

A Geometric Inspection of Pennsylvanian Dutch Hex Signs

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Abstract

This paper discusses the mathematics that is involved in the construction of “Hex Signs” and describes the construction of such signs. Hex Signs are circular discs with intricate geometric designs with specific meanings that were hung on barns in the “Pennsylvania Dutch” region of the United States. Common designs include: Rosettes, Birds, and Star Polygons.

1. History of the “Hex Sign”

Since the beginning of time man has created designs to portray his feelings. He used these designs to communicate his feelings, and at times, to protect him from what he did not understand or feared. Some common cave drawings are now believed to have been created for good luck for the upcoming harvest. In the middle ages, Europeans were using decorative symbols and motifs on everyday objects to brighten up their lives. These symbols also had a dual purpose, one of religious and ritual protection. Some symbols were used to ward off supposed evil spirits, while others were considered to be good luck or a key for a long and healthy life. Often these symbols took on specific geometric designs which were representative of their purpose. Others included everyday objects such as birds, tulips, hearts, and stars with each representing a specific and different meaning [6]. Over time these symbols became widely known and used among the Europeans.



Figure 1: *Single Distlefink, Double Eagle, and the Welcome Bird*

In the early 19th century, a large wave of German farmers immigrated to America and a significant portion settled in the plush valley lands between Harrisburg and Philadelphia, Pennsylvania. This valley came to be known as “Pennsylvania Dutch” country. Although the name is a misnomer, these early settlers weren’t Dutch, they were German; however, “Duetch” is the German name for someone from Germany. These farmers were mainly German Lutheran and Reformed settlers that commonly decorated everyday items with colorful designs. These designs generally used the common motifs carried over from the European middle-ages. In the middle of the 19th century folk artists began enlarging these old geometric designs and transforming them onto barns. Whether these signs, later to be known as HEX SIGNS, were made to display ones cultural heritage, simple decorative pleasure, encourage prosperity, or to ward off evil spirits is widely debated.



Figure 2: *Two barns with Hex signs.*

One theory is that the geometric circles are representative of a family heritage, such as a coat-of-arms commonly used in England [1]. A farmer would commission a folk artist to paint a geo-circle design with various symbols and motifs that represented a particular lineage. A good portion of hex signs found today have the same picture and design, thus ruling out the theory that a hex sign shows one’s lineage.

Another theory is that a hex sign is simply for decorative purposes. This arises from the fact that the Pennsylvania Dutch people have a history of painting everyday items with colorful designs. However, the act of painting a hex sign on one’s barn in these times took a lot of time and money, neither of which the average farmer had much of. Most hex signs created in the last 50 years are identical or similar in design, leading one to believe that the purpose for the creation of hex signs now involves the need to feed the growing tourism industry in that area of Pennsylvania.

The last and most widely accepted theory is that these hex signs are exactly that, HEX SIGNS. In German “hex” means “witch” and it is believed that these beautiful geometric designs were created to ward off evil spirits or used to beckon the spirits for prosperity in the upcoming years [4].

Despite all the various theories one thing is certain, these simple looking geometric designs are far from easy to create. They are each composed of circles that surround various animal, flower, or star designs arranged to convey a specific motif or meaning. These symbolic meanings include: a heart representing love, a tulip for faith, an eagle for strength, the color white for purity, a black circle for the belief in Christ, and a brown border for long life.

We shall dissect some commonly found hex signs, discuss their meanings, and how they were constructed. Upon closer scrutiny, one will see the incredible geometric relevance of these hex signs, as well as a greater appreciation for their makers. Remember, these constructions were made from simple tools (nail, rope, hammer, straight edge) and paint.

We will first examine the most common geometric design found in the Pennsylvania Dutch Hex Signs, the six pointed Rosette. The single rosette is a basic motif of hex signs and it is one of the most ancient designs in the world. The rosette appears on buildings, furniture, gravestones and pottery. A green scalloped border symbolizes smooth sailing through life and the red colored rosette is used to symbolize strength. This sign would be considered a potent safeguard against harm and portrayed a strong sense of good fortune. This design is based on seven congruent circles. One circle as the main central circle and six circles that pass through the center of the original circle with their centers located on the circumference of the main central circle. One can see the relationship between this figure and the “Kissing Number of a Circle” which is also six.

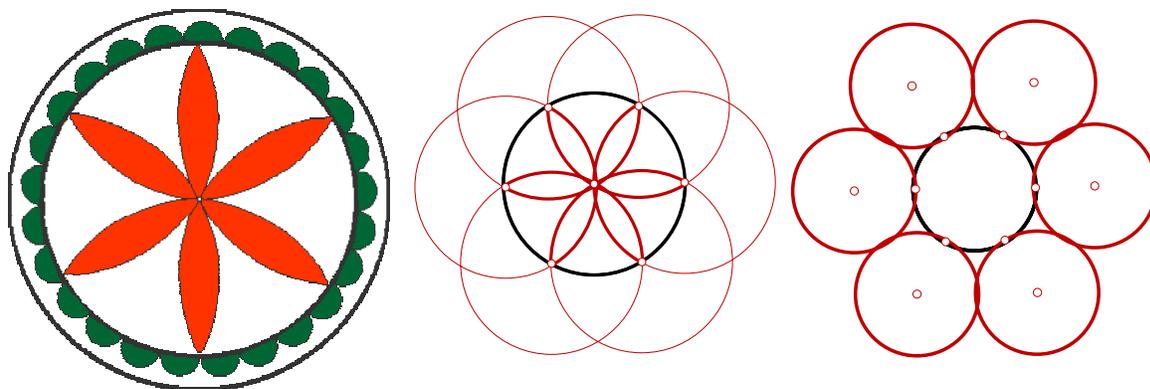


Figure 3: *The six pointed Rosette, its geometric construction, and the Kissing Number of a circle .*

This single rosette has a D_6 dihedral symmetry with order 12 and is found abundantly in the Pennsylvania Dutch countryside. It has appeared painted on barns in the mid 19th century and continues to be prominent to this day. It is now more common to find these hex signs already painted on circular cuts of plywood ready for installation.

2. Other Hex Signs and their Meaning

Other hex signs have animal figures and common objects that carry different meanings. The Distlefink was the good luck bird of the Pennsylvania Dutch (Figure 1). It was actually a stylized version of the goldfinch. The goldfinch eats thistle seed and uses thistle down for its nest and was called a thistlefinch from which comes the Pennsylvania Dutch "Distlefink". This double distlefink sign is also a common hex sign. The two birds give a double measure of good fortune and the Trinity tulips stand for faith in yourself, faith in what you do and faith in your fellow man. The scalloped border symbolizes ocean waves for smooth sailing through life. This particular hex sign has no rotational properties but does have a one fold reflection down the center (an $m1$ or $pm11$) [5]. These designs were generally made by a local folk artist who was commissioned by a Pennsylvania Dutch Farmer to paint such a hex sign on his barn. Some folk artists had created stencils of particular hex signs and would simply trace the hex sign onto the barns, while other talented folk artists would paint by free hand creating a distinct and unique hex sign each time.



Figure 4: *Double Distlefink*

Some of the more complex geometric hex signs make use of star polygons. A star polygon is defined by the following theorem.

Theorem: Let n be the number of equally spaced points on a circle. Begin at a point and, going around in one direction, join every k th point. Then (n, k) star polygon—a star based on meeting all the vertices in a single stroke—exists if and only if $k \neq 1$, $k \neq (n - 1)$, and n and k are relatively prime [3].

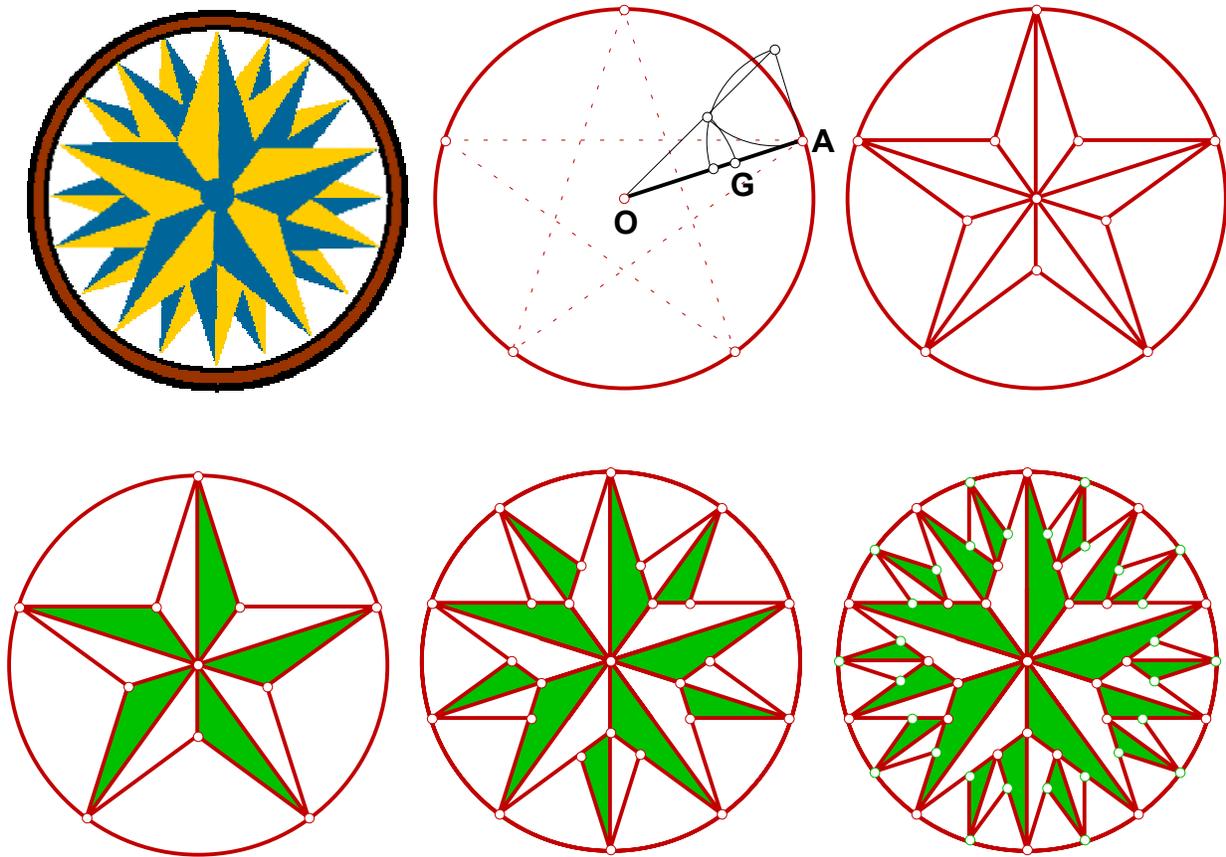


Figure 5: *The Triple Star, a $(5, 2)$ Star Polygon, Pentagram, that has been constructed based on a circle with radius OA divided into ten congruent arcs to OG , the large part of the Golden Cut, and the process of making the Triple Star from a $(5, 2)$ Star Polygon.*

The Pennsylvania Dutch folk artist used this simple concept to create the spectacular triple star hex sign. The Triple Star motif symbolizes good luck, success and happiness. The ring of brown is associated with the cycle of life making this particular sign a wish for a lifetime of happiness. Although this hex sign appears to have a very basic construction, upon further study one will see the complexity involved in creating such a design. On close inspection we can see the hex sign is made up of four overlapping pentagonal star polygons $(5, 2)$, *Pentagram*. One can now see the complexity in design of this simple looking hex sign and its C_5 cyclic symmetry of order 5 [5]. The relationship between the golden cut and the production of a decagonal figure on a circle within this segment is another interesting point about this design.

Some hex sign designs include the construction of a smaller circle within the bigger circle to bring out more artistic value and meaning. The eight pointed star is another fairly common hex design; with the blue star symbolizing goodwill, the tulips representing faith and trust in man, and the sheaves of wheat symbolizing abundance. This design was often used to decorate large buildings and it proclaims abundance and goodwill for all. This hex sign makes use of two (8, 3) star polygons; one on the outer ring (blue star) and one superimposed in the center circle (red star). This design has a D_8 dihedral symmetry with order 16.

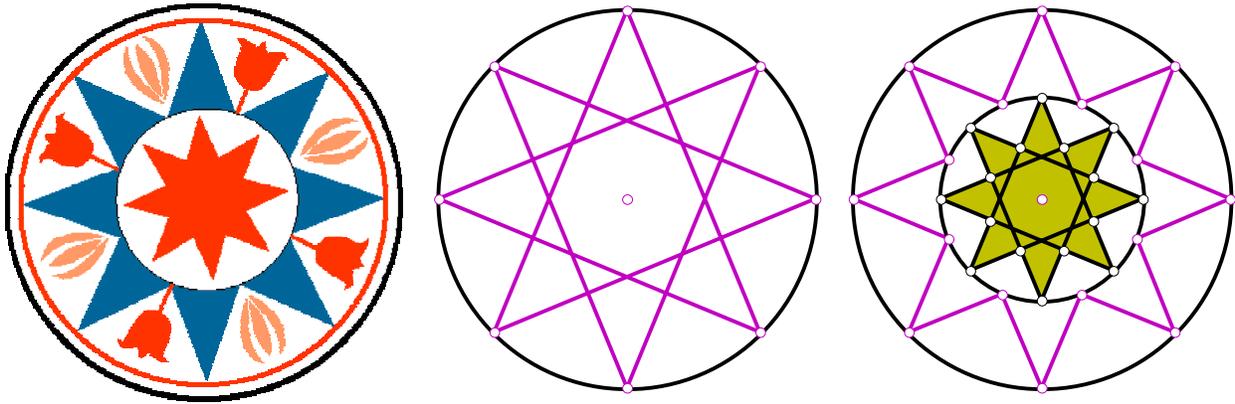


Figure 6: A hex design based on the construction of a (8, 3) Star Polygon.

The leaf designs below are the *Maple Leaf* (lower left) and the *Mighty Oak Leaf* (lower right) hex signs. The first depicts five large maple leaves radiating from a design center, sporting an array of colorful earth tones. The leaves portray the diversity and beauty of life here on earth. A good luck eight pointed star (in the center) completes the design. The design represents appreciation of life's beauty and the sweetness and purity of life. This design is based on the division of the outer ring into five equal parts (the five maple leaves). The Oak Leaf or Mighty Oak is made up of four oak leaves in bold colors radiating from the center. The Oak symbolizes strength in body, mind and character. The four colors of the leaves symbolize the seasons of life and the wavy border in the outer ring symbolizes smooth sailing through life [6]. The Oak Leaf hex sign has an outer ring that is based on division of a circle into eight equal arcs with an inner circle having a six petal rosette as we presented in Figure 3.



Figure 7: The Maple Leaf hex design with an inner (8, 3) Star polygon, and The Mighty Oak Leaf with an inner six pointed Rosette.

The stylized tulip with its three petals is a dominate feature in Pennsylvania Dutch folk art. It is referred to as the *Double Trinity Tulip* and it symbolizes the trinity as well as faith, hope and charity. The heart in this sign (as well as other Pennsylvanian German folk art) is not the heart of sentimental "Victorian" valentines. Rather, it is religious in its representation of the heart of God, the source of all love, and hope for a future life. The colors in this heart are used to give it additional meanings. Red symbolizes strong emotion and blue is used to indicate strength, especially spiritual strength. The white background adds purity and the solid black circle conveys unity in Christ. This hex sign has a one fold reflection down the vertical center while the inner blue rosette has a D_6 dihedral symmetry of order 12.



Figure 8: *Double Trinity Tulip*

The next hex sign, known as the *Daddy Hex*, has an outer ring divided into twelve equally spaced petals and an inner ring divided into eight equally spaced petals [4]. The outer rosette provides twelve months of good luck, while the smaller rosette provides an added measure of good luck during difficult times of the year. The outer ring of this particular hex sign looks like a D_4 symmetry but closer inspections reveals that if we consider the colors of the pedals, then the design is only a C_4 cyclic group since no mirror reflection is admitted. The inner circle then would be a C_2 cyclic group.

We must give credit to those Pennsylvanian Dutch folk artists for creating such magnificent signs. The geometry and mathematical properties that these particular creations have is too profound to discuss in this paper, but further investigation is encouraged.

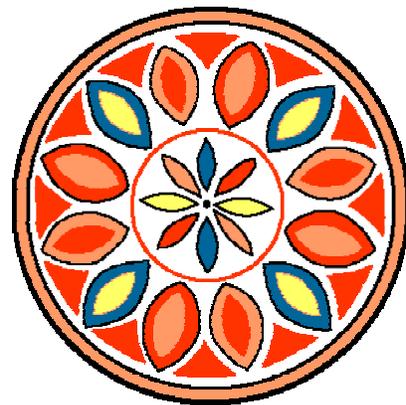


Figure 9: *Daddy Hex*

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