THE REGULAR POLYGON BUNDLES OF CARL KEMPER

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Introduction

The geometric models created by Carl Kemper (architect, painter, sculptor, 1881 - 1956) consist of a defined number of mostly regular polygons sharing a common centre point.

Similar to the Platonic solids, every Kemper model is an expression of certain spatial symmetries. The models are not "bodies" in the familiar sense, but, due to their space-partitioning structure, are similar to "combs", so named by Georg Unger (1975). (Technically they should be called point-combs to distinguish them from space filling honey-combs)

If, for example, an icosahedron is described as consisting of 20 triangles, then these triangles are arranged as a separating skin between inside and outside. This is not the case with a Kemper model, which for example consists of 4 hexagons: here the polygons go through a common centre point. In this respect an opening of the centre towards the outer space is the underlying principle of the model. The Kemper models have no physical shell. Their boundary is formed by the observer. The interplay of space-partitioning structure and hull thus touches questions in architecture about the representation of the inner structure in the outer form, and achieves a harmonious, almost musical quality in the Kemper model.

The Rudolf Steiner Archive in Dornach (CH) contains an extensive collection of the models made by Carl Kemper in 1955/1956. Some of these geometric models have been described by Georg Unger (1975) and Renatus Ziegler (1998). There is no systematic description of the generating principles of Kemper Models and their relationships with one another. Kemper models are not represented on the internet. Nor are they recorded in any database of mathematical models.

Based on the analysis of the models in Dornach, the article examines the relationships between them. It systemizes the variety of possible regular polygon bundles and introduces new models that result from the consistent application of the principles used by Kemper. The contribution thus closes gaps in the collection and explores the limits of its system.

The Research

Regular polyhedra in three positions

To capture the systematics behind the creation of Kemper Models, it is helpful to group the symmetry planes of each regular polyhedron into three sets. Both Paul Schatz and Buckminster Fuller suggested a strategy for that.

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Paul Schatz (3) speaks of the standing, the swimming and the floating position of polyhedra, referring to an experiment, observing a (light-weight) cube in an aquarium, while the water level rises. In the empty basin, the body stands on one of its faces. Halfway under water, it comes to the position in which an edge is at the bottom like a keel and the polyhedral object swims like a boat, until it finally floats in the water with a tip down and vertical axis.

In this article Paul Schatz´s nomenclature of the three positions is adopted, naming the planes which cut a Platonic solid in the appropriate position horizontally through the centre.

In the situation now introduced, the horizontal plane is fixed and the body is brought into positions relating to it. The polygon to be determined is created as the intersection of the horizontal plane passing through the centre of the polyhedron with the interior of the polyhedron. Since this situation has similarities with an actual handling of the solid, understanding the different symmetry planes of a polyhedron becomes intuitively easy to grasp.

For the sake of brevity, in the following is simply spoken of “swimming division”, “standing division” and “floating division”. In the Kemper model, it is only these cutting faces that are applied.

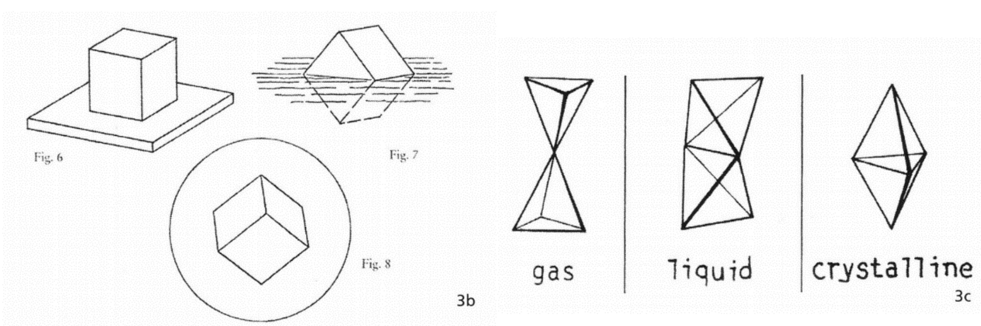

Fig.1. Regular polyhedra in three positions. Left: the “standing”, “swimming” and “floating” position of the cube. After Paul Schatz (1975: 12). Right: the “gaseous”, the “liquid” and the “crystalline” connection between two tetrahedra. After Buckminster Fuller (1982: 688).

Combs from divisions according to standing and floating position

In standing and floating division, the dual relationship between pairs of Platonic solids is clearly shown: The standing division of the octahedron is identical to the floating division of the cube (4- hexagon-comb), the standing division of the dodecahedron is identical to the floating one of the icosahedron (6-hexagon-comb).

But differentiations also appear: The 3-square-combs, which arise from the standing division of the cube on the one hand and the floating division of the octahedron on the other hand are not identical: In the octahedron their intersecting lines end in a vertex of the square, while in the cube they end in centres of the square´s edges. Between the floating division of the dodecahedron and standing division of the icosahedron the number of edges in the polygons is even doubled (10-dodecagon-comb in the icosahedron, 10-hexagon-comb in the dodecahedron).

Combs from divisions according to swimming position

Swimming division produces irregular central polygons in the Platonic solids: the 6-rectangle-comb in the cube, the 6-rhombus-comb in the octahedron, and two 15-hexagon-combs of irregular hexagons, which, depending on whether they arise in the icosahedron or dodecahedron, are irregular in two different ways.

Kemper always strives to give the polygons, which he has gained as parts of the whole, as much autonomy as possible. Therefore he uses

- colouring;
- extension of the irregular polygons of the swimming divisions to regular polygons - whereby the polyhedral boundary is crossed (Fig. 2 and 4);
- division of the rectangles into two sets of double triangles, creating two double-triangle-combs from one rectangle comb (Fig. 2 and 3). (Double-triangle-combs also use the diameters and diagonals of the Platonic solid as boundary lines.)

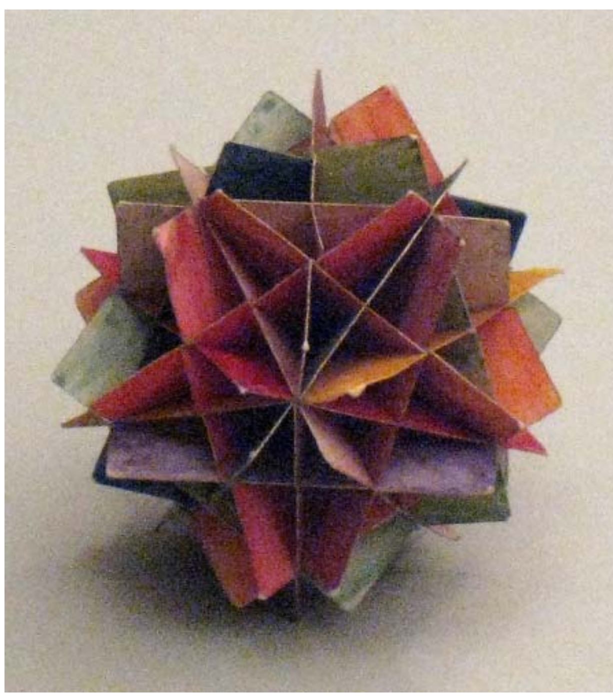

Fig. 2a. 15-square-comb, Hexagon-, rectangle- and double-triangle-comb in the icosahedron - paper models by Carl Kemper. Left: 15-square-comb (extension of the 15-hexagon-comb in the icosahedron);

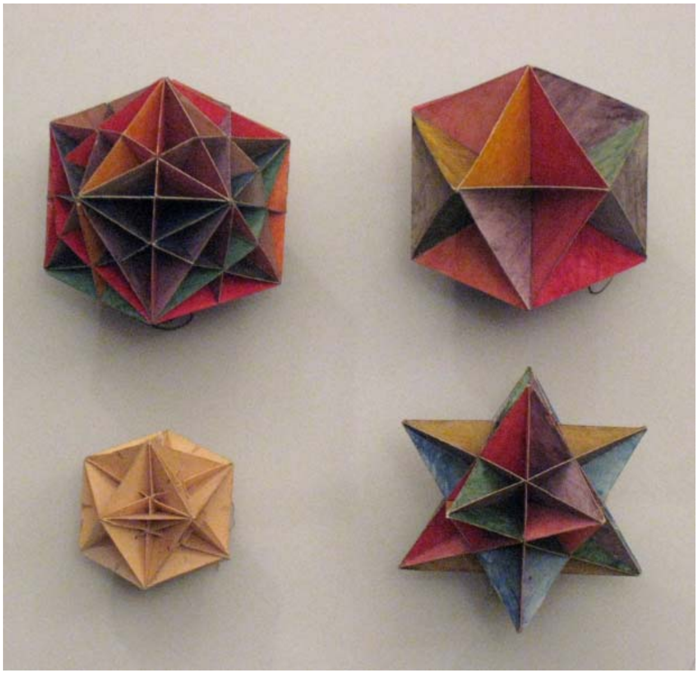

Fig. 2b. Right, clockwise, starting top left: 15-hexagon-comb in the icosahedron (hexagons irregular, bounded by the edges of the triangular faces of the icosahedron and their altitudes); Icosahedron-comb (15 double-triangles bounded by the diameters and edges of the icosahedron); Poinsot-star-comb (15 double-triangles bounded by diameters and diagonals of the icosahedron); 15-rectangle-comb in the icosahedron (rectangles bounded by diagonals and edges of the icosahedron

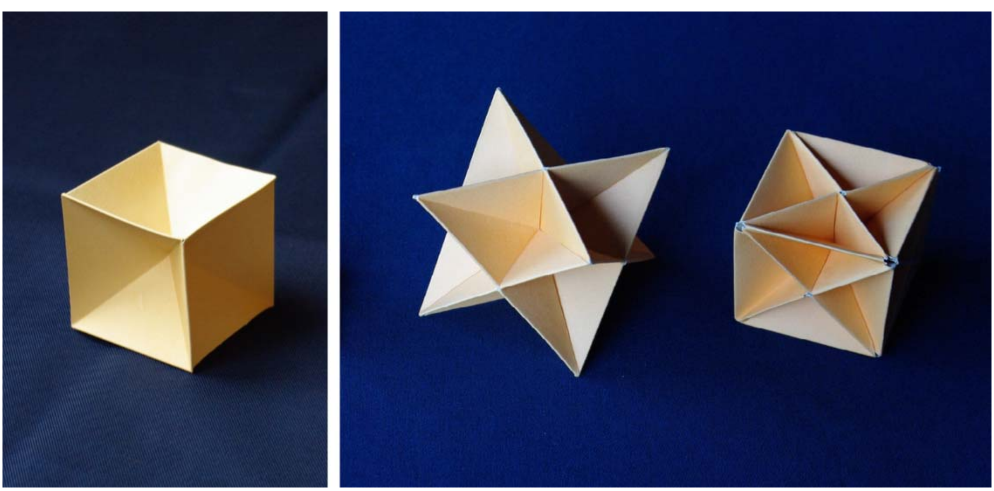

Fig. 3. Rectangle and double-triangle combs in the cube. From right to left: Cube-comb (6 double- triangles, bounded by the diameters and edges of the cube); Stella-octangula-comb (6 double-triangles bounded by the diameters and face-diagonals of the cube); 6- rectangle-comb in the cube (6 rectangles bounded by the face-diagonals and edges of the cube)

Supplementing and complementary combs

Two combs of double-triangles generated as above from a rectangle comb have a special complementary relationship to each other, since taken together they form a comb of rectangles. Their appearance is quite different; the close bond is not obvious at first (Figs. 2 and 3).

Also behaving pairwise complementary to each other, but in a different sense, are each two combs resulting from two different extensions of irregular polygons to regular polygons.

(Recall that the irregular polygons only arise from swimming divisions.) Kemper gives a 6-square- comb as an extension or the 6-rectangle-comb in the cube (Fig. 4), and a 15-square-comb as an extension of the combs from 15 irregular hexagons in the icosahedron (Fig. 2).

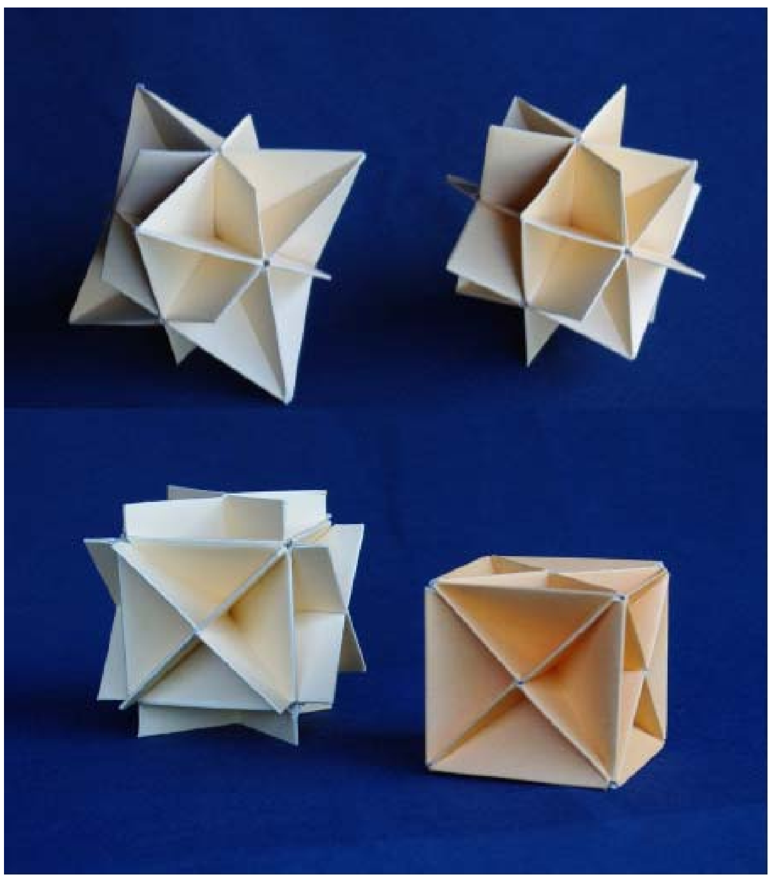

Fig. 4. Combs from division of the cube and the octahedron in swimming position, and their extensions. Bottom right: the 6-rectangle-comb in the cube; bottom left: the cubic 6-square-comb (extension of the 6-rectangle-comb in the cube): top left: the 6-rhombus-comb in the octahedron; top right: octahedral 6-square- comb (extension of the 6-rhombus-comb in the octahedron).

New Kemper models

To the combs created by extension of swimming divisions given by Kemper (6-square-comb and 15-square-comb) can each be found a second, as a result of alternative extension of the irregular polygons.

The octahedral 6-square-comb shown in Fig. 4 is not included in Kemper's inheritance, it seems to be new. Further new models, which result from the consistent application of the principles to the formation of combs introduced by Kemper, are introduced in the article. Also new are the two 3-double-triangle-combs in the octahedron shown in Fig. 5.

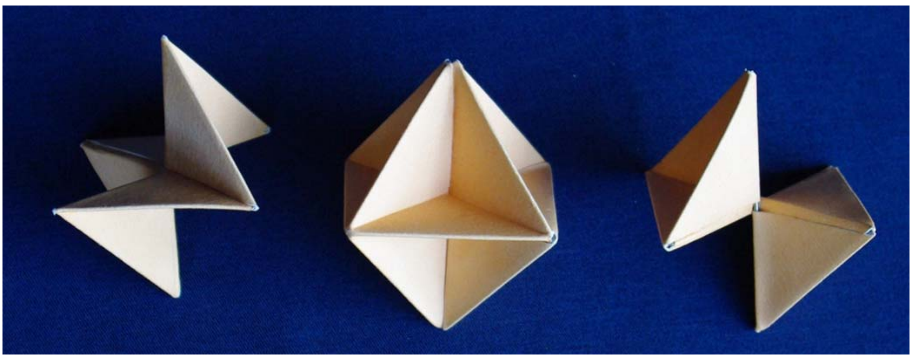

Fig. 5. Squares and double triangles in the octahedron. Middle: 3-square-comb in the octahedron; left: 3-double- triangle-combs in the octahedron; right: the complementary 3-double- triangle-comb in the octahedron.

Platonic combs

The basic combs (the two 3-square, the 4-hexagon, the 6-decagon and the 10-hexagon combs) can be called "Platonic combs". Between them the whole variety of relations between the Platonic solids takes place, extended by the additions and complements described above.

Conclusion

As alternative representatives of spatial symmetries, Platonic combs are an important part of the canon of geometric forms of thought. They are more difficult to represent and grasp than the Platonic solids, but if one goes beyond the purely formal use of polygon bundles, a free area opens up that allows new spatial formulations. In many areas of life and design, boundaries can thereby be experienced as permeable structures.

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