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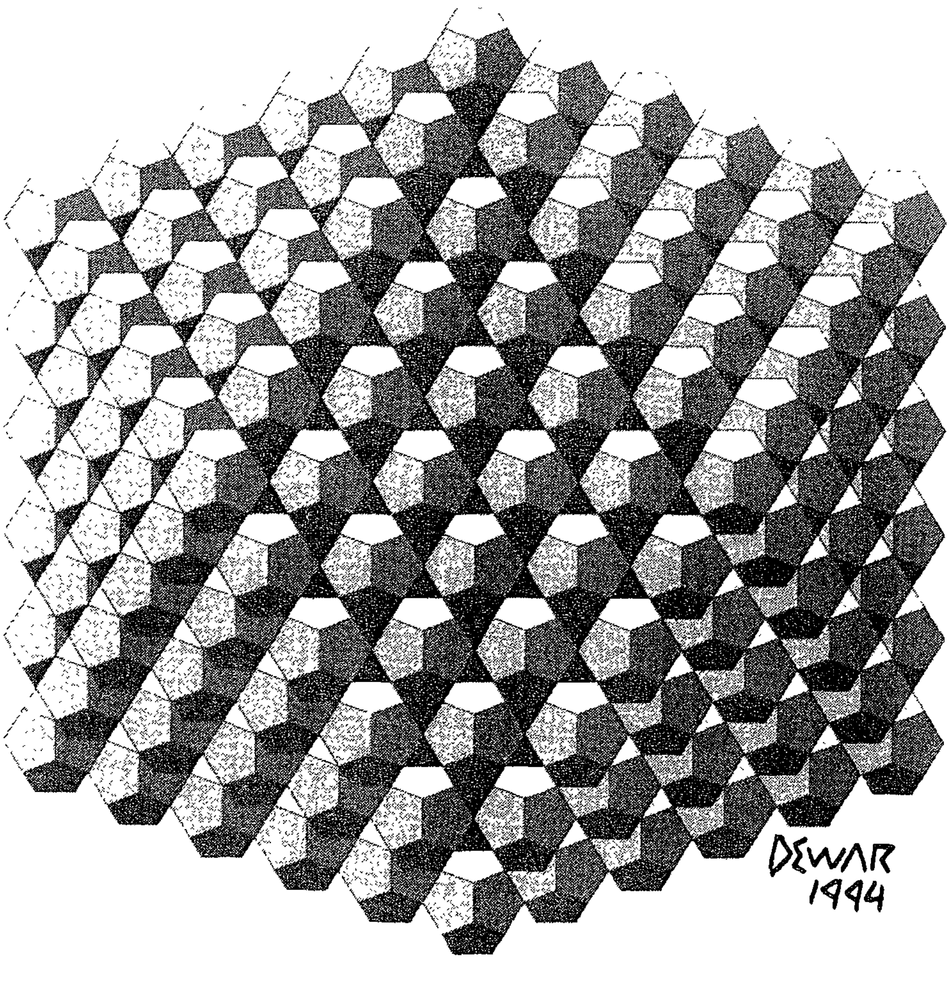

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THE PROGRAMMED DESIGN: PROBING THE DISCERNIBILITY OF PROPERTIES OF SYMMETRY

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In 1964, while teaching in the Department of Architecture at the then Carnegie Institute of Technology, an industrial design student in the Department of Design approached me about one of my studio class assignments—the *programmed design* project—which probes the edges of symmetry. During our discussion, he showed me a numerical series, which has fascinated me ever since:

1 / 22 / 11 / 2 / 1 / 22 / 1 / 22 / 11 / 2 / 11 / 22 / 1 / 2 / 11 / 2 / 1 / 22 / 11 / 2 / 11 / . . .

It is relatively safe to conclude (even short of mathematical certification) that this series never repeats itself. Passages in the series will match one another for three or four segments; then each will evolve in a different way. The series seems to mutate endlessly. In fact, it does not mutate: It is predetermined, segment by segment, according to a definitive generating code. In a word, the series has *symmetrical* properties—but symmetrical in ways that go against intuitive notions about symmetry and challenge conventional definitions of it, even such a definitions as offered in a recent article by Giuseppe Caglioti:

> *Symmetry* is *invariance against transformations. Symmetry* is *indiscernibility of a transformation.* In other words, *symmetry* is a *no-change as a result of a change.*
> As such, symmetry is associated with the permanent, characteristic properties of a structure.[1]

In this definition, Caglioti uses the conspicuous word *indiscernibility*—and special attention should be given to it.

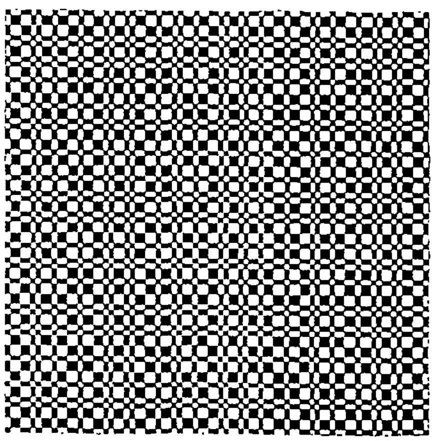
What is *indiscernible*—to one who comes upon the *1 22 11* series—is not the *effect* of its *transformations*, but some sort of underlying invariant factor that is *otherwise* fundamental to the very nature of its structure. A chance encounter with *1 22 11*—superficial that first impressions can be—would, no doubt, prompt little reason for many an unsuspecting person to spend time and effort to delve into it.

As one who is visually oriented, I am, by nature, concerned with what captures and dominates the attention of the eye—as well as what eludes it. When *coverage operations* have been performed upon an *isometric* structure and transformations have, consequently, taken place, those transformations are *not* visually detectable; that is, they are *indiscernible*. By the same token, one's perception of the regulating elements of symmetry in an *isometric* configuration is all but visually irresistible; in other words, the kinds of operations in play are conspicuously, in fact, involuntarily *discernible*.

The visual appearance of the non-isometric *1 22 11* series, however, is one of constant change; and its regulating set of operations is an invariant factor of the series that is inconspicuously, indeed, unsuspectingly embedded in it; the set of operations is not readily identifiable, even when one is alerted to its presence.

My intention is not to take issue with Caglioti's use of the word *indiscernibility*, but to allow this word to serve as a point of departure for the recognition that invariants can be obscured—can, on the surface, be *indiscernible*—though not undetectable. Put another way, there are differing levels of *discernibility*. Rigorous examination can lead to uncovering patterns that are not immediately, perceptively obvious; analysis can be the means to *discern* what the eye may *not discern*—hidden regularities. If no regularity (invariance) is discerned, either through the senses or through analysis, a symmetry will go undetected—as it did for so long, for instance, in the cases of the orbits of the planets and the laws of heredity.

Caglioti's complementary statement that "*symmetry* is a *no-change as a result of a change*" refers to appearance; it does not address the invisible code within the structure of the *1 22 11* series. All structures with properties of symmetry are, in fact, distinguished by *no-change* (or invariant) factors. In many cases, *no-change* factors are evident—and manifested in their appearances—as they clearly are in isometric structures; but in some cases, as noted, *no-change* factors are nonapparent. Not being a mathematician, I do not know by what rigor the cryptically embedded *no-change* property of *1 22 11* can be unwrapped under the probing scrutiny of an inquisitive and able analyst; should, however, the fractal nature of the series come to be *discerned*, by scientific method or by chance, its secret will have been exposed. In the end, regardless of the discernibility or indiscernibility of the *no-change* factors, the presence of symmetry is, as Caglioti correctly asserts, ultimately contingent on "permanent, characteristic properties of a structure."



Gridding with the *1 22 11* Series
freehand sketch on graph paper
by: William S. Huff, 1993

My fascination with the *1 22 11* series lies in its having the visual appearance of arbitrariness, of randomness, yet being totally *programmed*. It is composed of few parts (single and double 1's and 2's—otherwise, identifiable as four components: 1, 11, 2, and 22) that are controlled by two simple rules (a. components alternate between 1's and 2's; b. the number of subcomponents, singles or doubles, in each component is designated serially by the series itself).

As noted, one outstanding, though not at all obvious, property of the series is that of a fractal—and so it was recognized, even before the word *fractal* was coined.

The secret of this property is unlocked—I now reveal to all who are still baffled—by writting down the number of subcomponents in each component; it turns out that, as a natural consequence of the second rule, a new series is generated, which appears as 1 2 2 1 1 2 1 2 2 . . ., or, as notated, 1 / 22 / 11 / 2 / 1 / 22 / . . .

One may, incidentally, as easily generate a similar series with 1's, 2's, and 3's —and, it seems to turn out, with any other sets of numbers, whatsoever:[2]

1 / 22 / 33 / 111 / 222 / 3 / 1 / 2 / 33 / 11 / 22 / 333 / 1 / 22 / 333 / 111 / 2 / 3 / . . .

Though the series is essentially a lineal structure, I generated a planar grid of it by coordinating its numerical components in a quadrant of two rectangular axes —and then applying checkerboard coloring. As can be anticipated, this manner of gridding the series automatically induces one discernible element of symmetry: A mirror axis, emanating from the origin of the coordinate axes, runs diagonally through the grid. (Discrete areas having an absolutely random appearance can be blocked out on either side of the mirror axis.)

My introduction to this series has provided me with an exquisitely instructive example of K. L. Wolf's fourth degree (or order) of symmetry, *katametry* (or "low symmetry"), which is preceded, according to Wolf, by *isometry*, *homoeometry*, and *syngenometry*.[3] The recognition of a hierarchy of symmetry is the key to unraveling the predicament that is encountered in Caglioti's use of the word *indiscernibility*: The higher the degree of symmetry in a structure or system, the more *no-change* factors there are; and the higher the degree, the more obvious the visual effects are of those *no-change* factors. Though invariant properties peel off at each descending degree of symmetry, a *katametric* structure, at the lowest level, is still organized by invariant rules—which can be intricate and nearly, though not inevitably, *indiscernible*.

The challenge to my students to design structures with *less discernible* invariances is the main objective of the *programmed design* assignment—which is simply stated as: *the applying of a set of operations to a set of parts*. (This brief does not take into account the *aesthetic* component that must be collaterally addressed. That is where the designer's individual discretion becomes paramount—how an automatized or *programmed* structure becomes a *design*, that is, a selectively generated and perceptively appreciated man-made artifact.)

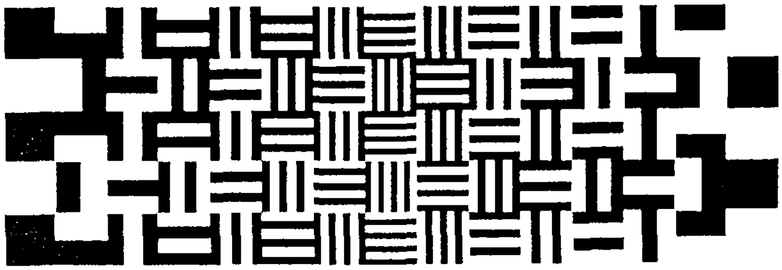
In their early endeavors to concoct *programmed designs*, students are often surprised when they chance to devise a repetative pattern—only to be even more surprised to learn how unimpressed I am with the rather predictable outcomes. Those first results do, however, provide an experiential introduction to a lecture about the "seventeen wallpapers." From there, my students are encouraged to probe beyond the repeating patterns and to explore Wolf's three lower orders of symmetry—especially the lowest order, *katametry*.

Notes:

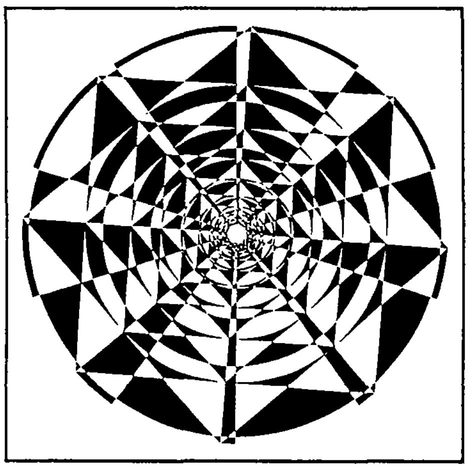
1. Caglioti, Giuseppe. "Ambiguity in Art and Science." *World Futures*, 40 (1979): 63-74.

2. If the series is begun with 2's instead of a 1, the same series occurs—without the opening 1: 22 / 11 / 2 / 1 / 22 / 1 / 22 / 11 / 2 / . . .

3. Wolf, K. Lothar, und Robert Wolff. *Symmetrie: Versuch einer Anweisung zu gestalthaftem Sehen und sinnvollem Gestalten systematisch dargestellt und an zahlreichen Beispielen erläutert* (2 vol.). Münster, Germany: Böhlau-Verlag, 1956.



Programmed Design: *Figure-Texture-Ground*
after: Robert Iland
from: Basic Design Studio of William S. Huff
Carnegie Institute of Technology, 1964



Programmed Design: *Dent de Lion*
by: Alex A. Halpern
from: Basic Design Studio of William S. Huff
State University of New York at Buffalo, 1993

Across a 5 x 15 checkerboard (upper), the five whole squares at the left are sequentially sectioned into two, three, four, and up to eight parts, then, sectioned in reversed, while the resultant bars process in the vertical rows (bottom to top) by 90° rotations that turn only clockwise. Vertical bars occur in respect to the underlying black-square positions; horizontal bars, to the white-square positions. It is to be noted that the black and white gestalts at each end do not duplicate one another, not even anti-symmetrically. If the number of squares along the horizontal is not $4n$-1, the resolution would be *discernibly* more symmetric.

Two homoeometric polar grids (lower), coincident at a single center of dilatation, slide over one another: Two sets of concentric rings dilatate geometrically at different rates; one set of radials divides the disk into eight equal intervals; the other set, into ten. Two diagonals crisscross the group of cells that are delineated by the set of more rapidly dilatating rings and the set of eight radials; the result is the unpremeditated, but welcomed emergence of two sets of nested squares. Rendering the final network with the two-color map treatment produces an anti-symmetric figuration. Note that one radial of the set of ten radials bisects the angle between two radials of the set of eight—and is a kind of datum.