BRIDGES
Mathematical Connections
in Art, Music, and Science

Polyhedra Plus

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Abstract

This slide presentation is essentially an exploration of six basic families of polyhedra: the Deltahedra, the Platonics, the Archimedeans, the Catalans, the Prisms and Antiprisms, and the Fullerenes. All the forms have been constructed with a constant edge length. All the forms have a serrated pattern at each edge to emphasize the joint. All the forms have been color coded. Each face has math information about the particular polyhedron.

Mathematicians investigate the nature of space, and its partner, form in order to understand the primary qualities of both. Artists explore forms in nature setting them in the context of space. In fact, Space is the expressive vehicle of the visual arts. Artists by inclination are subjective beings even when they are acting the most objectively. On the other hand, mathematicians celebrate objectivity and eschew personal response. For them, space is a neutral arena. For the artist, it is charged with both emotional and symbolic content. A fruitful collaboration, therefore, of artist and mathematician can occur when they share insights into their understand of what constitutes space.

Design, or composition, is the overarching category that is large enough to contain architecture, painting, sculpture, and the decorative arts. Design involves the principles of organization of elements, within a spatial field whether it be the plane or the volume. Ratio and proportion are universal mathematical ideas in the practice of design as well as the teaching of design. These implicitly involve the questions of beauty and ugliness, which may or may not have universal answers. How each artist composes within the constraints of two or three dimensions is one aspect of an artist's style that gives clues to the personality and concerns of the creator. It is the uniqueness of the style that becomes the signature of that artist. How does the artist learn the "rules" of space? Is it through intuition, reason, or a combination of both?

Many artists are not able to see the connections between art and mathematics. Their educational training tends to be minimal, if not downright nonexistent, in mathematics. Yet it is the study of geometry, and more recently topology, that can give strength to the design curriculum of any art department at any grade level. For it is geometry as form and space, not geometry as proof of logical thinking, that is valuable.

In the average art school curriculum, three-dimensional design tends to receive less attention than classes in two dimensions. Drawing, color and composition, painting, graphics, computer art, all focus on the plane. Yet, it is three-space that we all actually occupy.

1, personally, think that the study of polyhedra is a most important way of looking and thinking about forms in space and how space determines form. It can be the very basis of three-dimensional experiences in the classroom. It is the very logic, precision, and orderliness of polyhedra that make for their essential attractiveness. In a world where much ambivalence prevails, the no nonsense, this-is-the-way-we-are of

polyhedra is most reassuring. The objects provide conceptual, visual, and tactile experience in the process of building them. They also aid in the development of craftsmanship and patience. A poorly built polyhedron does not come together nor does it last. The forms can provide insight into important concepts of symmetry, surface, pattern, and space-filling.

In my thirty years of teaching, students of various ages have found the construction of polyhedra exciting. When given a certain kind of design freedom within limits, very personal and satisfying results are obtained. The acts of piercing, truncating, augmenting, and surface manipulating, take polyhedra out of the realm of pure mathematics into the world of artistic expression.

POLYHEDRA PLUS

All art works created by Janice McMillan
1- The Slit plane
2- The Stacked Plane
3- Deltahedron (12) plus net
4- Archimedean/Catalan duals
5- Fullerene C$_{60}$