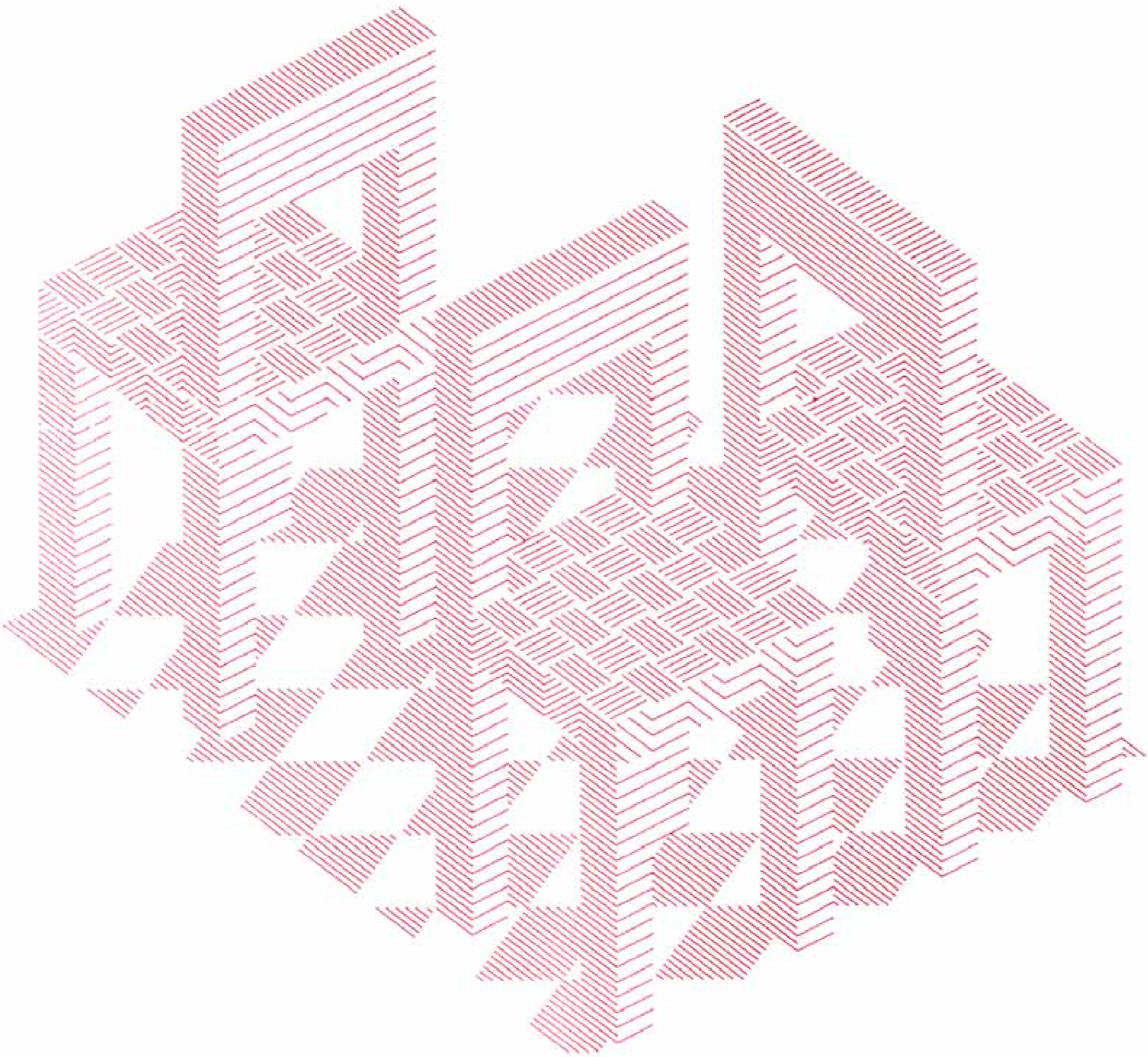
MT 122



MATHEMATICS TEACHING · MARCH 1988

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MT 122

P2 Chris Drury‘s Deer Seats, Deer Bones, Pine Cones, Pine Bones
Photographed by Sean Hudson, 16 Danube Street, Edinburgh ~II4 INI
Illustrations for Bubbles and articles starting on pages 24, 28, 44, and 65 by Zena Ginifer.

MATHEMATICS AND MODERN ART: MODULE AND STRUCTURE

Ulrich Grevsmühl

The modular principle was first discovered in the order and structure of our natural surroundings. Science has taught us that macrocosm and microcosm show a well-defined order and consist of specific building elements, or modules, which are related to each other by fundamental laws, to form structures. Atomic theory, for instance, has revealed that the vast range of forces found in nature can, despite their different appearances and notations, be reduced to manifestations of just four fundamental forces:

- gravitational, which act on mass and bind the universe
- electromagnetic, which hold matter together by electric and magnetic properties
- strong nuclear, which bind protons and neutrons in the nucleus of an atom
- weak nuclear, which control radioactive decay.

Order and structure also appear in civilizations and cultures where modules are used in the construction of buildings, roads, towns and in the manufacture of fabrics and machines. In fact, knowledge itself has a modular feature. In particular, the advances of modern physics and technology in this century initiated a revolution in thinking, an analytical approach which was also adopted in other areas of knowledge [1]

In art, modules may also be regarded as building elements, which, together with a generative principle or function, form the total structure of the system or series. Order manifests itself as the relationships between these modules. Unlike modules in science which have an analytical function in that they help to reveal the internal relationships of a structure, modules in art are synthetic and serve as elements for creating patterns and rhythm.

The use of mathematics in art and architecture has been found in many early civilizations. Numerical progressions and orderings, geometric proportions and scalings were extensively used by the ancient Egyptians, Greeks and other cultures, often expressing symbolic and mystical meanings, their relationship with the universe and their concept of the ideal. Renaissance artists saw linear perspective as a tool for ordering and representing 3-D space in two dimensions and for controlling the spectator [2]. It was not until this century, however, that numerical and geometrical systems became the actual subject matter in art, rather than finding their expressions in pictorial terms.

Today, in art, many explorations are undertaken with modules and generative principles which employ algebraic functions, transformations, mappings, permutations or elements of chance in the organisation of the structure. The international movement of constructive artists has its aim in the search for the principles of order in nature, in our society and in our technological surroundings and to express these by the means of art.

This search for the essential elements in art concerns primarily the relationships between the modules which constitute the structure. In conjunction with mathematics and science the objectives are to find and explore suitable systems, their patterns of behavior and the processes that govern them. The use of rational and explicable procedures and the systematic control of the means of expression ensure the principle of recoverability — the spectator can come to an understanding and appreciation of the generative principle of the systems by analyzing the structure of the work. As the Swiss constructivist Richer P Lohse wrote:

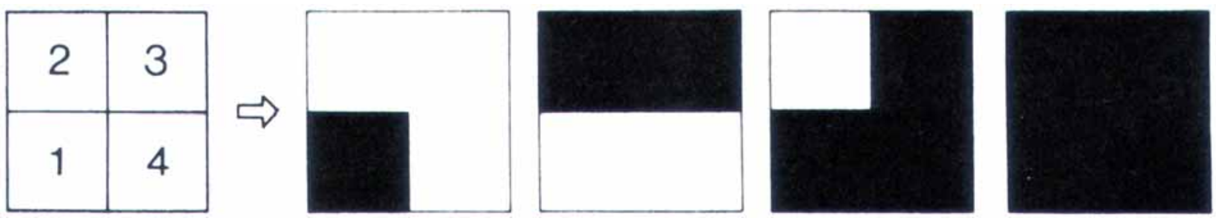
, Only open secrets are effective‘[3].

In other words, the generative system of the work should be accessible and the results universally comprehensible.
Systematic investigations often form the basis of these procedures, but it is important to note that, as the artist Susan Tebby points out about the interrelation between the finished work of art and the underlying generative system, the outcome of the work is rarely a predictable one of the system that has generated it and that therefore the system itself can be used to develop both the system and art [4].

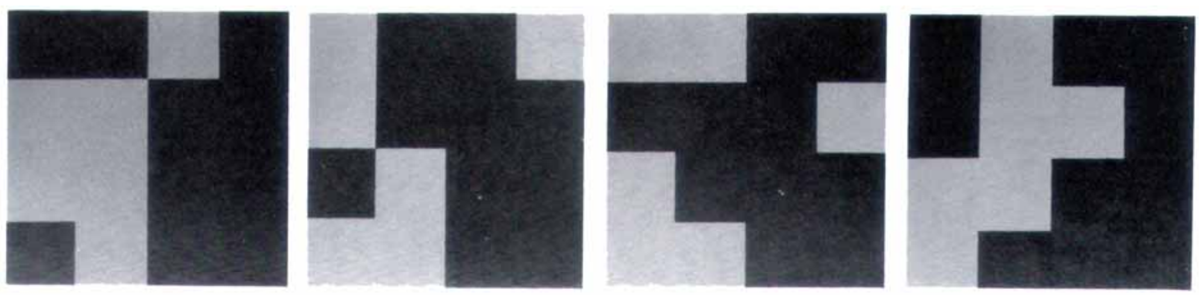
The following works of six constructivist artists demonstrate the variety of approaches in dealing with specific mathematical systems. Tim Johnson and Jean Spencer both employ mathematical procedures in structuring 2-D space by means of a grid which provides a framework where numbers, colors or objects can be positioned according to a determined order. This matter is carried further by Michael Kidner who explores the transformations of orthogonal grids using wavy lines. Investigations of representing 3-D space in two dimensions follow where Wendy Smith offers a solution solely based on the module of a straight line. The last two examples are concerned with the structures in nature, Joost Baljeu exploring patterns of growth in organic and inorganic systems, Arthur Wilson investigating the structure of wave movement of the sea.

Tim Johnson *Born in Waterloo, Liverpool 1961. Lives in London*

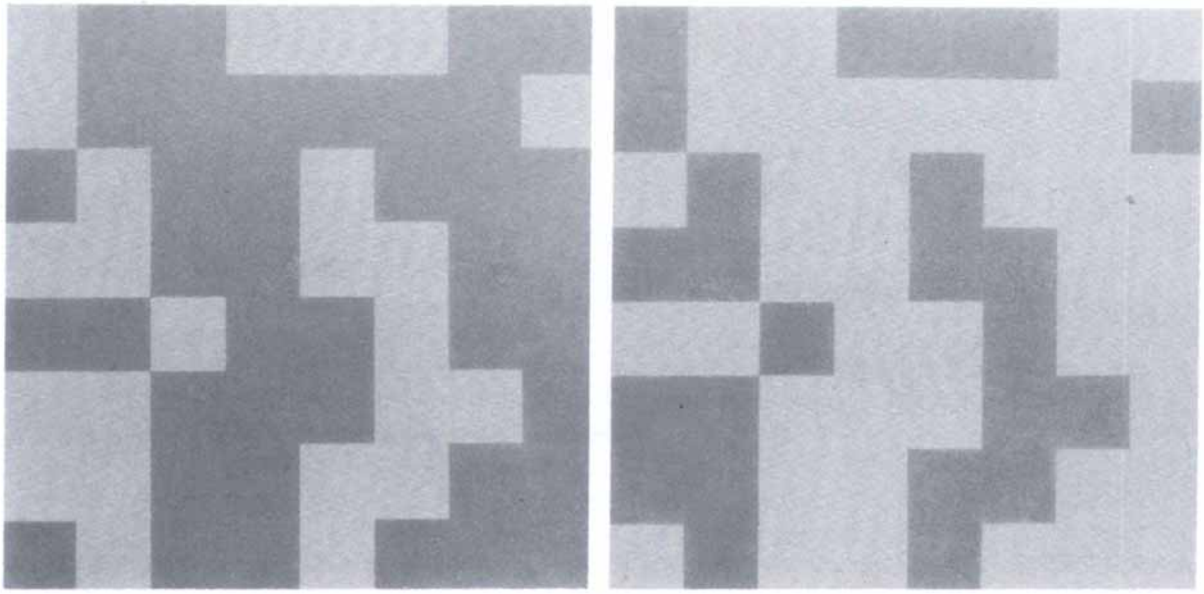
In his series of paintings, Tim Johnson combines numerical orderings with rotational transformations. Taking a square grid with the numerals 1 to 4, a set of four squares is produced by using a generating rule which determines Position and area of the shaded regions.
The four squares are then placed in one image following the same order as before.



From this image a set of four paintings is produced. 1987, 40” x 40” each, acrylic one linen



The procedure is repeated by using the four paintings as modules in further paintings…
1987, 32” x 32” each, acrylic on linen

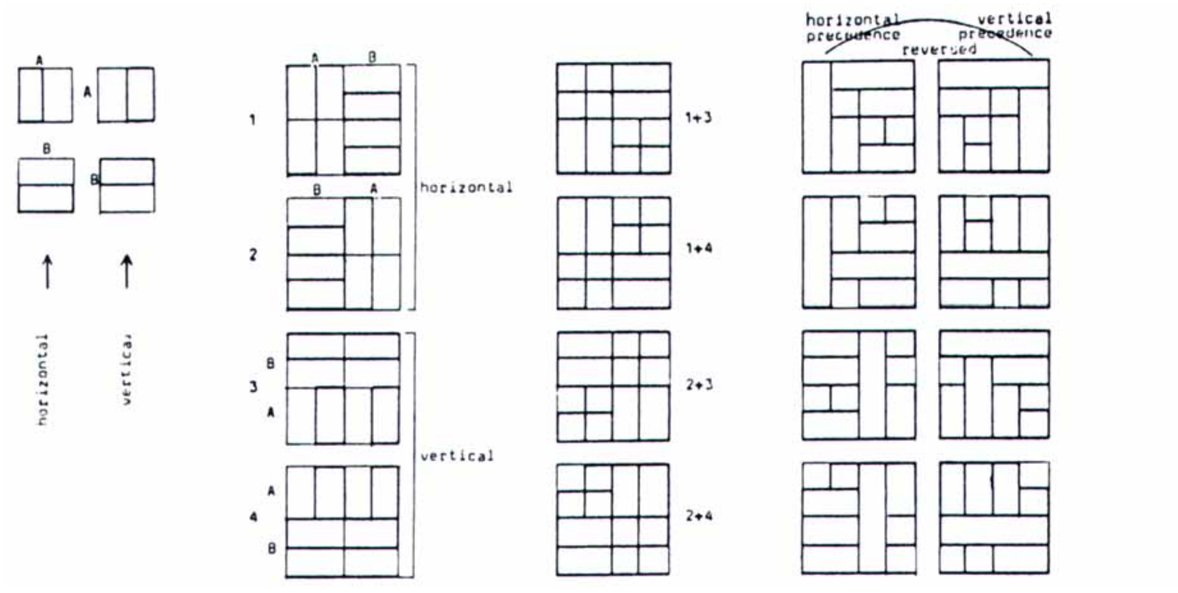


Jean Spencer *Born in Hampshire 1942. Lives in London*

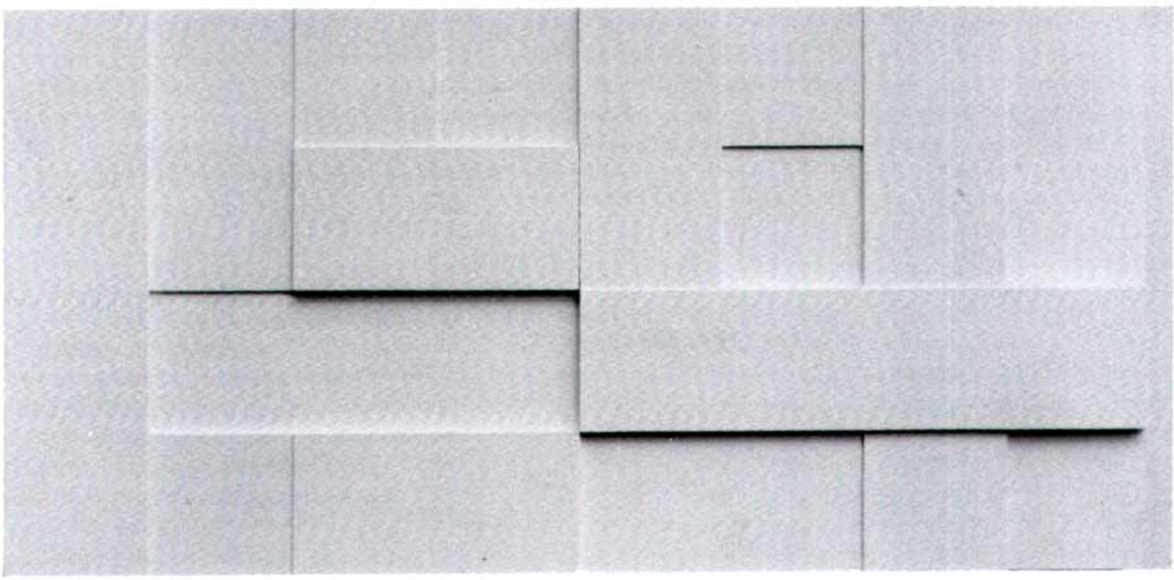
Jean Spencer explores sequences of change. Her serial structures are formally organized and each uses a single number system which, generates the structure and controls the direction and rate of change for each element‘ [6].

‚These drawings are part of a series of works using two overlaid offset grids and a (legislating) matrix. The grids are defined by area, as in a chequer-board (presence/absence). The matrix orders the sequence of disjunction (where either one grid or the other is present) and conjunction (where both are present). In addition a second matrix order is superimposed which is an inversion of the first (positive/negative). There are four structural variables within the system:

- the grids
- the relation of the grids to each other
- the position of the matrix relative to the grids
- the ordering of the elements within the matrix‘ [6].



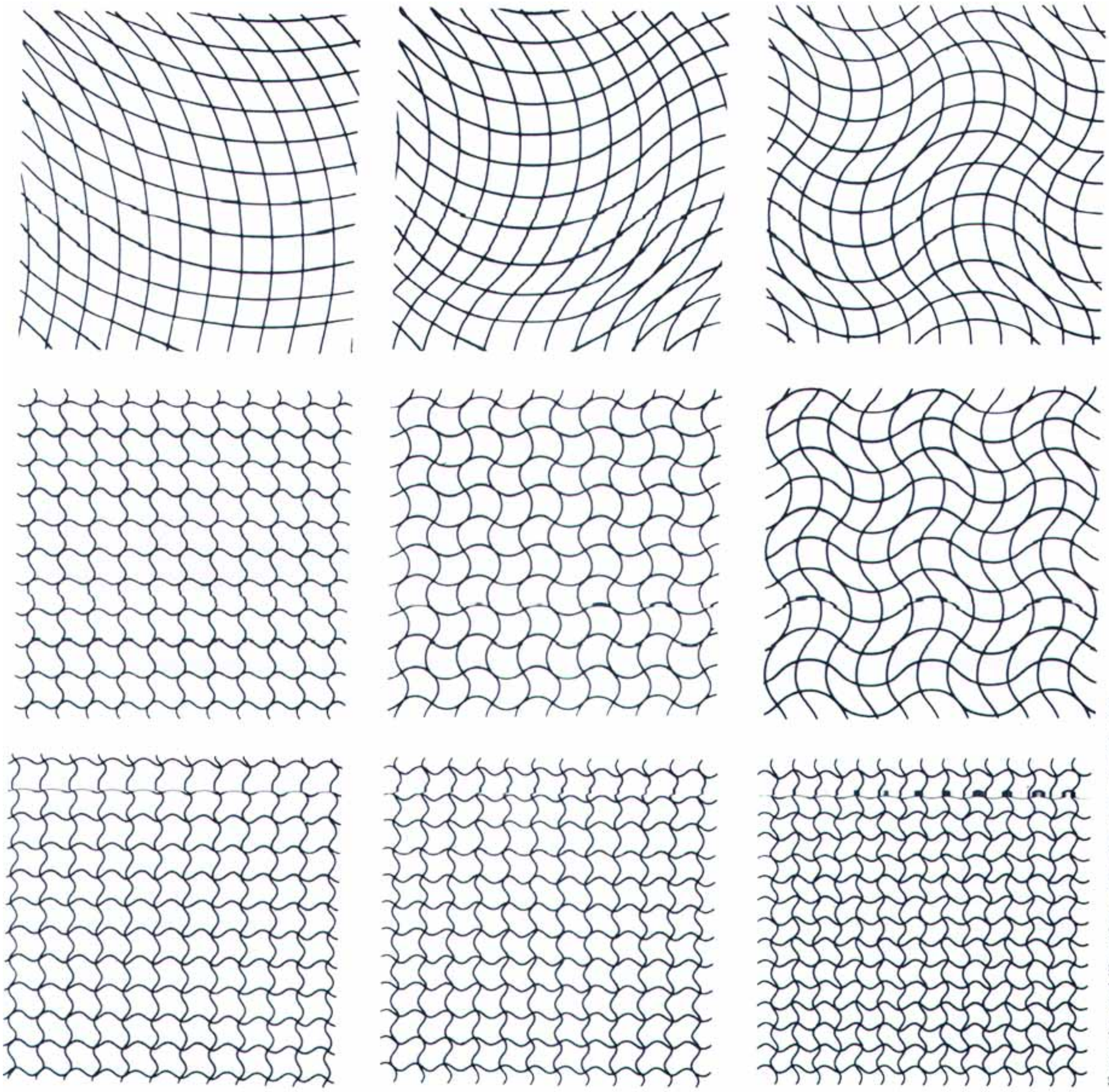
Working drawings


Double Square Relief No 2 (Varese) 1977, hardboard and acrylic

The mathematical content of the drawings and the reliefs may thus be described by matrix algebra. The four small grids are taken as the elements of a 2 x 2 matrix. According to the position of the letters A and B, the two grids on the left are labeled “horizontal”, the others “vertical”. From the 36 combinations, to allocate the four elements to the corresponding 2 x 2 grids, only those four are chosen which are purely ‚horizontal‘ (grids 1 and 2), or purely “vertical” (grids 3 and 4). Matrix addition is used in combining these horizontal and vertical grids with each other.

For Relief No 2, matrices 1 and 4 have been added. The elements are treated as non-commutable, in the sense that either the “horizontal” or the “vertical” grid has precedence; the latter case is indicated by showing the reverse side of the grid.

Michael Kidner *Born in Kettering, 1971. Lives in London*



Formation and Transformation, 9 panels each 61 × 61cm, silk screened on paper and laminated in plastic, 1982

Michael Kidner uses the systematic approach, the constructive investigation, both for creating and developing new ideas and making his works more comprehensible, ensuring the principle of recoverability at any stage of the composition. His works combine rationality and feeling, order and beauty. He states:
“Mathematics is for me a word which suggests an attitude of mind rather than a skill — it offers a reference to my work which 1 find presently more acceptable than any alternative. Such an attitude allows me the freedom to organize and relate my colors and forms as abstract units but withholds the license to do anything whatsoever that 1 choose” [7].

Michael Kidner has extensively used the wavy line as a means of structuring and creating rhythm and pattern since 1964, first in the context of a simple contour or band, later as a structural element of a grid. In both cases the lines are used as a module, but in the case of the grid, the spaces between the lines also become a structural element.

In the nine panels, the structure of the repeated wave patterns is revealed when comparison is made of the wavelengths and the spacings of the lines which form the grid. Moving in the top row from left to right and down to the middle row and from there right to left, the wavelength is halved each time, but the spacing of the lines in the grids stays the same. Moving further to the right and along the bottom row, the wavelength now remains constant but the spacing of the wavy grid lines shrinks. The middle left hand panel with its completely regular pattern may thus be regarded as the standardized grid, the pattern at rest or the starting point from where the movement develops [8].

Column in front of its own image II, is one of the most impressive of its kind, where the painting is a visualized description of the four-faced, doubly curved column placed in front of it. Michael Kidner writes:

“It is the area between the second and third dimension which interests me — the order which lies between imagination and reality” [9].

The painting results from the projection of the column onto the plane. Self-taught geometrical procedures and a color code are used to represent the curvature of the column. Placing the actual column in from of its own image does not only create space and depth, but also involves the spectator in a permanent dialogue with the composition. It is just this point which is one of the artist‘s concerns:

“The order in a painting refers to a much larger concept of order outside the painting. The order in mathematics refers to an order we perceive in the cosmos... the painter may think of himself as creating order, as discovering order, or as observing order”. [9]

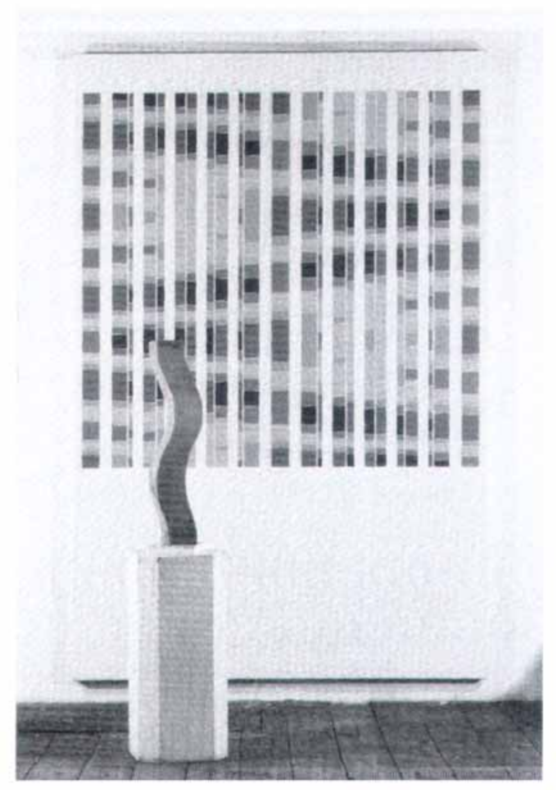
Wendy Smith *Born in Mansfield, 1946. Lives in London*

Although Michael Kidner rejects the straight line as something which is not organic, Wendy Smith deliberately bases her pen and ink drawings on the straight line as a module in creating order and structure. Her tight geometric pictures stem from an initial curiosity about the relationships between object and perception, configuration and representation, and the role language plays in the process of perception:

“An object looks like what it is, its appearance exists nowhere outside our descriptions of it. We see things, we do not see appearances. We can only speculate as to how things are. Our conception of what the world looks like derives from images and not the other way around” [10].

She is mainly concerned with the notion of an invented imagery which may or may not be directly derived from the visible world, like the chairs, reprinted on the front cover of this issue of MT, but which are nevertheless essentially objective and concrete. Interesting parallels can be found in comparing her pictures with the invented rooms of H P Reuter, or the strong spatial illusions in the works of J Albers and V Vasarely [2].

The cover illustration of this MT is from the series, *A tendency to exist*, 77 x 120 cm, pen and ink drawing, 1985



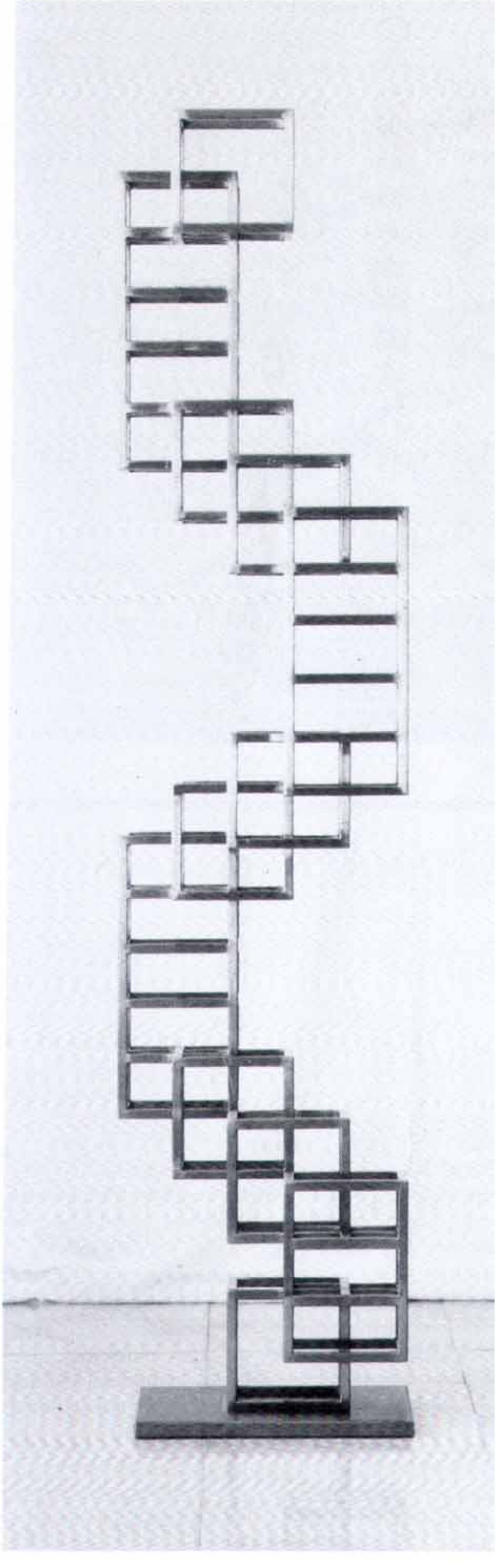
Column in front of its own imagery II, 228×152.5cm, acrylic on cotton, dark green fibreglass column, 1971

Joost Baljeu *Born in Middelburg, 1925. Lives in Amsterdam*

Joost Baljeu developed a theory of plastic expression for the four dimensions of space and time. Analyzing fundamental forms of growth in nature, he found that nature basically employs three formative principles:

- straightness
- obliqueness
- roundness.

These principles produce a wealth of forms and may therefore serve as a basis for invention [11]. Use is also made of the principles of translation and rotation as well as reversibility. F18 is an example of a series where each time a cell, in this case a cube, is taken as a module and where the intersection with other cells produces a rhythmic structure. In this work the structure is closely related to the number 4. There are 4 vertical columns and the intersection of one cube with another occurs at half the length of the edge and amounts to a quarter of its volume when the cubes are dislocated along one of their diagonals, or to a quarter of the total volume of two cubes when there is a translation in the vertical direction [12].



Synthesist construction F18, 190×46×42cm, stainless steel, 1985

Arthur Wilson *Born and lives in London.*

Arthur Wilson’s work again shows a strong reference to nature. In an extensive study, of which Sea Box 10 is just one example, he investigates the movement of the sea. us work is based on direct observation by means of drawings and photography and is then given form by constructions using connecting planes which are arranged within a 3-D grid. The grid is analogous to the sea, and its depth and planes arc plotted within it using isometric graph paper and card models. Generally, a module is invented which is then used in building up systems of forms, each system having its own rules. He finds an almost infinite variety of relationships that would be difficult to invent in any other way.
(Sea Box 10 can be found over the page)

The creative act in these works necessarily implies decisions made by the artist. The editors of the journal Constructivist forum, Nathan Gohen and Tim Johnson, comment on this: *"...the Constructivist artists individual act of invention is not in the formal elements themselves, but in the particular ordering of them. The ordering is the work‘s content. The content in Constructivist art is therefore structure”* [5].

Despite working systematically and rationally within specific mathematical systems, there are no limitations to the artists’ methods of expression, nor restriction to their individual emotions.

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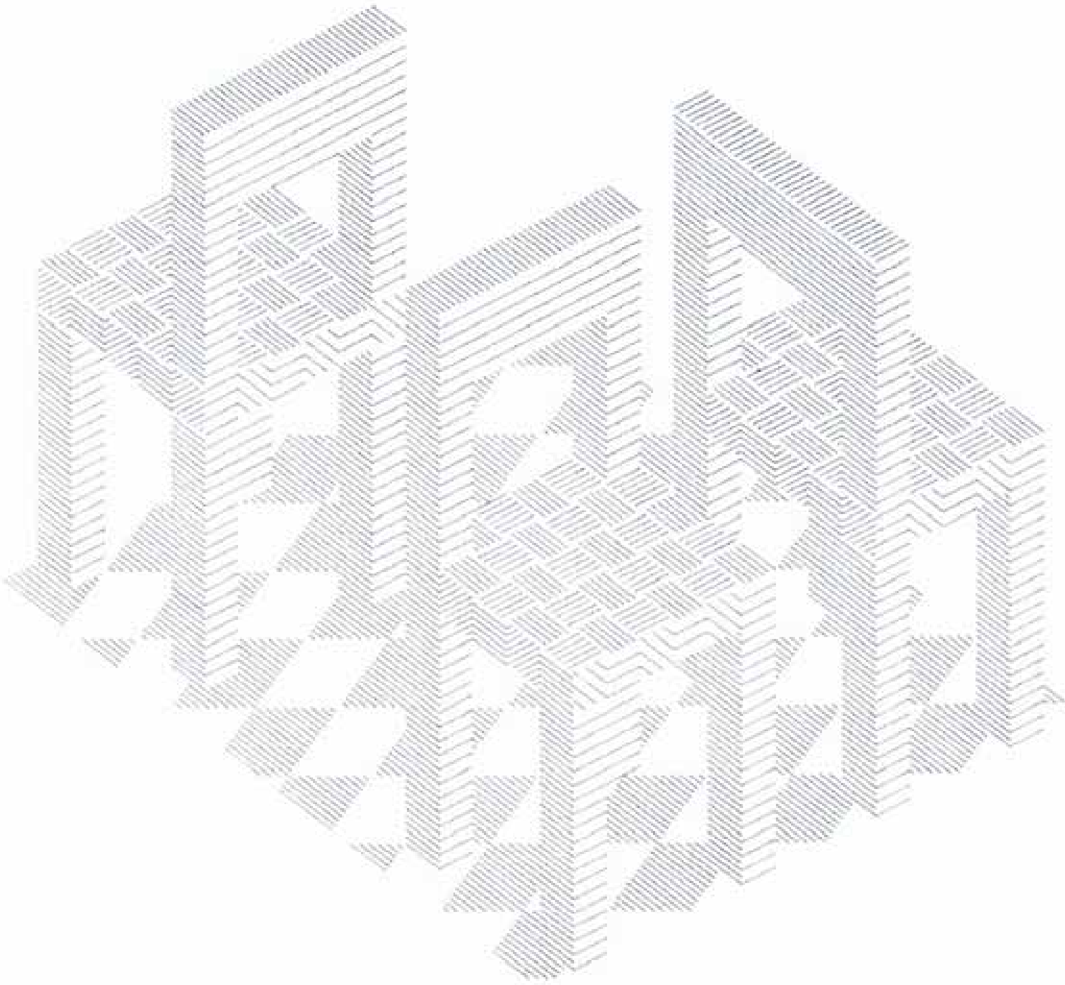

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