

Reflection of mathematical concepts and theories on art

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Abstract

The source of mathematics and art is nature. In everything that is visible or invisible in nature, there is a certain order and arrangement. While science and mathematics use evidence in the process of understanding nature, the desire to create beauty has formed art. As a problem question, do we need mathematics to create beauty? Galilei's expression that 'Nature's book is written with mathematics' can be a response to that question. Maths allows us to get to know nature better by enabling us to measure and calculate the formal features of objects in nature, their ways of functioning and thus to be able to create successful designs in the fields of architecture and arts. As a result, although mathematics and art are different fields, like mathematics, art abstracts and reinterprets nature. In this study, it has been aimed to analyse the effects of mathematics and developments in the field of mathematics on various branches of art and architecture in the 21st century. The works carried out in the branch of architecture and plastic arts where the relationship between mathematics and art are exemplified examine the literature on the relationship between mathematics and art as a method.

Keywords: Mathematics, art, ceramic, geometry, number, abstract art.

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1. Introduction

The word mathematics was first used by members of the Pythagorean schools around 550 BC and it was introduced in the written language by Pythagoras around 308 BC. The meaning of the word is 'what needs to be learned'. Mathematics and arts are abstract concepts and both of them interpret nature. There is no mathematical point or a straight line in nature. There is no object that we can physically indicate as a point or a line, and likewise, there is no object that we can show as a circle. Circle is a concept created by mathematicians. In his book, *Mathematics and Nature*, Ali Nesin states that, 'Have these concepts existed from nothing? We know that nothing will exist from zero (!) Even the most abstract ideas come from concrete. Also mathematical concepts did not exist from nothing'. There is no such thing as 'the product of pure thought', and there cannot be. Every product of thought stems from realities around us. The main source of every abstract thought, every concept, whether in art, science or philosophy, is nature, the universe and the world around us. To think the opposite is to think that something can exist from nothing. Galileo states that the language of nature is mathematics: 'The great book of nature can only be read by those who know that language. This language is mathematics.' Nature is written in the language of mathematics and there is aesthetic in everything we see when we look around.

2. Mathematical concepts affecting art

When we look at the structure of plants, objects and living things that fascinate us with their beauty in nature, the mathematical and geometric features are striking. The spirals that are seen in ivy branches, sea snails and the perfect hexagons in beehives are the first examples that come to mind. The symmetry of mineral crystals is also surprisingly beautiful. There is a certain order and sequence in everything from the trees, flowers, butterflies and DNA coils found in our cells and that we cannot see with our eyes. Mathematicians and scientists have developed mathematical formulas based on these orders and sequences. These formulas can be expressed in numbers as well as geometric shapes. Fibonacci numbers, golden ratio, Mobius strip, Klein flask, polyhedral (polyhedral), Hilbert's space-filling curve, fractal geometry and helicoid curve are systems created by analysing forms in nature and these systems have been analysed by painters, sculptors, ceramicists and architects, as well as mathematicians, to produce their art work.

2.1. The Fibonacci numbers and the golden ratio

Fibonacci founded the Fibonacci number sequence which is named after him. The sequence starts from zero and continues with the sum of the two preceding numbers. 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597 ... (Akdeniz, 2007).

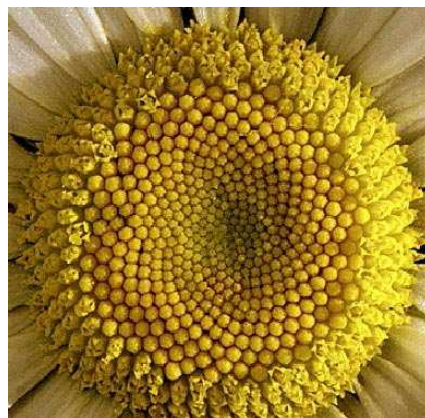


Image 1. Sunflower



Image 2. Ilhan Koman, Deniz Kabugu (Seashell)



Image 3. Alison Gill, Fibonacci Rabbit Generator, 2001–2010



Image 4. Max Bill, 'Unite tripartite'



Image 5. Segerman, Bronze-Silver, 1.18 × 3.07 × 3.38 cm

2.2. Mobius strip

It is obtained by bending one end of a long strip 180° and binding it with the other end. It was named after the mathematician A.F. Mobius, who lived between 1790 and 1868.

2.3. Klein bottle

It is a three-dimensional geometric form with the characteristics of the Mobius strip. Klein bottle also has a single surface like the Mobius strip. The Klein bottle is characterised with its surface that intersects with itself. However, when it is defined in four dimensions, the discontinuity is about the problem (Ozaygen,1998).



Image 6. Klein bottle

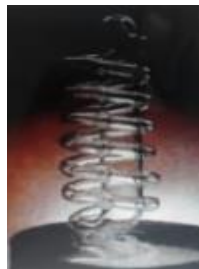


Image 7. Alan Bennett, Spiral Klein Bottle with nine twists

2.4. Polyhedral

Three-dimensional geometric forms, the surfaces of which consist of polygons, are called polyhedral. Polyhedral are named according to the number of their surfaces. In a polyhedron, when all the surfaces are equal it is called a smooth polyhedron. Diamond cut and brilliant shapes can be given as examples for cubic polyhedral. Polyhedral have multiple symmetrical features (Gunduz, 1998).

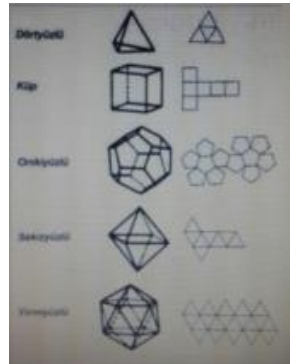


Image 7. Polyhedral

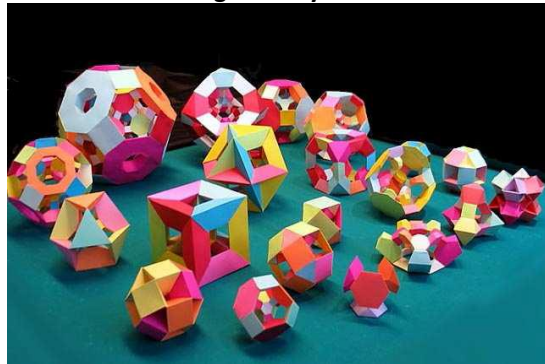


Image 8. M. Wenninger, Polyhedral models

2.5. Hilbert's Space-Filling Curve

It is named after German the mathematician David Hilbert, who made important contributions to the formation of the formal foundations of mathematics. Hilbert's space-filling curve is defined as the plane generated by a continuously repeating curve. When this process is repeated in infinite multiplicity, the one-dimensional curve becomes a two-dimensional plane. These and these kinds of curved shapes form the basis of fractal structures (Koc, 1995).

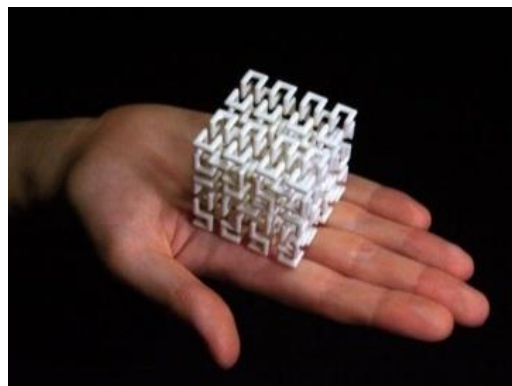


Image 9. Henry Segerman, Plastic, 4.44 × 4.44 × 4.44 cm



Image10. Heleman R. P. Ferguson, UmbilicTorus

2.6. Fractal geometry

It is derived from the word ‘fractus’ which means fractured, fragmented and divided. As it is understood from the meaning of the word, fractal is the formation of a unit that repeats itself and that gradually shrinks and continues forever. In almost every element that we see in nature, there are different sizes of fractals that are similar to the other. For example, it is possible to see fractals in snowflakes, seashells, veins in our bodies, galaxies, the order of galaxy clusters and many others. Mandelbrot’s fractals have a radically different structure from the traditional geometry as they have fractional dimensions (Erzan, 1998).



Image 11. Cauliflower plant



Image 12. Tommy Stockel, Isn't Life Beautiful?

2.7. Helicoid curve

The twisted shape, which is called Helices or Helix, is a three-dimensional form. The helicoid curve, which is called spiral in Turkish, is a part of our daily life as it is available in objects and structures such as screws, cylindrical springs, bottle caps, fire stairs and minaret stairs. It is possible to see this structure in plant branches and leaves, spiral galaxies, bacteria, seashells, DNA molecules and most of the proteins (Deligeorge, 1998).



Image 13. LeftHanded Spiral Leaf



Image 14. James Watson and Francis Crick

2.8. Soap Bubbles

In the 19th century, the Belgian physicist Joseph Plateau conducted many experiments on the structure and features of soap bubbles and came up with a result of four items: a soap membrane consists of a collection of smooth pieces; the average curvature of each smooth piece is firm; the surfaces of three soap bubbles form a smooth curve where they merge and divide each surface with an angle of 120° ; and the resulting six curves form a point where they come close to each other and at this point. The angle between each pair is equal (Ozsoylev, 1998).

3. Examples in architecture

Jane Burry is a professor at Swinburne University of Technology. His research focuses on mathematics and computing in contemporary design. His recent works deal with the use of simulation and feedback and digital production to create better, more responsive, human-centered areas. With the use of geometry in design, energy efficiency, thermal air flow and acoustics are created more

accurately. The book ‘The New Mathematics of Architecture’, which was published in 2010, includes conceptual and practical analyses of sample structures and spaces created by mathematical methods (Turhan, 2018).



Image 15. Bronze sculpture (Séquin, 2003)



Image 16. 1972 Summer Munich Olympic Park by Frei Otto.

4. Conclusion

Mathematics, improvements in science and artistic creation, which have a powerful interaction, support each other by forming a basis for each other. These two phenomena that support each other, ‘the aesthetic aspect of mathematics’ and ‘the measurable aspect of art’, show a spiral characteristic to each other and have other features independent from each other as well.

Mathematics, architecture and art without dispute contain measurable features. Ratio–proportion, symmetry, perspective, order and harmony form the basis not only of measure but also of aesthetics. These concepts are related to both the foundation and continuity of mathematics as well as architecture and all the other branches of art. Understanding mathematics may contribute to the development of aesthetic understanding and the emergence of different interpretations. The research that will be conducted on this issue, the experience and new perspective might also constitute the preliminary steps of different inventions for the future. Developments in mathematics, science and technology can further strengthen the relationship between art and mathematics, paving the way for creativity and innovation and new expressions in art.

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