A study on application of the golden and Fibonacci geometry in design of fashion accessories

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Abstract. The paper presents a study of application of the golden and Fibonacci geometry in design of fashion accessories: bags, scarfs, small accessories, etc. The connection between the application of the golden and Fibonacci geometry in accessories design and sustainable fashion is one of main accents in the study. The application of golden and Fibonacci tilings, floral and animal ornaments, which are created on their base, and geometric forms in golden or Fibonacci proportions are shown. As expressors of beauty, aesthetics, and harmony, the creations on the base of the golden and Fibonacci geometry can be applied in design of fashion accessories directly, as frames, and as parts of new forms. Regardless of the way of the application, the new designs are in strong connections with the sustainable fashion: slow fashion, sustainable trends, zero waste cutting, minimal waste cutting, ecological printing, etc.

1. Introduction
It is considered that the Golden ratio [1] and Fibonacci sequence [2] are the mathematical expression of beauty and harmony. By this reason from the ancient times the golden ratio is used in art and architecture for creation of beautiful proportions. In the present both the golden section and Fibonacci numbers, and their geometrical application are used in arts, design, and architecture.

An investigation of application of the golden ratio, geometrical creations on the base of the golden section (the golden triangle, the golden rectangle, and the golden ellipse) and Fibonacci sequence in fashion design and pattern making is presented in [3]. The research from [3] gives ideas for the presented study about fashion accessories.

This paper presents a study of application of the golden and Fibonacci geometry in design of fashion accessories: bags, scarfs, small accessories, etc. The connection between the application of the golden and Fibonacci geometry in accessories design and sustainable fashion is one of main accents in the study.
2. Golden and Fibonacci series tilings
In the design of fashion accessories tilings with squares and triangles on the base of the golden ratio and Fibonacci sequence can be used: the golden tiling with squares in a spiral direction [4], Fibonacci series square tiling in a spiral direction [5], the golden square tiling in two perpendicular directions [4], Fibonacci series square tiling in two perpendicular directions [5], a tiling on the base of the golden triangle [3], Fibonacci series tiling with regular triangles in two spiral directions [6, 7], etc. Figure 1 presents an application of Fibonacci series tiling with regular triangles in two spiral directions, known as Fibonacci rose [6, 7], in design of a lady’s bag, made with a technique, similar to the patchwork.

![Figure 1. Application of Fibonacci rose in design of a lady’s bag.](image)

3. Floral and animal ornaments and forms
The golden and Fibonacci tilings are used as frames of creation of different geometric forms, which can be used for design of ornaments: floral, animal, or other different from geometric ones.

The golden [8] and Fibonacci [9] spirals are the most popular geometric forms. The golden and Fibonacci spirals are created in the frames of the golden and Fibonacci square tilings in spiral directions. The golden and Fibonacci spirals can be applied in design of butterflies, formed on the base of two golden or Fibonacci spirals which are connected each another on the base of a bilateral symmetry. The creation of Fibonacci butterfly on the base of two Fibonacci spirals is presented in Figure 2. The golden butterfly is designed similarly on the base of two golden spirals.

Figure 3 presents the ornament of golden butterfly and its application as print in personalized designs of a bag, a watch, a laptop case, and a face mask. For personalization web based services are used: https://studio.shopvida.com, https://artofwhere.com, https://www.zazzle.com, etc.

Figure 4 shows embroidery of Fibonacci butterfly which can be used in designs of scarfs, bags, etc.

Figure 5 presents a necklace with Fibonacci butterflies on the base of Fibonacci spirals made from recycled textile and plastics materials. The same Fibonacci butterflies from recycled textile and plastic materials can be used as bags decoration.
Figure 2. Creation of Fibonacci butterfly on the base of two Fibonacci spirals.

Figure 3. Personalized designs with golden butterfly prints.

The golden and Fibonacci spiral can be used in forming of hearts, created on the base of two golden or Fibonacci spiral which are connected each another on the base of a bilateral symmetry. The design of Fibonacci heart on the base of two Fibonacci spirals is shown in Figure 6. The golden heart is created similarly on the base of two golden spirals.

Fibonacci and the golden hearts are bases of creation of clovers, designed by four hearts using radial symmetry. A Fibonacci clover, designed on the base of four Fibonacci hearts, is presented in Figure 7. The golden clover is formed similarly on the base of four golden hearts.
Figure 4. Embroidery of Fibonacci butterfly.

Figure 5. Necklaces with Fibonacci butterflies.

Figure 6. Creation of Fibonacci heart on the base of two Fibonacci spirals.
Figure 7. Creation of Fibonacci clover on the base of four Fibonacci hearts.

Similarly, to the golden and Fibonacci spirals other geometrical elements can be drawn in the frame of the golden and Fibonacci tilings. The golden and Fibonacci [10] circles are created in the frames of the golden and Fibonacci square tilings in spiral directions. Figure 8 presents Fibonacci circles, drawn in the frame of Fibonacci square tiling in a spiral direction. The golden circles are formed similarly in the frame of the golden square tiling in a spiral direction. The golden and Fibonacci circles directly form floral ornaments of roses.

Figure 8. Fibonacci circles, drawn in the frame of Fibonacci square tiling in a spiral direction. Fibonacci circles directly form floral ornaments of roses.

The golden and Fibonacci spirals can be replaced by spiral forms, created by the diagonal lines in the frames of the golden and Fibonacci square tilings in spiral directions. And the golden and Fibonacci butterflies, hearts, clovers can be design with these forms.

Figure 5 presented a second neckline with Fibonacci butterflies created by diagonals in the frame of two Fibonacci square tilings in spiral directions. The butterflies are made with the use of 3D marker [11]. For the same design 3D printer can be used.

Figure 9 presents a Fibonacci hearth, created by diagonals in the frame of two Fibonacci square tilings in spiral directions, made using the patchwork technique, which can be used in design of bags, small bags, scarfs, etc.
4. Geometrical elements in golden or Fibonacci sequence proportions

In design of fashion accessories geometric elements in golden and Fibonacci sequence proportions can be used.

Figure 10 presents a design of a scarf with isosceles obtuse triangles with golden proportions between lengths of the base and both equal sides. The shown scarf is dyed with turmeric.

Figure 11 shows a design of a scarf with hexagons in different sizes in golden proportions between the lengths of the hexagons sides. The presented scarf is dyed with turmeric and black tea.
5. Design of accessories and sustainable fashion

What is connection between presented application of the golden and Fibonacci geometry in design of fashion accessories and sustainable fashion?

At first the golden ratio and Fibonacci sequence are symbols of beauty and harmony, and therefore, the designs created on the base of application of the golden and Fibonacci geometry are sustainable fashion elements which are independent from the fashion trends. They are always fashionable. Therefore, these designs have long fashion life, or they belong to the slow fashion.

The use of the golden and Fibonacci series tilings as pieces in fashion creations leads to zero or minimal waste cutting, like presented design of lady’s bag with the use of Fibonacci rose, shown in Figure 1. Some ornaments and forms, designed on the base of the golden and Fibonacci series tilings can be made with minimal waste too, like Fibonacci heart from Figure 10.

The floral, animal and other forms, created on the base of the golden and Fibonacci tilings are realized from recycled textile and plastic materials, like the necklace with Fibonacci butterflies, designed with Fibonacci spirals, or be made with 3D marker and 3D printers with eco friendly materials, like the necklace with Fibonacci butterflies, formed with straight diagonal lines. Both necklaces are shown in Figure 5.

The ornaments created on the base of the golden and Fibonacci tilings and the geometric elements in golden and Fibonacci sequence proportions can be realized with ecological print. Accessories with the geometric elements in golden and Fibonacci sequence proportions can be dyed with natural ingredients, like the scarfs with elements in golden proportions, presented in Figures 10 and 11. The scarf with triangles, shown in Figure 10, is colored with turmeric. The scarf with hexagons, presented in Figure 11, is dyed with turmeric and black tea.

6. Conclusion

As expressors of the beauty, aesthetics, and harmony, the creations on the base of the golden and Fibonacci geometry can be applied in the design of fashion accessories directly, as frames, and as parts of new forms. Regardless of the way of the application, the new designs are in strong connections with the sustainable fashion: sustainable fashion elements with long life in fashion trends and used in the slow fashion, zero waste cutting, minimal waste cutting, 2D and 3D ecological printing, ecological dyeing, etc.
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