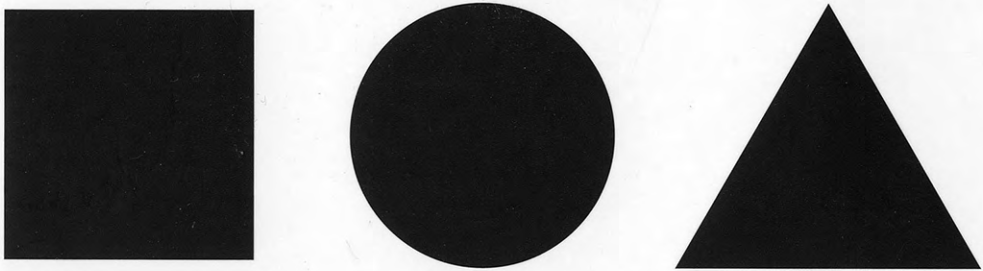


# Bruno Munari
# Square Circle Triangle

The square is as high and as wide as a man with his arms outstretched. In the oldest writings and in the rock inscriptions of early man, it signifies the idea of enclosure, of home, of settlement.

Enigmatic in its simplicity, in the monotonous repetition of four equal sides and four equal angles, it creates a series of interesting figures: a whole group of harmonic rectangles, from the Hemidiagon to the Sixton, generate the Golden Section and the logarithmic spiral found in nature in the organic growth of plants and animal parts.

Its structural possibilities have helped artists and architects of all generations and styles by giving them a harmonic skeleton to which to apply an artistic construction. Accordingly, it is present in all styles of all peoples in all ages, both as a structural element and as a surface that supports and determines a particular decoration.

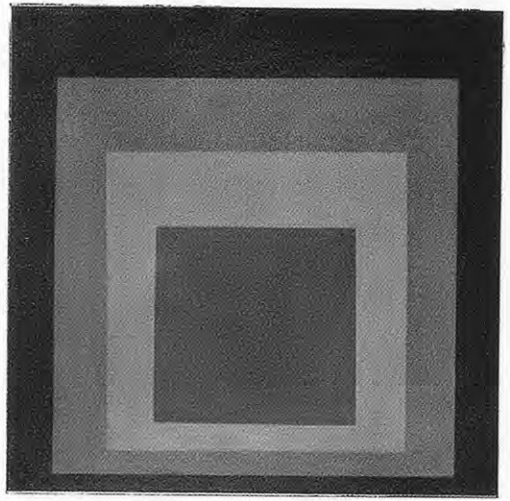
It is static if it stands on its side and dynamic if it stands on an edge. It is magic if filled with numbers and it can even be diabolic and satanic when these numbers retain the same relationship even when squared or cubed. It is found in nature in many minerals. According to Peano it is a curve. It can be turned into triangles or rectangles only by making the right cuts and moves. In ancient times it had the power to drive out the plague. It has given shape to famous ancient cities and even modern buildings: Babylonia, Tell el-Amarna, the Parthenon, the arch of Septimius Severus, the Duomo of Pisa, Palazzo Farnese, Le Corbusier's museum of unlimited extendibility...The bays of Brunelleschi's Portico degli Innocenti are square. In the ground plans of many churches the square space beneath the hemispherical dome is the most logical shape. In the same way, the square of the photograph coincides with the round lens, without waste or distortion. Phidias used a square module for his lacunaria. At the Acropolis of Olympia the Palestra, the Theocoleon, the Leonidaeum and other buildings had square plans...

Many ancient games still played today are based on the square: chess, checkers, the fifteen game with its ten trillion possible combinations, dice, puss in the corner...and then there are the famous cowboy square dances.

In the Eastern Chin dynasty it gave Chinese writing a stable square form. It gave structure to the letters of our alphabet, and to the Hebrew one and others. A small square of cloth is a handkerchief the world over. Two square mats are the basic unit for the traditional Japanese house. Twenty-eight squares cover the surface of a brick. According to an ancient Chinese saying, the infinite is a square without angles.

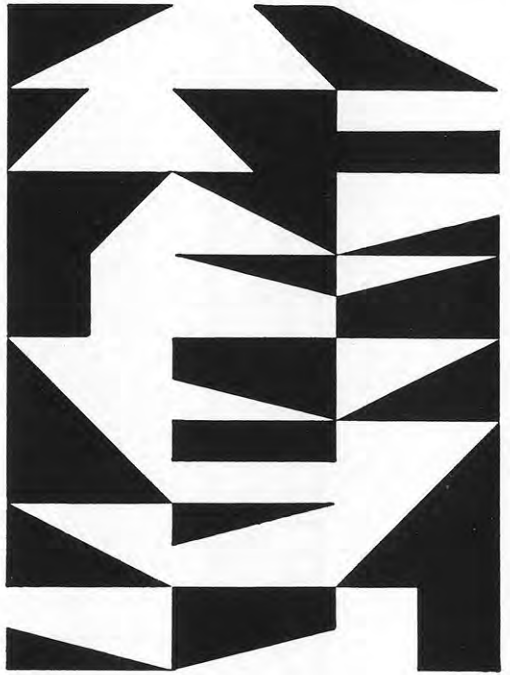
The square is the finest expression of a spatial idea complete in itself. It represents an order of charged spiritual symbolism. All other rectangles, with their different sides, derive from the square but relax its law by expanding in height or width.

JOSEF ALBERS



Homage to the "twilight" square, 1951.

AAGARD ANDERSEN



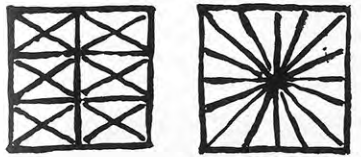
Black and white image on a surface of forty-eight squares.

ALTAR OF THE HOLOCAUSTS

"And thou shalt make an altar of shittim wood, five cubits long and five cubits broad; the altar shall be foursquare..."
—Exodus 27.

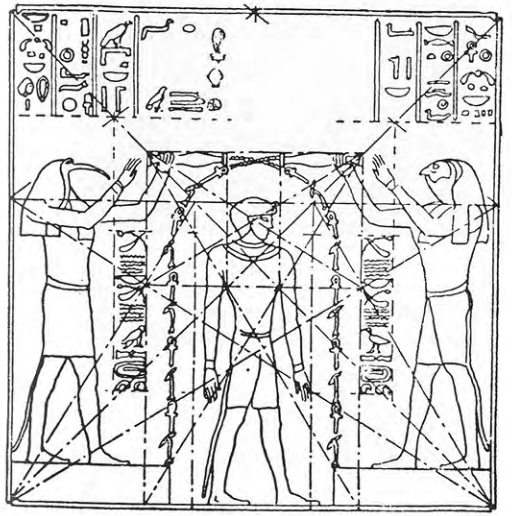


ANAGUTÀ

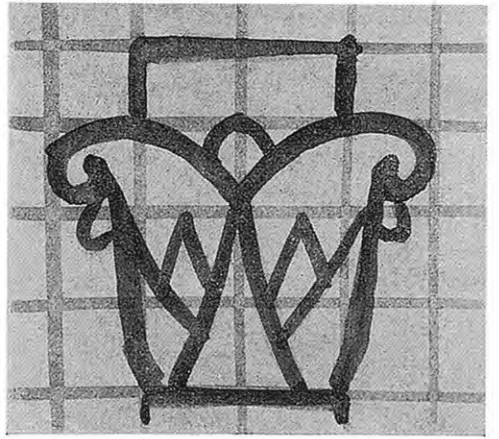


Pictures from American petroglyphs.

ANCIENT EGYPT



In ancient Egypt art was based on geometry and on the fixed rules of a canon. The square was at the basis of this canon. Since the time of the Old Kingdom, as the third-dynasty tomb of King Zoser at Sakkara shows, the artists who were to decorate a wall began by dividing it up into a network of squares so as to be able to calculate the proportions. Traces of these grids were also found in other tombs at Sakkara and in the tombs of the New Kingdom at Thebes.

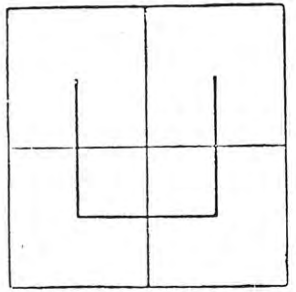


In sculpture the square inspired the so-called cubic statues, in which the human figure, usually a person of rank, was arranged so that it remained set within the coordinates of a cube. A typical example of this is the statue of the architect Senmut of the XVIII dynasty, in the Museum of Cairo.

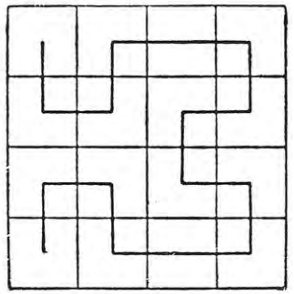
The square is central to the pyramid and, in the gnostic period, mystical and symbological interpretations associated with it became widespread. With its four sides, the square was seen as the symbol of the four elements and therefore of materiality, subordinate to the triangle whose three sides, symbol of the spirit, also determine a schematic rising flame: pyr, fire, thus pyramid.

## PEANO'S CURVE

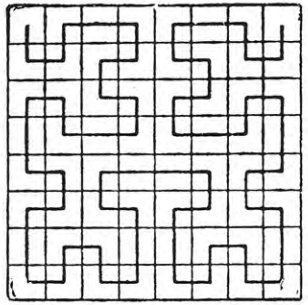
One of the cardinal principles of geometry is that points have no dimensions and that a curve has only one dimension and can therefore never fill an area. This is another firm belief that has to be shattered because "Peano's curve," which belongs to the supreme type of pathological curves, does indeed fill an area. Not only does it occupy the whole inside of a square but it climbs into the space of a whole cubic box. The subsequent stages of this curve are shown in the following figures:



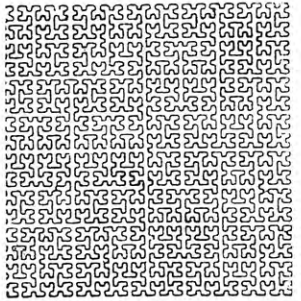
1



2



3



4

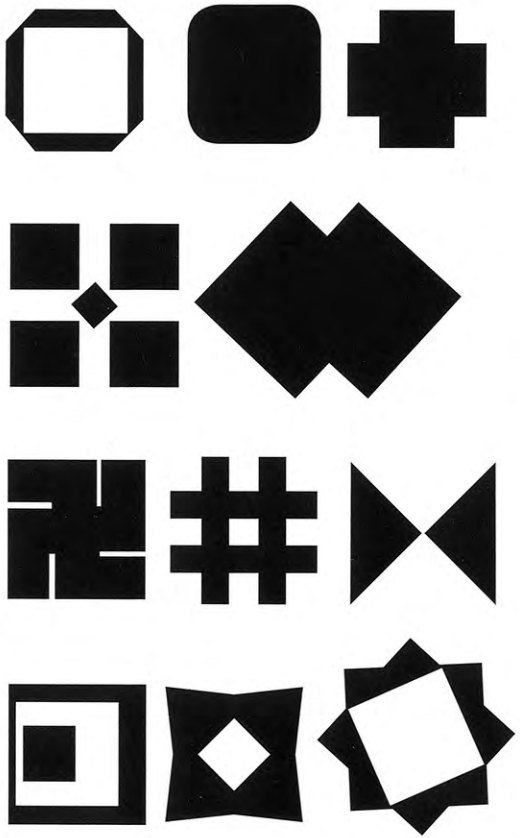
Take any point of the square or the cube. It can be demonstrated that, when completed, the curve will pass through this point. And since the same reasoning can be extended to any other point, the logical conclusion is that the curve must fill the whole of the square and the whole of the cube. Mathematicians once held that every curve had to have a tangent because, they claimed, this property is self-evident. But in 1890 Peano, to the amazement of the mathematicians, devised a curve that did not allow for tangents at any of its points, a curve that filled the whole area of a square, and as such could only be represented by a square black mark. Since then mathematicians have been familiar with curves without tangents.

## CHECKERS

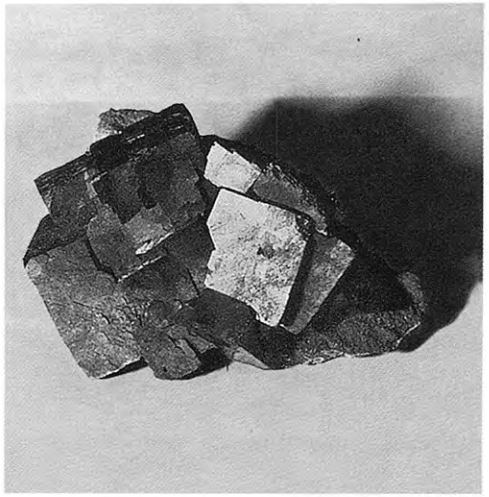
Checker players in the open air in Bournemouth, United Kingdom.

FORMS DERIVED FROM THE SQUARE

Two-dimensional compositions obtained from combining, rotating, or modifying square surfaces.



FLUORITE



Right-angled structure of fluorite crystals.

WINDMILL

Four cuts along the diagonals of a square of cardboard make up this simple toy.

While the square is closely linked to man and his constructions, to architecture, harmonious structures, writing, and so on, the circle is related to the divine: a simple circle has, since ancient times, represented eternity, since it has no beginning and no end. An ancient text says that God is a circle whose center is everywhere but whose circumference is nowhere.

The circle is essentially unstable and dynamic: all rotary movements and impossible searches for perpetual motion derive from the circle.

Despite being the simplest of the curves, it is considered by mathematicians as a polygon with an infinite number of sides. If you remove an invisible point from the circumference of a circle then it is no longer a circle but a pathocircle, which presents complicated problems. A point marked on its circumference eliminates the idea of eternity, indicating a beginning and therefore an end to the circumference itself. If this circle rotates on the flat, the point marked on its circumference describes a cycloid. The circle is easy to find in nature, all you have to do is throw a stone into still water. The sphere appears spontaneously in soap bubbles. Trees grow following a concentric circular pattern: a section shows its rings.

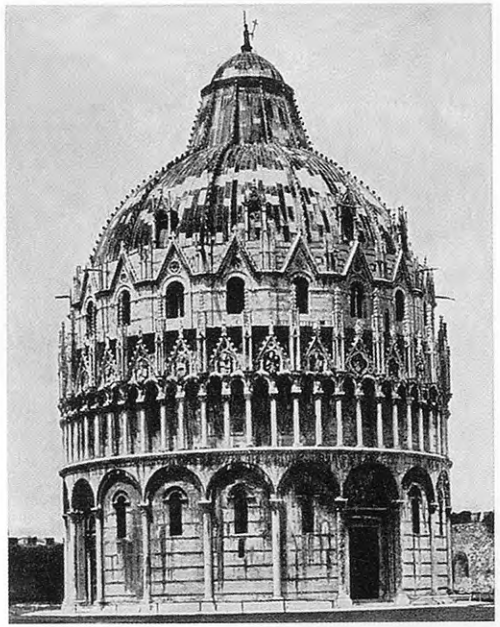
A circle drawn by hand showed the skill of Giotto. The first thing a child draws looks like a circle. People spontaneously arrange themselves in a circle when they need to observe something close up, and this led to the origin of the arena, the circus, and the stock exchange trading posts.

One of the oldest symbols is a disk made up of two dynamic equal and opposing parts: Yang-Yin, which represent the balance of opposing forces in all living things.

Famous painters have painted on a circular surface, each of them finding compositional solutions closely tied to the circular shape. In certain cases, such as in Botticelli's *Madonna of the Magnificat*, the final effect of the work appears spherical to the eye.

A disk lying on a flat surface cannot be placed wrongly, which is why plates are almost always round, and it is easier to arrange them on the table. If they were hexagonal or square or oval it would require greater care to lay them out without creating a sense of disorder. A circle instead is always tidy. This is even truer of the sphere, which cannot be overturned in any way. A sphere is always the right way up, so to speak, in any position.

BAPTISTERY



The Pisa Baptistery, one of the most beautiful old buildings on a circular base.

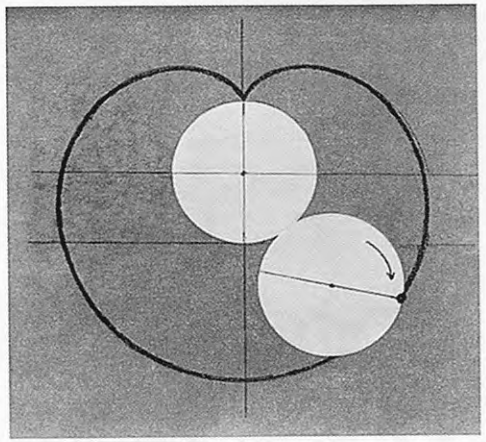
SOAP BUBBLES

A natural sphere.

MAX BILL

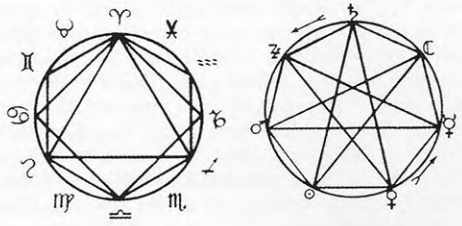
Design made from a series of circles, 1942.

CARDIOID



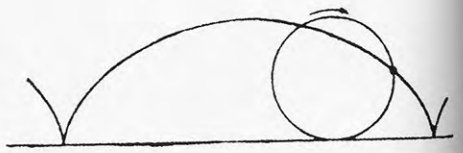
A curve described by a point situated on a circle which rolls, without slipping, around the circumference of another circle.

Astrological circles used to calculate configurations.



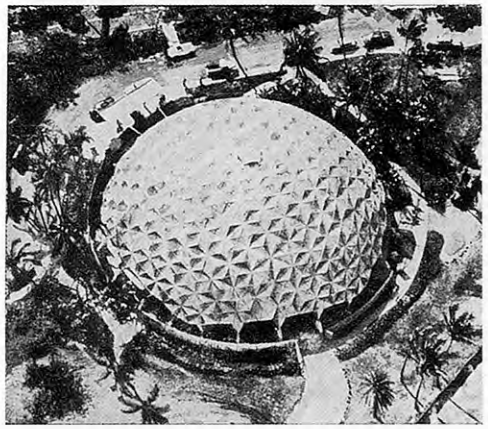
CYCLOID

The cycloid is the path traced by a fixed point on the circumference of a circle that rolls along a given straight line. An interesting property of the cycloid was discovered by Galileo: with the help of the cycloid we can construct an area that is exactly the same as that of the given circle. First of all, the length of the cycloid from cusp to cusp is equal to four times the length of the diameter of the generating circle. On the basis of this it can be demonstrated that the area delimited by the portion of the cycloid between the two cusps and the straight line that unites them is equal to three times the area of the circle. Therefore the space delimited by each part of the circle is exactly the same as the area of the circle itself.





COMPASSES

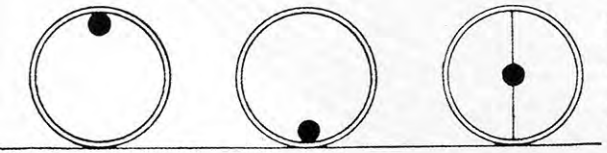


BUCKMINSTER FULLER

One of the many geodesic domes designed by Fuller. In 1957 it took twenty-two hours to build this enormous dome in Honolulu for a series of concerts. All geodesic domes are built using prefabricated parts and are easily assembled. In certain cases, some domes were hung from a metal cable and transported by helicopter. Fuller created geodesic domes in a wide range of different materials: plastic, wood, and, at the Milan Triennale of 1954, cardboard with a radius of approximately 33 ft. (10 m).

SPHERICAL BUILDINGS

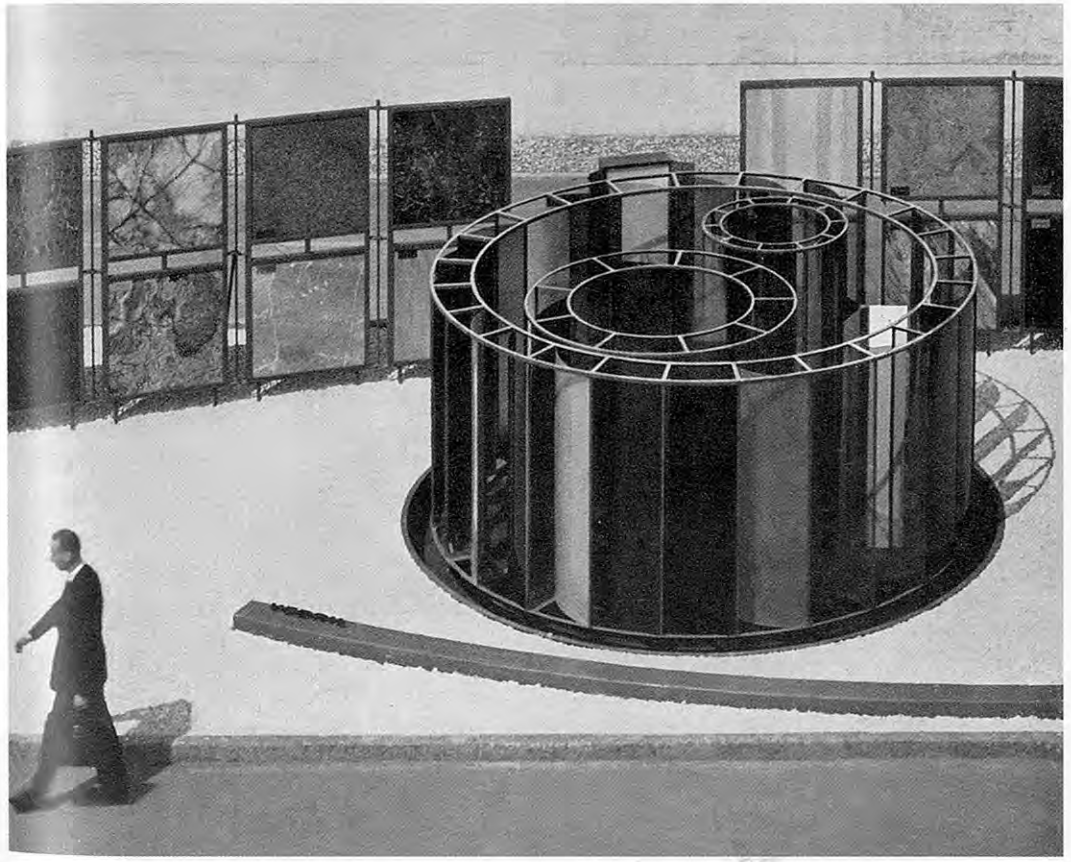
In 1770 Claude-Nicolas Ledoux designed a giant sphere as a symbol of eternity for the cemetery of Caux. He also designed a spherical home for the caretakers as a symbol of human solitude. In 1800 Lequeu designed a spherical "Temple of the Earth." Later, the Russian composer and theosophist Aleksandr Skrjabin designed a semispherical building that would stand over the water so that its reflection would complete the other half of the sphere. The building was to be constructed in India and was to be the site of a holy play about universal redemption. Russian architects, who tended towards futurism, designed a suspended spherical building to be used as a planetarium and reading room for the Lenin Institute. In March 1958 Johann Ludovici submitted a spherical house made of metal to the London Exhibition.



BALANCE

The three stages of balance of a wheel: With the weight at the top it is unstable. With the weight at the bottom it is stable. With the weight in the center, it is neutral. Spontaneous motion can only arise in the first case. This principle is always put into practice for models of machines for perpetual motion.





CYLINDRICAL FOUNTAIN

The outer cylinder is 6 ft., 6 in. (2 m) high with a diameter of 13 ft., 1 1/2 in. (4 m). It is made of iron with panels of colored plastic material

The illustrations and information contained in this book are only about equilateral triangles and not other triangles like right-angled triangles, isosceles triangles, and scalene triangles in all their variations. Whereas a right-angled triangle can have sides of different length and hence be different shapes, the equilateral triangle is the most stable form with its fixed structure of three equal sides and three equal angles. Its distinctive structure means we find it in lots of complex structures and in many mineral and vegetable forms and structures found in nature, ranging from the clover to the oleander.

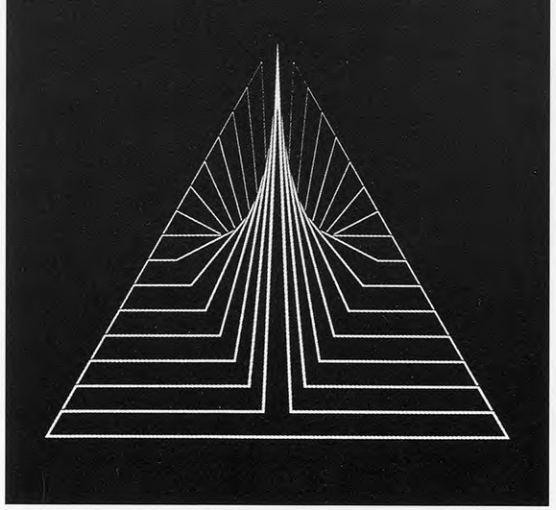
The equilateral triangle is one of the three basic forms, along with the circle and square. A full pattern of equilateral triangles touching on a surface creates a structured field in which endless other combinatorial forms may be constructed, as we can see in many Arab, Chinese, Persian, and Japanese decorations. Many styles of decorative art are based around a triangular structure. A triangular (or tetrahedral) structure also gives the overall formal balance to lots of works of pure art. Nowadays, many constructions are based on a triangular structure and the modules deriving from it; we might, for example, mention the modulated constructions designed by Buckminster Fuller and a number of works of architecture by Wright and other young architects or classical constructors. An equilateral triangle can easily be found inside a circle by measuring its radius six times around the circumference and joining its three equidistant points by three lines. An equilateral triangle can be found inside a cube by joining the opposite ends of the three lines meeting at any apex. A cube has a tetrahedron inscribed inside it.

Understanding every aspect and formal-structural possibility of this simple, basic form is a great help to a designer. Due to static reasons, design-construction practicalities, and economic factors connected with manufacture, transport, and assembly, a modulated construction is now easier to design than the kind of visually striking pictorial-sculptural construction that used to be built. The most popular structure in these cases is square-based, but it is also the blandest. On the other hand, triangular and tetrahedral structuring often produce more unexpected results, ideal, for example, for designing an exhibition facility that must really stand out in its setting.

In the field of technical-artistic education, experimentation with triangular forms and structures is common practice in design schools. A lot of the illustrations in this book are the result of experiments like this carried out in various schools.

Coherent forms may be constructed in model form, using sheets structured in the form of equilateral triangles, by cutting the sheet along the structural line and folding it according to the angle of the equilateral triangle.

One of the strangest traits of this kind of triangle is that, when drawn over a sphere covering one eighth of the space, it will always be an equilateral triangle with three right angles.

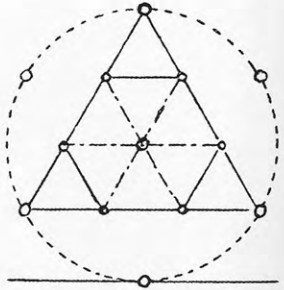


BERTOLIO

Architecture of a triangle, 1974.

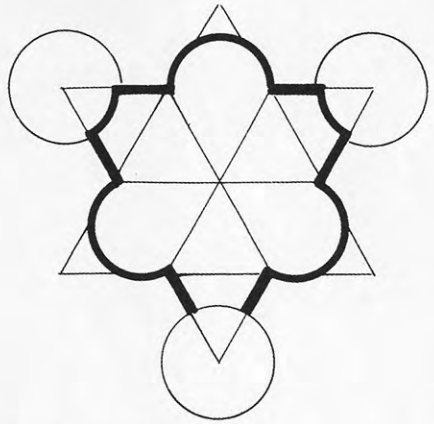
BUDDHA

Statue of Buddha and its harmonious structural scheme.





BORROMINI



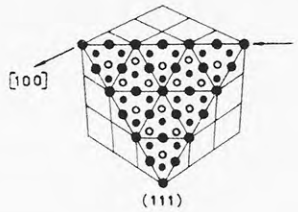
Geometric scheme of the plan of Sant'Ivo alla Sapienza in Rome, 1650.

COCONUT

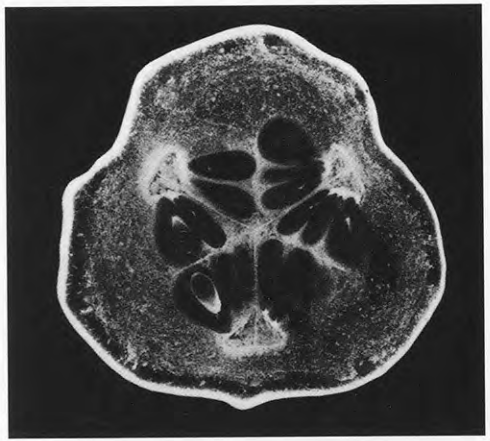
The embryonic attachments of a coconut. The triangular vegetable structure can also be seen in the bottom part of the fruit.

CRYSTALS

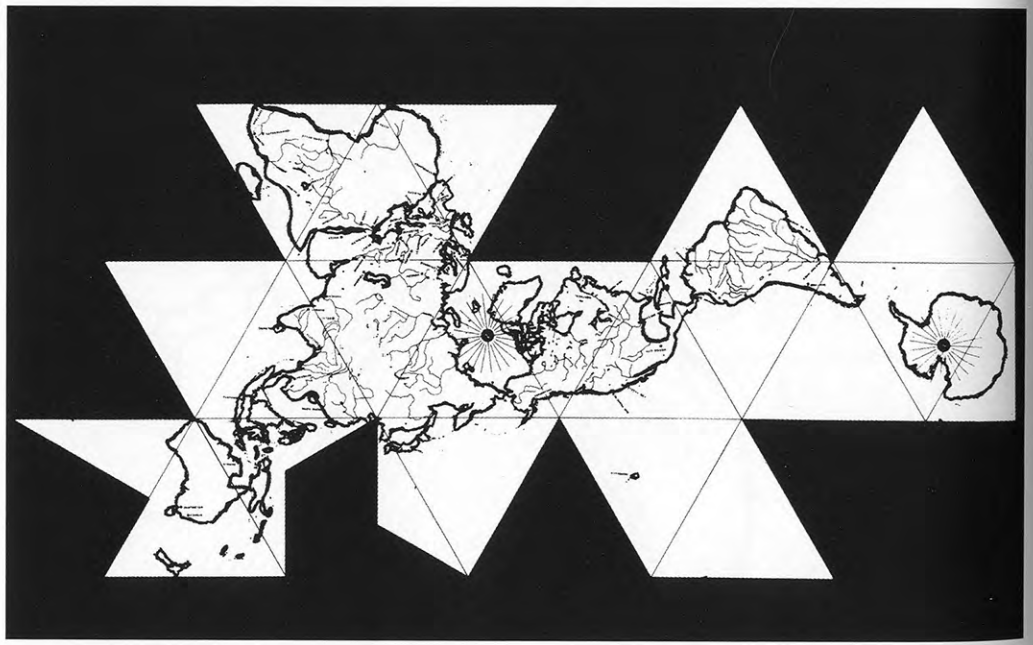
Triangular figures in the attachment of silver crystals according to the 1-1-1 plane of the Miller index. Microphotograph.




CUCUMBER

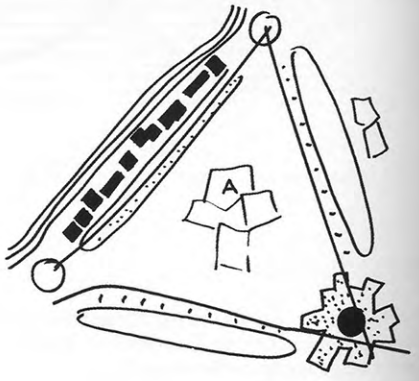


Section of the fruit showing the seeds arranged in triangular equilibrium.



ATLAS

New way of showing the continents based on an idea by Buckminster Fuller, 1934.



LE CORBUSIER

Diagram of three human settlements by Le Corbusier, 1947. The linear industrial city ideally takes up one side of the triangle. The other two sides are formed by the radiocentric exchange city, and the farm settlement unit is in the center.

MOUNTAIN

Old Chinese symbol for a mountain.