

תורת המסלול 123



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Photographs: p28 Balloon and vanishing point, Dave Hewitt;
Dodecahedral rubbish container from the Loire valley, D J Blow;
Pont de Brotonne, France, Roger Waddingham; Gardens at Villandray,
Loire Valley, France, Tony Brown (ed); Light parallels. Roger Jones.
Illustrations: pp 4, 5, 19, 39, Zena Ginifer
Front cover: The design for the Bristol Water Maze, Victoria Park,
South Bristol. Image by Peter Milner and Nick Levine; Concept by Peter
Milner and Jane Norbury; Project initiated at Avon County Community
Environment Scheme (AGCES); now part of Changing Places
Environmental Arts.
Back cover: The design for the Water Maze was based on a painted roof
boss in St Mary Redcliffe Church, Bristol. Photograph from p21 of
A celebration of mazes (see p9).
There are about 35 A2 posters of the maze available at £500 each inc
p&p, proceeds to Action Aid for clean water projects for Burundi, write
to Changing Places, The Old Police Station, 6-8 Sommerville Road,
St Andrews, Bristol BS7 9AA.

MATHEMATICS AND MODERN ART: TRANSFORMATION GEOMETRY

Ulrich Grevsmühl

For many contemporary artists geometrical systems are the basis for investigations where geometric shapes are used as modules and where transformation geometry and number properties are the generative principles in the formation of the structures of their work. In some cases the transformations themselves are used as modules. As the act of invention is not in the forms themselves but in the ordering of them, the relationships between the forms and the processes that govern these systems are the means for communication and constitute the content of the work [1,2].

The works of the following artists illustrate the use of affine transformations of the plane and of three-dimensional space, where parallel lines are mapped onto parallel lines. Before reading any further however, you might like to turn over the page and reflect on the generative principles and transformations used in their works.

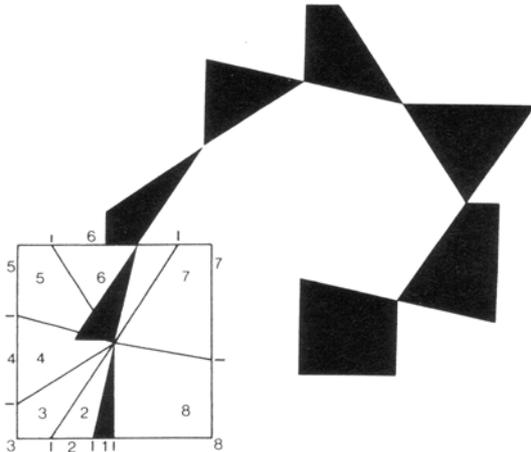
Andy Warhol *Born in Pittsburgh, USA, 1930. Died 1987*

As in *Last supper* (1989, 304 x 610cm, acrylic on canvas), repetition of the object is a common feature in Andy Warhol's work and is achieved by geometrical translations. An object shown in isolation emphasizes the individual, its uniqueness and its inseparability. Producing doubles or a series of the same object leads to a reinforcement of the percept but at the same time to a devaluation of the object. The object becomes a stereotype, particularly when it is drawn in a simplified and stylised way. Instead of looking at the details of a single figure in the picture, one is tempted to pick out a single element, for instance an eye or a pointed finger, and to put these together to form or create a new pattern. By this our perception reveals the structure of the work and tries to impart meaning to what we see. But a row of repeated eyes are not the eyes of a certain person.

Norman Dilworth *Born in Wigan, 1931. Lives in Amsterdam*

For Norman Dilworth the search for images involves play and experiment by which elements are related in controlled sequences of growth. The rhythms and harmonies that occur are created by the underlying structure of the system. The use of number and proportion are the means and the components of the resulting image. He finds that in an expressive image, there is a balance between the strength of its structural formation and the feeling he has for its character. The following two works are an ideal illustration of this:

Parts of a circle (1986, hardboard painted green, 211 cm high) was created by cutting a circle into a set of eight segments with angles of 10° , 20° , ... 80° . For Parts of a square (1985, hardboard painted brown, 270 cm high) a 9 by 9 square was divided in a slightly different way by counting the intervals around the four sides. In both cases the beauty of the spiral is achieved by a set of translations which map each of the segments onto its image, suggesting a pattern of growth and the organic nature of the system.



Peter Lowe *Born in London, 1938. Lives in London*

The work of Peter Lowe deals with fundamental forms and relationships in systems that are based on number, space, symmetry and direction. As art is concerned with communication and has nothing to do with taste, it is essential for him to choose systems and rational methods that minimize decisions based on taste. He writes: 'Once certain forms have been selected and various possibilities and impossibilities realised, it becomes apparent sooner or later that subsequent arrangements are prescribed by known or unknown laws inherent in the forms and processes' [3].

His untitled paintings (1987, diameter of 200cm each) are two of a series of works involving the positioning of shapes inside and outside the perimeter of a regular polygon. In this case right-angled isosceles triangles are arranged around the perimeter of a decagon with one of the short sides of the triangle touching the sides of the decagon so that in each work four distinct groups of one, two, three and four triangles appear to face alternate and opposite directions. Corresponding groups in the two paintings are linked by line reflection, and as parts and counterparts, they give rise to a perceptual interplay between the two works.

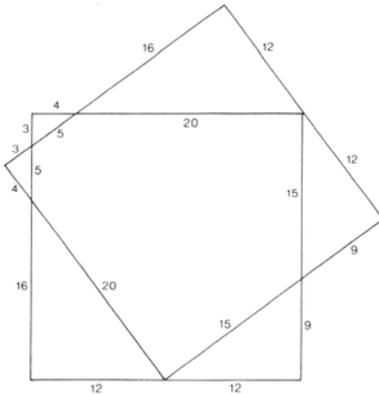
Max Bill *Born in Winterthur, 1908. Lives in Zumikon, Zurich.*

Max Bill, who is one of the founder members of the famous Zurich group of constructivist, regards art as aesthetic information which creates "a kind of non-changeable, elementary truth" that does not alter with time. It is a kind of truth which can be interpreted differently as the spectator and the environment are subject to change but which nevertheless remains the same [4].

This point is made clear in his works where he is often concerned with geometrical transformations which preserve area or volume. *In Four equal colour groups around a white square* (1973, oil on canvas, 120 x 120cm, diagonal 170cm) a square has been partitioned into four coloured isosceles triangles and a white square of the same size. The corner triangles,

each divided further into four isosceles triangles, display a rotational symmetry with permutation changes of the colours blue, red, yellow, and green.

His recent work *Blue-red-exchange* (1987, oil on canvas 80 x 40cm) demonstrates the solution to the following problem: How can a square be placed onto another square of the same size so that one corner of each square is located on one of the sides of the other square and the sides of the non-overlapping triangles take the ratios of pythagorean triads, ie are sets of whole numbers which satisfy the relation $a^2+b^2=c^2$? The sides of the right-angled triangles have the ratio 3:4:5 and multiples of it. The whole work shows a rotational symmetry by giving all parts of the two squares.



David Saunders *Born in Essex, 1936. Lives in Buckley, Clwyd.*

For David Saunders, making drawings, paintings and constructions is a way of transforming his intuitions and feelings into communicable information whereby rational methods are used as tools for exploration. The visible form of the work is the result of the structuring of space. The constructive work is the representation of relationships, not depiction of ideas.

Constructive works in series show how relationships change [5,6]. This point becomes clear when one looks at the rhythmic structure of his *Diagonal relief series* (3-1977/78, 1-4, wood, approx 14 x 14cm). Here the interrelation of the rectangles is achieved by a combination of two transformations, rotation and enlargement, where the scale factor is determined by the lengths of the diagonals.

Barbara Hepworth *Born in Wakefield, 1903. Died in St. Ives, 1975*

In England Barbara Hepworth was one of the first sculptors to make completely abstract work, both in thought and conception. Experimenting with new plastic media and methods, she extended the universal language of form and colour and initiated a new direction in English art. Like Max Bill and other constructivists, Dame Barbara sought an abstract beauty and the perfection of form. She wrote: "There must be a perfect unity between the idea, the substance und the dimension: this unity gives scale" [7]. Hut unlike many of her contemporaries on the continent, her work never lacked human significance:

"The two things which interest mc most are the significance of human action, gesture and movement, in the particular circumstances of our contemporary lift, und the relations of these human actions to forms which are eternal in their significance" [8].

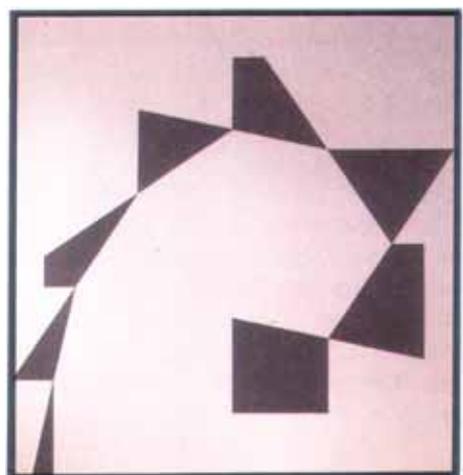
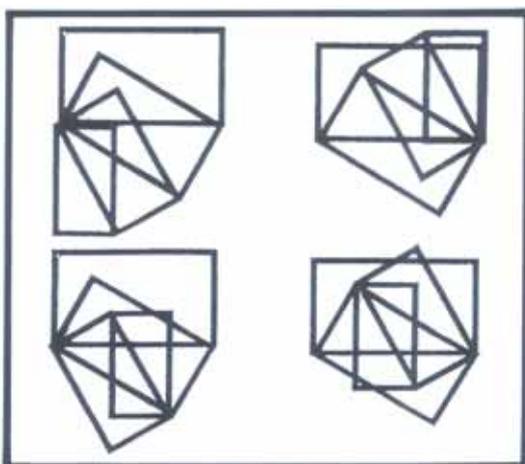
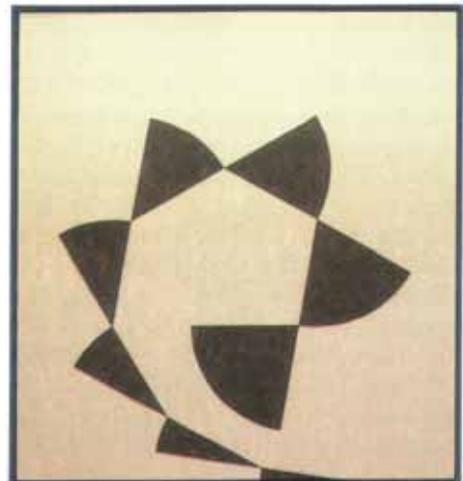
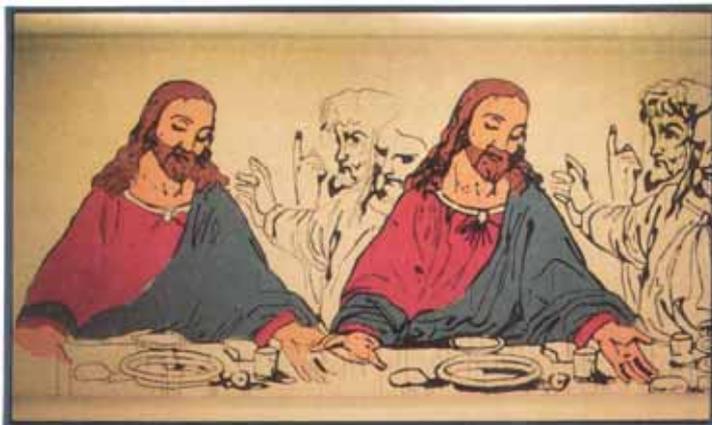
Impressive examples are her large sculptures *Two forms (Divided circle)* (1969, polished bronze) and *Fallen images* (1974), which is her last important marble carving.

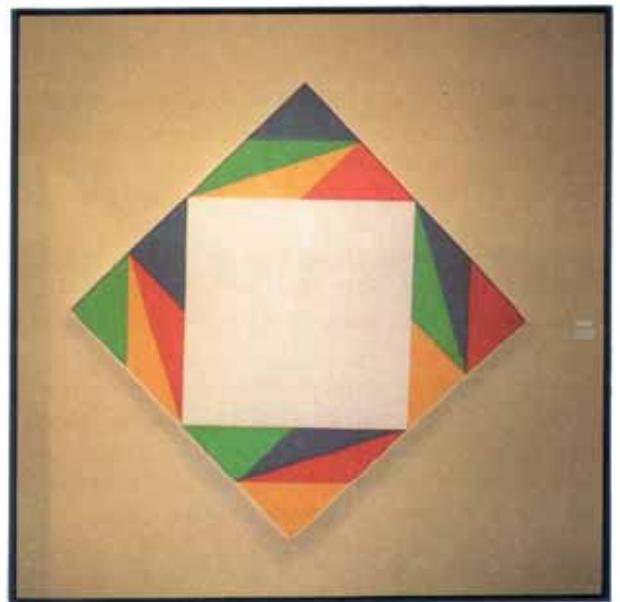
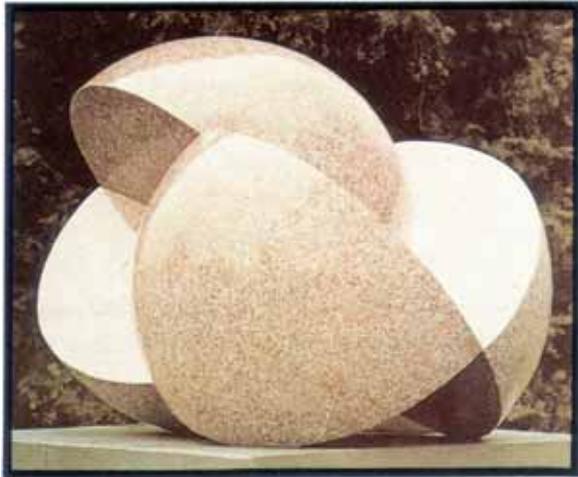
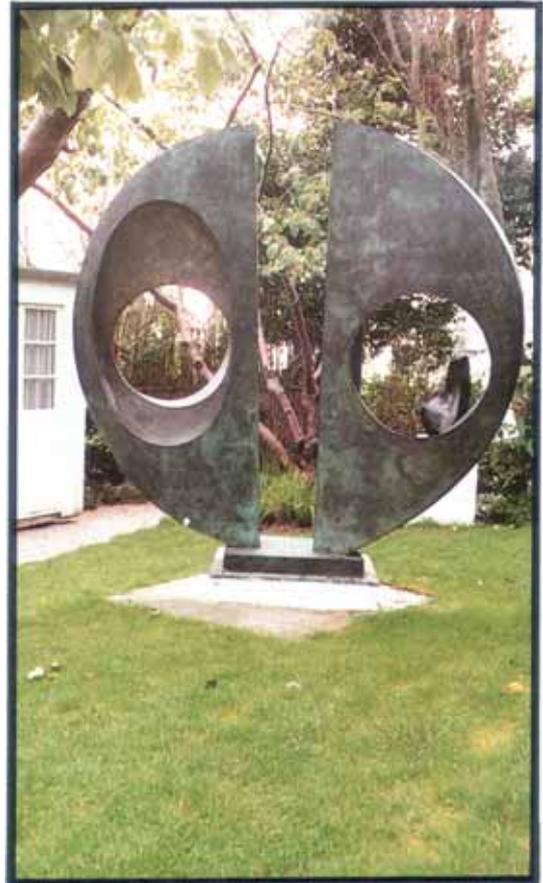
The role that mathematics plays in these works as a structural element cannot be overlooked but it is not the idea, not the spiritual inner life of these plastics.

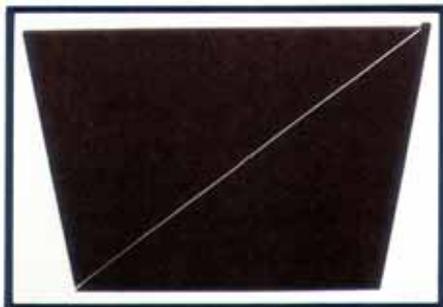
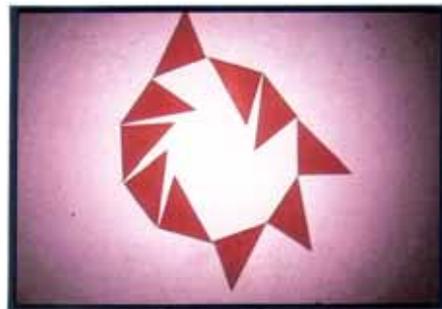
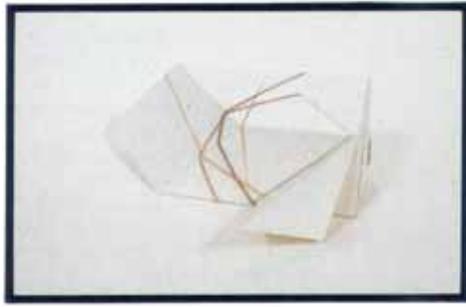
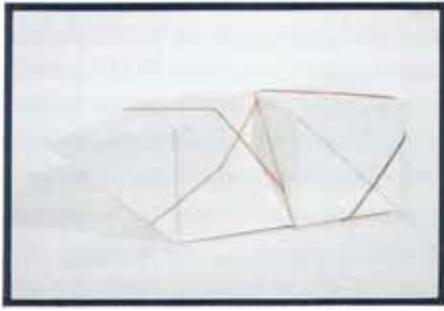
In contrast to this, the sculptures of Max Hill arise from the investigations of geometrical systems. They are based on mathematical problems showing precise solutions. *Driving forces of a sphere* (1966-67, Swedish granite, 60 x 90 x 60cm) is one of his many sphere plastics where the displacement of dissected parts reveals new insight into the structure, creating at the same time a new artistic dimension.

Complementary to the dissections of solid shapes are the geometrical transformations of skeletal solids which can be found in the sculptures of Joost Baljeu, one of which has been discussed in MT122 [1].

TRANSFORMATIONS



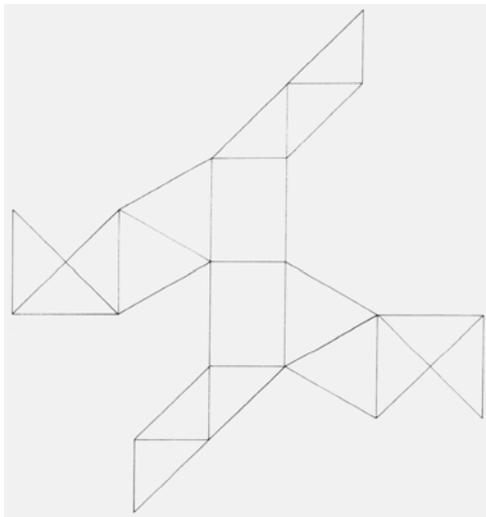




Douglas Allsop Born in Watford, 1943. Lives in London

In his most recent work Douglas Allsop investigates transformations of the cube into other polyhedra of the same volume. The mathematical problem may be defined in the following way: how can a cube be dissected into a set of non-cuboid polyhedra, which are connected within a single net, and where the transformations of the cube result in folding over the solid shapes? It is important to note that as a consequence of this, some of the faces in the total net will occur twice.

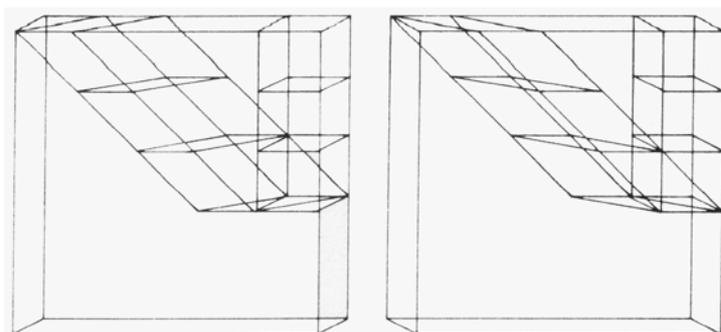
One of the solutions to this problem is obtained when the cube is cut into two triangular prisms along the plane leading through the diagonals of two opposite faces. After removing a vertex from each prism, one obtains two right-angled tetrahedra and two asymmetric rectangular pyramids where the *Planular drawing* looks like this:



The cardboard models, showing the front and rear view, demonstrate the interplay between two such cubes for one of the possible transformations. This transformation is a shear of the cube which is achieved by simultaneously folding over the two tetrahedra. In the models, the transformed state penetrates the untransformed one. Proof of the condition of sharing is given by the right-angled tetrahedra which exists outside the total form. Whilst one form is complete, the other is not. Our reading oscillates between the two states of the cube.

The *Two-part relief constructions* extend this shearing transformation to a vertical column of three cubes where the two bottom elements correspond to the two cubes of the cardboard models. Douglas Allsop states:

“Two elements of equal volume, one diagonal, the other vertical, form corresponding projections within each square. By their conjunction the immaterial is materialised, accordingly the material is de-materialised” [9].



In the *Two-part reliefs* (1987, 600 x 600 x 6mm each) the same transformation is applied to a column of 98 cubes. Here one has to take into account that each relief is the size of 100 by 100 cubes and that the original and transformed cubes shown in the drawing are the voids in the reliefs.

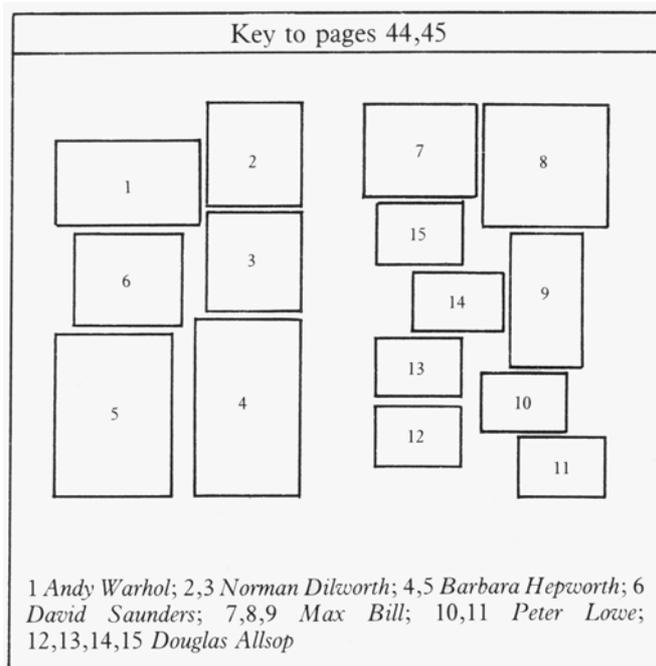
Douglas Allsop says about his work: *“For me the value of that which can be measured and become known is that this knowing releases knowledge of the unknown. In other words, it is not that which can be measured but that which cannot be that I wish to get closer to”* [9].

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My sincere tanks go to D Allsop, N Dilworrh, P Lowe, D Saunders for their collaboration. The photographs of B Hepworth’s sculptures were taken at the Barbara Hepworth Museum in St. Ives. The photograph of Max Bill’s Driving forces of a sphere was generously supplied by Gallery Teefel, Cologne.

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Postscript

