guided by the above table, can be followed for determining the symmetry type for a border.

1. Check for crossline reflectional symmetry. A mira can be used for this. This determines the first code letter.
2. Using the second column of the code table above, check for the additional symmetry types indicated by an m, g or 2. These types of symmetry can be checked with tracing paper. If none of these three are present then the second character is a 1.

We note again that a border can have more than one of the types of symmetry used to determine the second code character. For instance borders of type mm also possess half turn symmetry. However, when determining the symmetry code, we go down the second column of the code table and use the first letter that fits.

Something to Think About:

- Why isn’t there an eighth border type, namely type m2? This type would have crossline symmetry and also have half-turn symmetry.