Symmetry: Culture and Science

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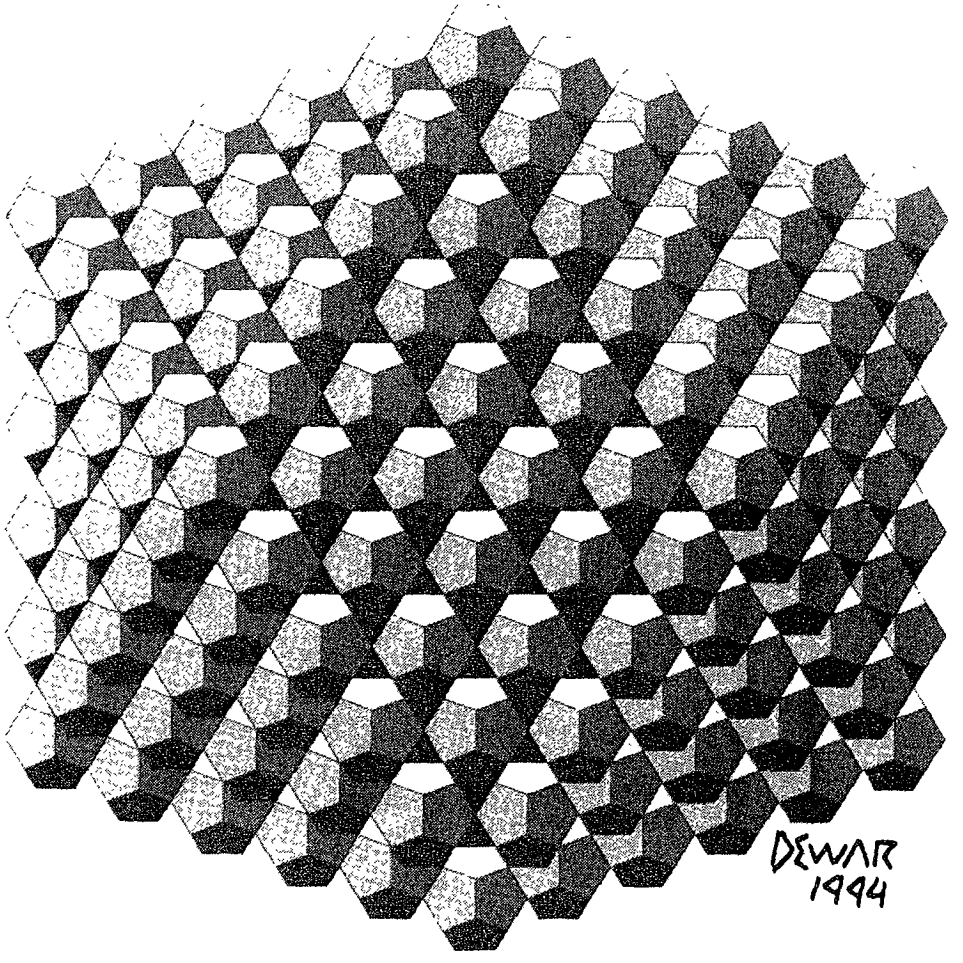

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SYMMETRIC INTUITIONS:

DYNAMIC GEOMETRY/DYNAMIC ART

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> "The scientist constructs his forms in the abstract 'language' of mathematics, while the painter develops his forms in terms of color, shape, line, texture, and other such components.... This means that the structure of each form is determined by the 'language' used and, therefore, analogy is the only possible means of comparison."
>
> --Edward B. Henning[1]

Or is it?

There are clearly parallels between art and the sciences--and in particular between art and mathematics. Successful work in both realms requires creativity, problem solving, and an understanding of underlying patterns and inherent order--both the recognition of structure and the deliberate search for exceptions to accepted frameworks. Both art and mathematics also require, ultimately, the development of intuition--the cultivation of informal as well as formal knowledge. Artists and mathematicians are guided by a "sense" of which tools, structures, and approaches will be productive in resolving a dilemma or expressing an idea. They develop the ability to see spaces of possible solutions, which helps them bring their accumulated vision to bear on subsequent problems.

Between these two worlds, however, there is a gap, in general perception if not in fact. Mathematics is seen by many as deductive, linear, objective. Art, in contrast, is thought of as indirect, holistic, interpretive. Mathematics is regarded as the consummate realm of logic, art as the arena of feelings. But if in reality both mathematics and art require formal skills, knowledge, as well as intuition, then both will benefit if the gap in perception between the two worlds can be bridged.

As Henning points out, the gap begins at a fundamental level, in the very language of discourse of mathematics and art: artists talk about composition, motion, use of space; mathematicians talk about symmetry, axes, and coordinates. Until recently (as Henning suggests) it was difficult to see a way to overcome the disjunction except by analogy. But recent technological advances make it possible to use computational tools to forge new links.

One such tool is The Geometer's Sketchpad[2], a computer environment that allows the user to define geometric objects (points, lines, circles, and so on) and create relationships between them. The position of objects can be changed, but the relationships remain constant--so, for example, one can create Point A and Line b, and then construct Line c *through Point A and perpendicular to Line b*. No matter where Point A or Line b are moved, Line c will be placed accordingly. One can also create shapes based on points, lines, and arcs, and any of these objects can be reflected, translated, and rotated to create a range of designs and patterns. Shapes, points, and lines can be given color and texture. Designs created in this way will also adapt to changes in the position of objects in the sketch. A face can be constructed so

that it will adjust its shape and retain its mirror symmetry if the curve of the mouth is changed on one side from a smile to a frown.

Of course, the program can be used to create, manipulate and display far more complex mathematical and artistic designs, many of which are based on underlying symmetries. The important feature to note about Sketchpad is that the program updates its display in continuously in real time. The user can "drag" a point or a line across the screen and the construction will respond accordingly. It is impossible to show this on a printed page, but the visual--and cognitive--effect is dramatic, and makes it possible to explore complex mathematical ideas in a powerful, visual way.

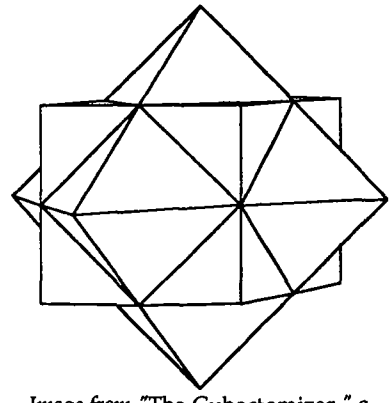

*Image from "*The Cuboctomizer,*" a dynamic model of truncations and stellations of a cube*

This dynamic quality of models constructed using Sketchpad makes it possible to explore concepts in mathematics and design interactively. One can test conjectures, or suggest alternative arrangements of motifs and symmetry elements, investigating why some combinations work mathematically and artistically and others do not. The program becomes an environment for exploring art in a mathematically rich way, and for exploring mathematics in a visual and aesthetic context. Used in this way, it provides the foundation for a bridge connecting the arts and sciences.