

The Fractal Geometry of Life

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The goal of this design project was to bridge the intentions of mathematical theory and wearable art design by experimenting with the merge of fractal art theory and the aesthetic of the artwork of Piet Mondrian to create an interesting, complex, and aesthetically pleasing visual form of wearable art. Several scientific and mathematical theories have been utilized in art such as in music, film, architecture, painting, and sculpture (Evans, 1992; Metiu, 2014). As apparel design scholars, we question whether mathematical theory could serve as a foundational concept in apparel design and how we could demonstrate expressive power or potential by combining fractal geometry of the Golden Spiral and the color properties of Mondrian's masterpiece.

The Golden Ratio is defined as an irrational constant of approximately 1.618. The principle of the Golden Ratio is that it occurs naturally around us and is present in everything: plants, sea shells, pineapple skin, pine cone and DNA. The Golden Ratio formula in science and math has been applied to various sectors in our daily life to represent the perfect proportion of beauty. Fractal art is an art format that is based on the technologies of computer design and carries a strong mathematical background. It is an interdisciplinary algorithmic art that has grown in popularity among to artists, mathematicians, and computer programmers (Garousi & Kowsari, 2011). The aesthetical character of fractal geometry is self-similarity such as infinite patterns with similar details at different size scales (Kelley, 2000). Most fractal artwork resembles the shape of a Golden Spiral, one of the most well-known Golden Ratio applications, as the Golden Spiral is self-similar and can be infinitely repeated.

This wearable art design centered on the Golden Face (Ghyka, 1977) on the top front piece of the dress. Humans are highly social animals, and facial structures are known to affect all aspects of human communications. The Golden Face, strictly measured in the Golden Ratio, is thought to be the most attractive face structure to humans. By matching the Golden Face motif, the designers intended to stimulate human instinct and natural appreciation of the pattern. Figure 1 shows the proportion of the Golden Face of Helen Wills, one of the Olympic tennis champions, to exemplify these dimensions. The diagram drawn from the proportion of her face matches the Golden Ratio (Ghyka, 1977). In order to completely adopt the diagram of the Golden Face in this design, the top front and side pieces of the dress were draped on a size 8 half-scale women's dress form. The top pieces were digitized into Lectra Modaris Classic 2D V8R2 to modify the accuracy and add seam allowances.

In the meantime, the designers experimented with applying shapes of the Golden Spiral onto the half-scale dress form. By determining the sequence of the Golden Spiral, it was decided the skirt length would be 9 inches long, as seen in Section A (see Figure 2). According to the formula (MacDonald, 2010) for drafting a circular waistline for a full skirt, the radius of the waist measurement is 2.1 inches based on a 13.25 inch waist circumference on the half-scale size 8 dress form. Therefore, the length of Section A is 11.1 inches. The shape of the Golden Spiral was calculated and drawn in Adobe Illustrator, and then digitally printed on the cotton sheeting for prototype making. The designers experimented using each section of the Golden Spiral to resemble a dress. Four sections (A, B, C, D), shown in Figure 2, were used as pattern-pieces on the dress; Section A was used as a quarter of the full skirt, Section B shows the pattern of the underneath mesh tulle, Section C displays the top back piece, and Section D presents half of the shoulder pieces. In order to achieve an accurate shape from the Golden Spiral and to generate full-size flat patterns, the designers used Lectra Modaris to create flat patterns for each piece of the garment once the measurements of each section were finalized.

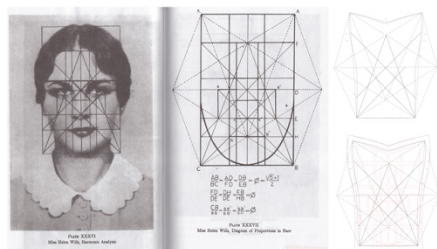


Figure 1. The Golden Face Ratio (Ghyka, 1977, pp.102-103) and motifs applied on the garment.

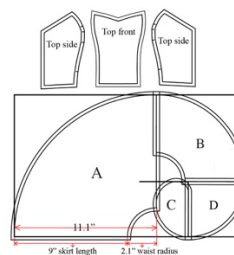


Figure 2. Digitized dress patterns.

The Modaris patterns were scaled up to the full-size patterns, exported into DXF format and then edited in Adobe Illustrator for motif arrangement. Inspired by fractal art, the patterns of the Golden Spiral were repeated at different scales on the full skirt (see Figure 3). After analyzing the motif of the Golden Face, the designers realized that the face sections were drafted by only horizontal and vertical straight lines, similar to the famous color block masterpieces of Piet Mondrian, whose work is representative of postmodern art. Thus, the designers combined Mondrian's primary colors, red, blue, yellow, black, and white, within in the fractal geometries on the skirt and the Golden Face motif.

To represent the effects of the fractal geometric art and the concept from Mondrian's painting, using laser cut technology was the most appropriate way to enrich this wearable art design. Black and white polyester velvet was used since the velvet is one of the best fabric choices for engraving with laser cutting. White velvet was used as the plain background, as in Mondrian's painting. Figure 3 shows the cutting (red lines) and engraving (black space) pieces of the white and black velvet. The engraving patterns using black velvet (the top back panels and shoulder panels) were created based on the theory of fractal art using the Golden Spiral motif, and then engraved by a Universal laser cutter with 10% power, 100% speed, and 500 PPI. The frame of the Golden Face, the lining of the shoulder panels, top side panels, and the fractal Golden Spiral skirt were cut from black velvet using 100% power, 100% speed, and 1000 PPI. In order to match the patterns with the black velvet and position the embellishment, the white top front piece and the skirt were engraved with straight lines and in the space of the embellishments.

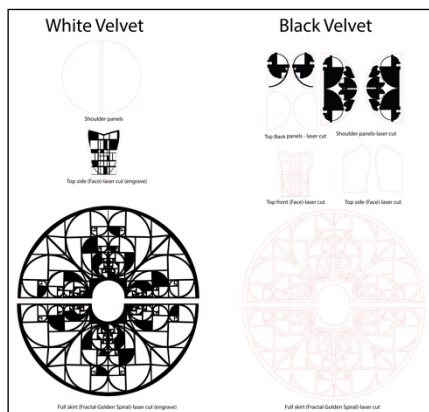


Figure 3. Laser cutting motifs.

Before assembling the garment, the designers embellished the garment using hand stitching and hand beading techniques. To mimic the diagram of the Golden Face in the Figure 1, the solid black diagonal lines were stitched by a sewing machine using regular black sewing thread on the white velvet cut. For the diagonal dash lines, one of the designers performed hand stitching using black and white embroidery threads. The primary colors of red, yellow, blue, and black were filled in a particular block on the top front and the full skirt using 12/0 opaque round glass seed beads. The black frame velvet pieces were attached and hand stitched along each straight line to secure two layers of the fabrics. Next, 3/4 inch black metal eyelets were attached on the top back panels to allow the 1/2 inch wide self-fabric string to lace up to secure the top on the body. The grey mesh tulle skirt was made to support the shape of the full skirt.

This wearable art design contributes an innovative design process that relies on computer software to give rise to the "chaos and regularity, the fractal dimension and infinity" (Garousi & Kowsari, 2011, p. 225), which is analogous to the fractal art design process.

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Figure 1. Front View



Figure 2. Back View



Figure 3. Side View



Figure 4. Detail