Geometry and Aesthetics of Pentagonal Structures in the Art of Gerard Caris

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Abstract

The work of the Dutch artist Gerard Caris is based on pentagonal structures. His work shows us the possibilities and stimuli that emerge from geometric structural thinking concentrated on regular pentagons. The artist developed aesthetical expressions by exploring pentagonal structures in the plane as well as in space. The paper tries to understand and reproduce the developments of his art creations in the form of drawings based on the pentagon as well as sculptures based on the dodecahedron. The artist's way to explore pentagonal structures will be related to the geometric research and the aesthetic categories by evaluating Gerard Caris' art in its relation to order and innovation.

Introduction

The work of Gerard Caris [1] shows us impressively which design possibilities and stimuli for art creations can be derived from a geometric structural thinking. With his concentration on the regular pentagon, he develops aesthetic expressions for his explorations of pentagonal structures and enables the viewer to discover the geometric knowledge on these structures in a playful and self-explanatory way.

William Hogarth raised the question in his book "Analysis of Beauty" [2] whether the aesthetics could be directly connected with the form. The book has the subtitle *"written with a view of fixing the fluctuating ideas of taste"*. He evaluated the serpentine line as the line of beauty. Caris' preference for the pentagon is not fixed on the form, not the form of the pentagon is declared as the aesthetic object, but rather the manifold geometric structures, derived out of the pentagon. Max Bense developed, especially in his work "Aesthetica" [3], new approaches to aesthetics, which could be helpful for the interpretation of Gerard Caris' art concerning the interrelations and differences between art and geometry. According Bense the geometric form, here the geometric element pentagon, is not identical with the aesthetic element, only in its materialization in a composition it becomes the aesthetic element. More details on the aesthetic theory had been given in *"Prolegomena zu einer geometrischen Ästhetik"* [4] by the author. Herewith the geometric analysis of pentagonal structures is clearly distinguished from Caris' artistic creations. But patterns and ornaments have a fundamental role for art according Paul Valéry [5], because fundamental order structures are expressed in ornaments. He compares the role of the ornamental drawing in art with the role of mathematics for the sciences.

In the following we want to understand and reproduce the developments of Gerard Caris in his art creations, in his Pentagonism as he calls his art posture. Historical and actual geometric research on pentagonal structures will be related to his art works.

Creation of the Pentagon

Gerard Caris expresses visual thinking and space concepts as the basis of his works. He experienced the dominance of the rectangle and orthogonal structures in the built surrounding, especially if structural continuity is desired. This dominance of rectangular structures brought him to search for a motif, which could be able to establish a personal universe of art. So he is looking for a new system of order for his art as an alternative for the overwhelming orthogonality. He calls his intuitively conceived in a spontaneous composition titled works “Birth of Forms,” 1968, and “Creation of the Pentagon,” 1969, (Figure 1) as his key works. They had been for him the answer to the question: How to imagine something from nothing? If you look at these works you think on a paper strip, which forms an irregular pentagon. It had been just intuitively created works for the artist, but the fact is fascinating, that the regular pentagon arises out of an overhand knot of a paper strip with uniform width.

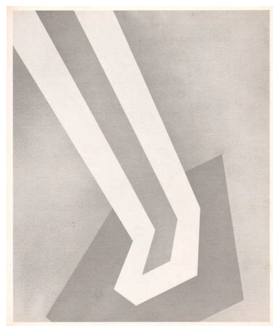
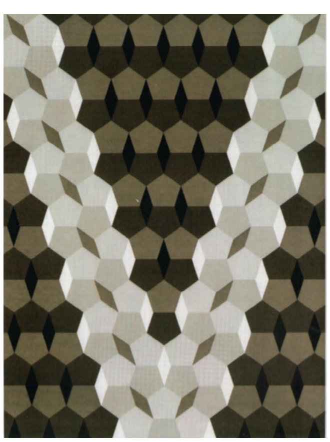


Figure 1: *Gerard Caris, Creation of the Pentagon, 1969.*

The accidentally discovered irregular pentagon had been the starting point of Caris’ Pentagonism [6]. Studies for tiling the plane with pentagons followed. Variations of irregular pentagon-hexagon tilings like “View of the Universe 1,” 1969, represent this analysis. From the irregular pentagon he comes to the regular pentagon and traces the impossibility of tiling by regular pentagons. There remains always a rhombus in between, which can be placed at various positions. The work in Figure 2 for example, suggests a spatial interpretation supported by bright-dark values, which is continued later on in reliefs. Previously Albrecht Dürer [7] and Johannes Kepler [8] worked on those tilings. Dürer (left in Figure 3) shows the rhombic spaces in various variants created by tiling with regular pentagons. Kepler arranges regular pentagons in a pattern where ten pentagons are grouped in a closed circle (right in Figure 3). The configuration shows the complex structures, which arise out of pentagonal structures.



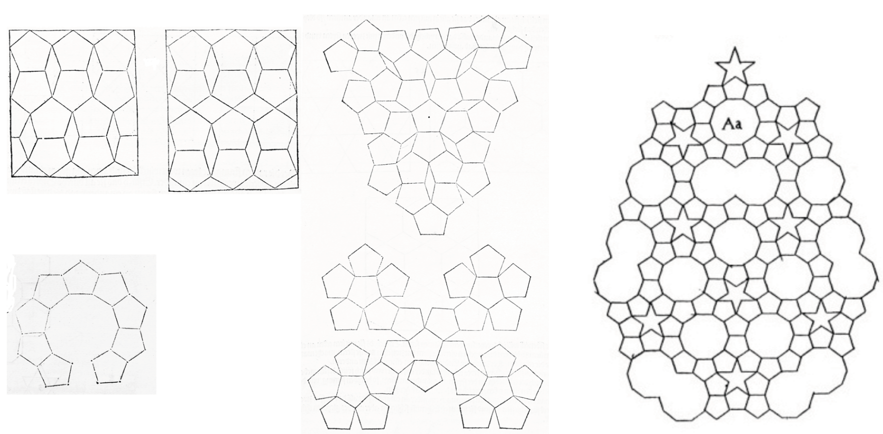


Figure 2: *Gerard Caris, Structure 6 C 2, 1975.* **Figure 3:** *Configurations by A. Dürer and J. Kepler.*

Tessellations and Pentagrid

Tessellations and Dualisation. The three possible tessellations by regular polygons: triangle, square and hexagon are confronted by Gerard Caris with the structures out of the tiling by regular pentagons. The usual geometric studies for tessellations go from the regular tessellations to the demi-regular, also called Archimedean. With the help of the mighty tool of dualisation of the demi-regular tessellations we get the tessellations by the same irregular polygons (Figure 4). In this way we get the so-called “Cairo Tiling,” which had been published by MacMahon [9] in 1921, by the dualisation of the demi-regular tiling out of three regular triangles and two squares. It is characterized by 3-3-4-3-4 because triangles and squares meet in each vertex in the same sequence. Additional irregular pentagon tessellations had been discovered.

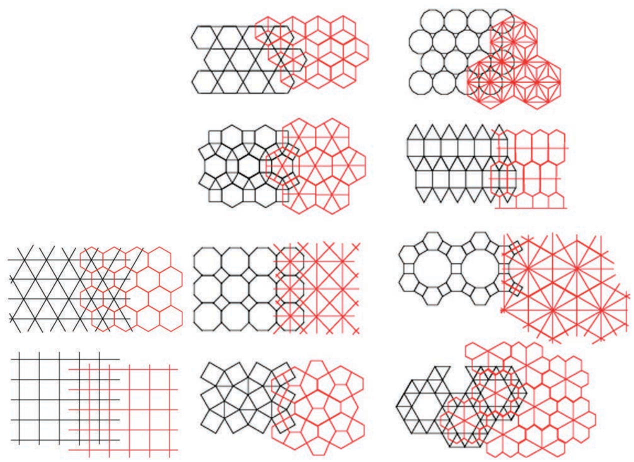


Figure 4: *Dualisation of the regular and demi-regular tessellations [10].*

Pentagrid. Gerard Caris does not work with irregular pentagons. His interests are the pentagonal structures based on the regular pentagon. He develops the pentagrid (Figure 5) out of various fillings of the regular pentagon configurations, which becomes the structural basis of his work. It contains the manifold relationships and configurations of the pentagonal structures. Caris describes the pentagrid as five-dimensional grid. These five lines form the fundamental structure of the pentagrid. The analysis of the regular pentagon with the relation of side to diagonal according the golden section leads to the grid with angles of 36°, 72° and their sum 108°, the interior angle of the pentagon (Figure 6). The two possible golden triangles are enclosed in the pentagon.
The fractal structures result from the infinite continuation of the subdivision according the golden section. In his works as shown in Figure 7, Gerard Caris explores the fractal structures in the pentagrid.

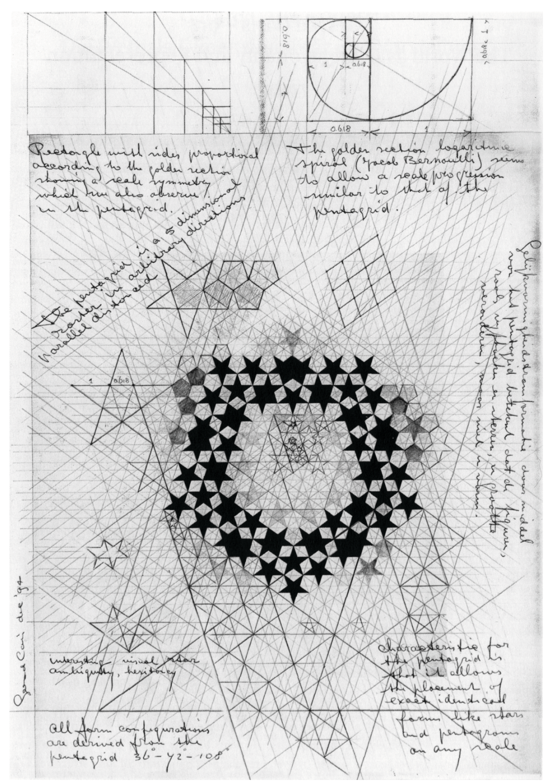


Figure 5: *Gerard Caris, Pentagrid, 1994.*

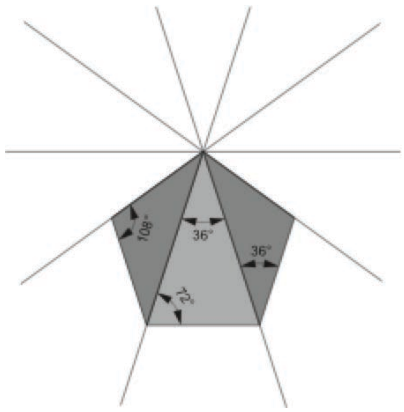


Figure 6: *Pentagon and five-dimensional grid.*

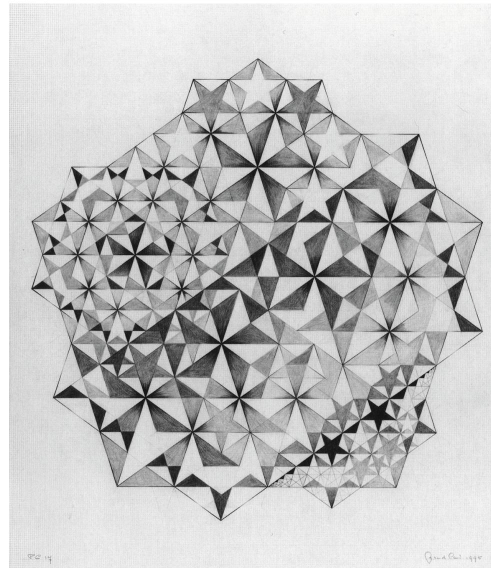


Figure 7: *Gerard Caris, PC 17,1995.*

Islamic Ornaments. The geometric patterns of Islamic ornaments refer already in the ninth century to patterns based on the golden section, besides root two and root three proportions. In Figure 8 the Islamic ornament is constructed out of the pentagon according the analysis of El-Said and Parman [11]. Figure 9 shows the work ETX 36, 1999, of Caris by using the basic structure of such Islamic ornaments.

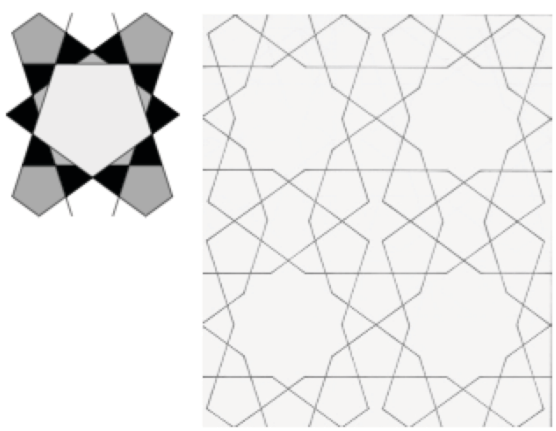


Figure 8: *Islamic ornament from pentagon.*

Figure 9: *Gerard Caris, ETX 36, 1999.*

Figures in the Pentagrid. The figures in the pentagrid are the pentagon, the pentagram, the golden triangles and the rhombuses, which derive from the golden triangles (Figure 10). Almost automatically the kites and darts (Figure 11), developed by Penrose from the rhombuses, are created.

Figure 10: *Figures in the pentagrid.*

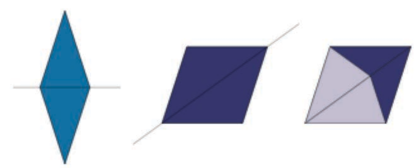


Figure 11: *The two rhombuses with kite and dart.*

Kite-Dart-Grid. The two rhombuses form the basis for the quasiperiodic tilings according Roger Penrose and Robert Ammann. Gerard Caris develops the kite-dart-grid from the pentagrid (Figure 12). His newest works from 2015 are based on the kite dart grid. When we look for the possibilities to arrange kite and dart around a node, we get the seven possibilities, named by Conway [12] with Star, Ace, Sun, King, Jack, Queen and Deuce, see Figure 13.

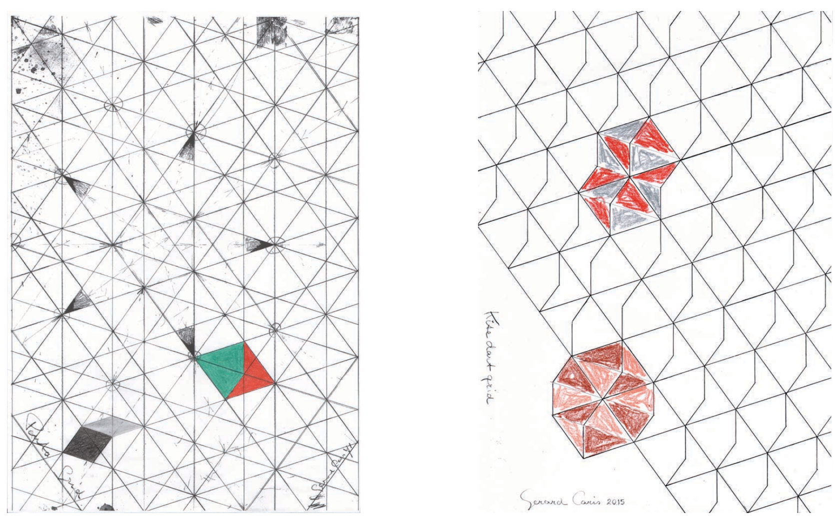


Figure 12: *Gerard Caris, Pentagrid, 1971 and derived Kite-dart-grid, 2015.*

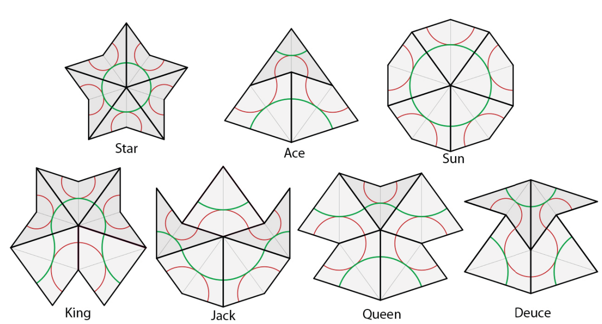


Figure 13: *The seven possibilities to arrange kites and darts around a node [13].*

The newest works of Gerard Caris tie in with these arrangement possibilities and develop extended configurations. In these works Caris is interested in the aesthetics of the figures resulting from the arrangements and the colouring of the included golden triangles as shown in Figure 14.

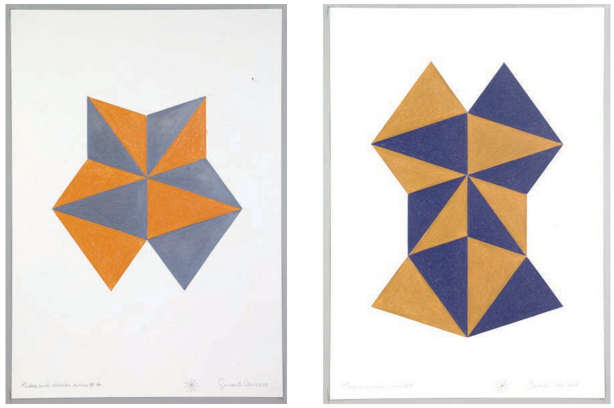


Figure 14: *Gerard Caris, Kites and darts series #4, 2015 and Kites and darts series #8, 2015.*

Spatial Structures

Dodecahedron. Gerard Caris develops the pentagonal structures also in space parallel to the pentagonal structures in the plane. He starts with the dodecahedron. Spatial configurations are arranged from the dodecahedron, for example by extending the edges of the dodecahedron. A spatial dodecahedron grid (Figure 15) is the result. In this way, but also with other criteria for the distances of the dodecahedron, sculptures like Monumental Polyhedral Net Structure, 1977, are created.

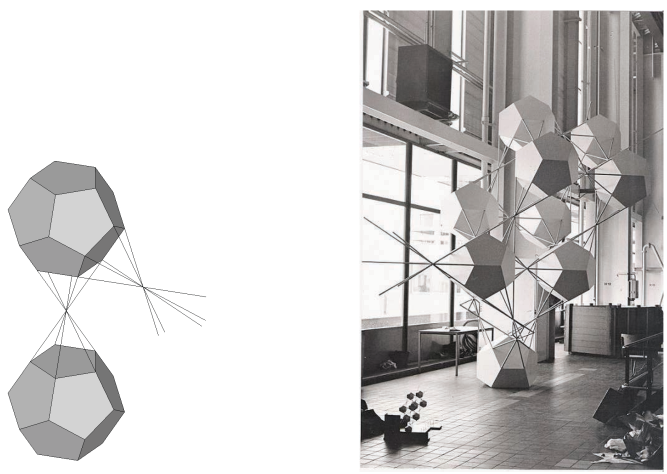


Figure 15: *Dodecahedron grid* and *Gerard Caris, Monumental Polyhedral Net Structure, 1977.*

Other spatial structures were found by truncating the dodecahedron, which the artist realized in sculptures and reliefs, but also in structures evoking buildings (Figure 16). The structures are based on the idea to inscribe a cube in the dodecahedron or starting with the cube and putting hipped roofs on the faces of the cube (Figure 17). Euclid had explained this construction possibility in his *"Elements"*. If we take a cube and put the six hipped roofs inwards, we get a so-called concave dodecahedron. For filling the space with dodecahedra, we can use this concave dodecahedron for the gaps.

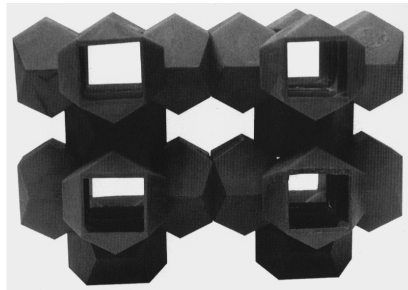


Figure 16: *Gerard Caris, Polyhedra sculpture 3 (truncated), 1979.*

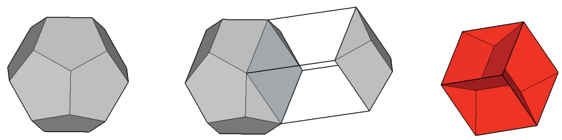


Figure 17: *Truncating the dodecahedron or putting hipped roofs on the cube faces.*

Golden Diamonds Composed of Rhombohedra. The Penrose patterns find their spatial counterpart in the so-called golden diamonds. The structural elements are, corresponding to the rhombuses in the plane, the rhombohedra, where the diagonals cut each other in a golden ratio. Gerard Caris transposes the design possibilities with the rhombohedra in sculptures and reliefs (Figure 18).

Figure 18: *Gerard Caris, Reliefstructure 14V-1, 2003.*

Aesthetics and Geometry

Gerard Caris refers in his art to the geometry of pentagonal structures in the plane as well as in space. He uses the geometric order structures for experiencing them in aesthetic compositional processes. In this way he explores many geometric relationships in an aesthetic expression. His art cannot be reduced to these geometric order structures, but structural thinking turns out as an adequate method to consolidate design processes [15]. According to the information aesthetics, redundancy or respectively order and innovation have to be in an optimal relation to achieve an aesthetic state. Max Bense explained in his *"Kleine abstrakte Ästhetik"* [3, p.356]: *"A perfect innovation in which there were only new states as in chaos, would not be recognizable. A chaos is finally unidentifiable. The recognizability of an aesthetic* *state requires not only the recognizability of its singular innovation, but also their identifiability based on their redundant order characteristics."* (translated from German by the author). By applying these characteristics to the art of Gerard Caris, we are able to determine that the aesthetic states are identifiable by the geometric order. The viewer of his works can take part in his design processes by following the structures. But the innovative aspects are not missed, because we experience manifold surprising and fascinating patterns, which catch the eye as images of spatial structures depending on the point of view.

Acknowledgment

Many thank to the artist Gerard Caris for the possibility to visit him in his atelier, showing and explaining me his work. The figures of his art works are used with his kind permission.

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