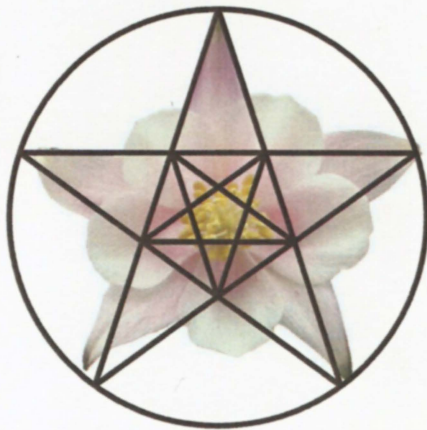


Constructing The Universe Activity Books
Volume 6

Secret Windows

Into Nature, Art and Technology



by

Michael S. Schneider

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Volume 6

Secret Windows
Into Nature, Art and Technology



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michael@constructingtheuniverse.com

Michael S. Schneider, M. Ed. Mathematics, is an Adjunct Professor
at the California College of the Arts (San Francisco and Oakland)
teaching mathematics to art students.

<http://www.constructingtheuniverse.com>

Cover: Different objects of nature, art and technology, like this columbine flower, pueblo pottery and automobile hubcap, share the same underlying geometric design.

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Introduction

When we see a flower we often notice and admire the colors of its petals and center. But how often does anyone think about its mathematics, the number of its petals, their shapes, or the subtle relationships among each of its parts? And why should we? A mental approach will ruin an emotional appreciation of the flower; but, in proper context, could it actually enhance our delight? When we sit before a dinner plate we might notice, if at all, below the food, its color and any design. But we probably don't consider the relationship of the rim to the center, or even why it's round in the first place. Yet mathematics is the foundation of everything in the universe, including objects that people design and create. Everything is made of numbers. We find them in the measures of any object's length, width, height, weight and temperature, to begin with. And everything has a shape – shapes are the masks of numbers. Even the invisible breeze has a shape making the dust and leaves whirl in spirals.

"Philosophy is written in this grand book--I mean the universe--which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures, without which it is humanly impossible to understand a single word of it."

Galileo Galilei (1623)

Galileo was right! Just look around. The countless objects which fill the universe and our home are actually composed of only a very few simple shapes which keep repeating in different sizes and materials. A spiral seashell resembles the water whirling around it, as well as water spinning down the bathtub drain and the cowlick of the baby sitting near it, and the whirling galaxies of stars embracing us all. This book is intended to show how the same shapes cross all boundaries of design, time and culture. And better yet, to give you the tools to see it for yourself beyond this book.

Just a handful of shapes keep repeating, like letters in nature's design alphabet, the proverbial Book Of Nature. Moreover, each shape tells us very specifically what's going on in a situation. Each shape is a message about a great idea solving a problem. It may be about how to balance while standing still (triangle) or how to balance when growing or moving (spiral) and yet be as strong and as light as possible. It might even be about how to fit the most of something, like seeds or boxes, into the smallest space (six-around-one). Some important shapes appearing in nature and in the objects people design include the circle, triangle, square, pentagon, hexagon, heptagon and octagon, among others. These are the shapes of our Secret Windows. We'll use them to peer into some of the designs shared by nature, technology and art.

"Secret Windows" are the clear plastic geometric grids found at the back of this book. They're used to look through at objects to easily see if they display any "openly-hidden" geometric design. They can be used to understand the beautiful forms of nature like leaves and flowers, as well as the inventions of technology like hubcaps and street signs, and works of art like pottery and round paintings and

architecture. This book was written – and the Secret Windows were tested – over a dozen years in botanical gardens, neighborhoods and at various art museums. I’ve delighted in what they’ve shown me (as are the people who’ve looked over my shoulder to see what’s so interesting). This approach seems to be the simplest, most direct way for anyone to see with their own eyes the same few shapes recurring throughout nature, technology and worldwide art, and often for similar reasons. This visual “shape-language” approach to the natural sciences (including environmental studies), technology and the arts hasn’t been the norm in most schools, but I suppose that’s partly because we don’t always notice what’s right in front of us, and what seems too simple is often overlooked and little valued.

The flow and rhythm of this book are intended to give readers a glimpse into the messages of each shape (please see *A Beginner’s Guide To Constructing The Universe* for more about each number and shape) followed by illustrations of each shape’s appearance in nature, technology and art. The pictures have been sized so that the reader can place the Secret Windows directly upon them for viewing, providing practice noticing number and shape clues and learning to see geometrically.

Is this book for children or adults? Actually, it’s for anyone who hasn’t already been told or shown how to enhance their wonder at this marvelous world by viewing it in terms of its numbers and shapes but would like to do so. My previous five *Constructing The Universe Activity Books* took a traditional approach to geometric exploration using a compass and straightedge. This Volume 6 is an even easier way to develop an interest in this subject without using those technical tools, although the hand-eye-mind relationship they do develop is remarkable. So perhaps this book’s approach will lead to further interest and exploration of these eternal Truths using a compass, but that’s entirely unnecessary for appreciating the simple wonders of the world around us. Thus, this book is for both youngsters and adults. Perhaps if more children are encouraged to notice and appreciate the beauty of simplicity, and recognize unity underlying diversity, there will be fewer adults unfamiliar with the indigenous language of our native universe.

Finally, I’d like to say a few words about why I’ve included art in this book. While the designs of nature and human inventions have the most obvious parallels between them, like whirlpools and shells resembling screws and springs, or hubcaps resembling petaled flowers, the appearance of geometry in art is more subtle, and controversial. All cultures through history and around the world, usually by individual initiative, create art. There are many ways to create art and even more reasons for making it. Some art is created spontaneously while other creations are planned over a long time. There are many well-known examples of art, crafts and architecture which been carefully designed by intentionally applying mathematics, numbers, shapes and patterns for their benefit. Architectural marvels like Christian cathedrals and Greek, Hindu and Buddhist temples absolutely require it. It’s recognized that some artists including Leonardo, Raphael and Dali intentionally used geometric planning in their

compositions. There's really no way *any* artist can avoid using mathematics in art, any more than a scientist can. Everything has a shape and a weight, measurements in three dimensions and over time, color intensities and other number-related ideas that artists *must* use in their designs. Some artists use them purposefully, while others don't, and needn't. Some artists feel that conscious awareness of the mathematics, especially of proportions, ruins it's feel of spontaneity. Others see such knowledge as a tool which can help reinforce the message. Though history many artists even knew how to use unseen geometry to unconsciously guide the viewer's eye to various points of visual interest. While it's obvious that the patents for many human inventions are really first held by nature, it's much less known that intentional geometric composition underlies many great works of art, crafts and architecture. We aren't usually supposed to see the original compositional plans, the art's secret geometric armature, whose feeling endures for the viewer in the visual precipitation of materials and scenes guided by it. But we can often find it if we learn to see with geometric eyes. Look through Secret Windows at the works of art included here, and at others in museums, and judge for yourself whether such schemes appear consistently within them and across cultures.

So I hope you enjoy the activities with Secret Windows in this book and, more importantly, that you take them outside to look at the wonderful designs of familiar nature and technology. Please take them to an art museum and enjoy a penetrating vision into your favorite works. Verify it all for yourself.

Although this book appears to be about shapes and patterns, it's really about *seeing*. It's not about seeing anything different or seeing anything new, but it's about *seeing what is already here* and has been waiting to be noticed and appreciated all along. Happy viewing!

Michael S. Schneider
 San Anselmo, California
 Lake Worth, Florida
 15 July 2009

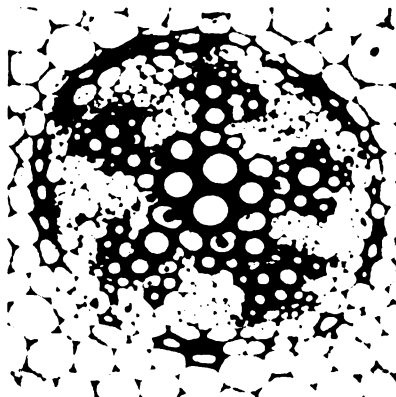
"The mathematical rules of the universe are visible to men in the form of beauty."

– John Michell (1933-2009, Antiquarian, philosopher, teacher, writer, artist, friend)

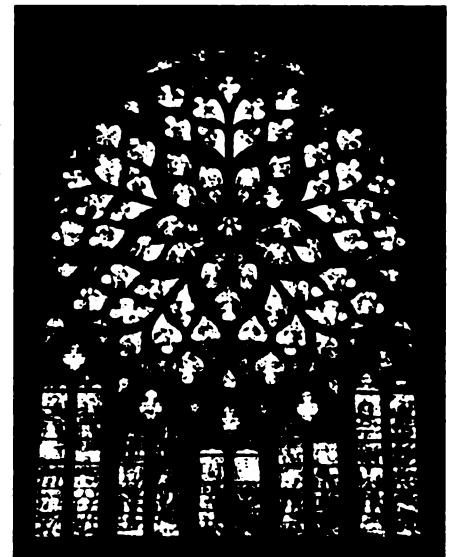
"All things are full of signs, and it is a wise man who can learn about one thing from another."

– Plotinus (205-270, Roman Neoplatonic philosopher)

Root Cross Section
 Microscopic View



Rose Window
 Sens Cathedral, France 1516

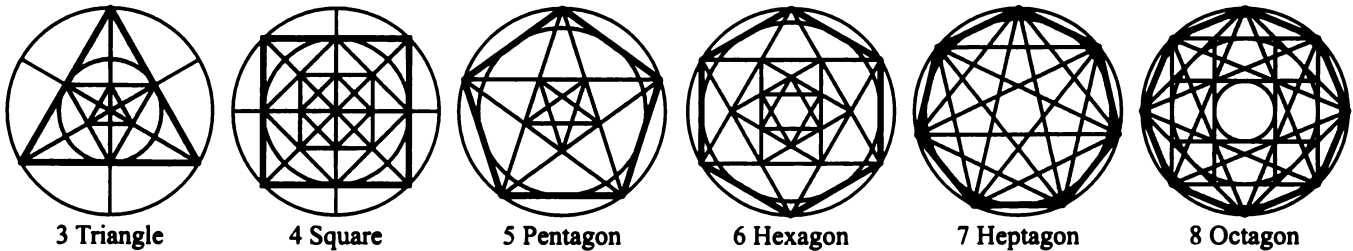


How To Use *Secret Windows*

"He therefore who wishes to rejoice without doubt in regard to the truths underlying phenomena must know how to devote himself to experiment."

– Roger Bacon (1220-1292, English philosopher and scientist)

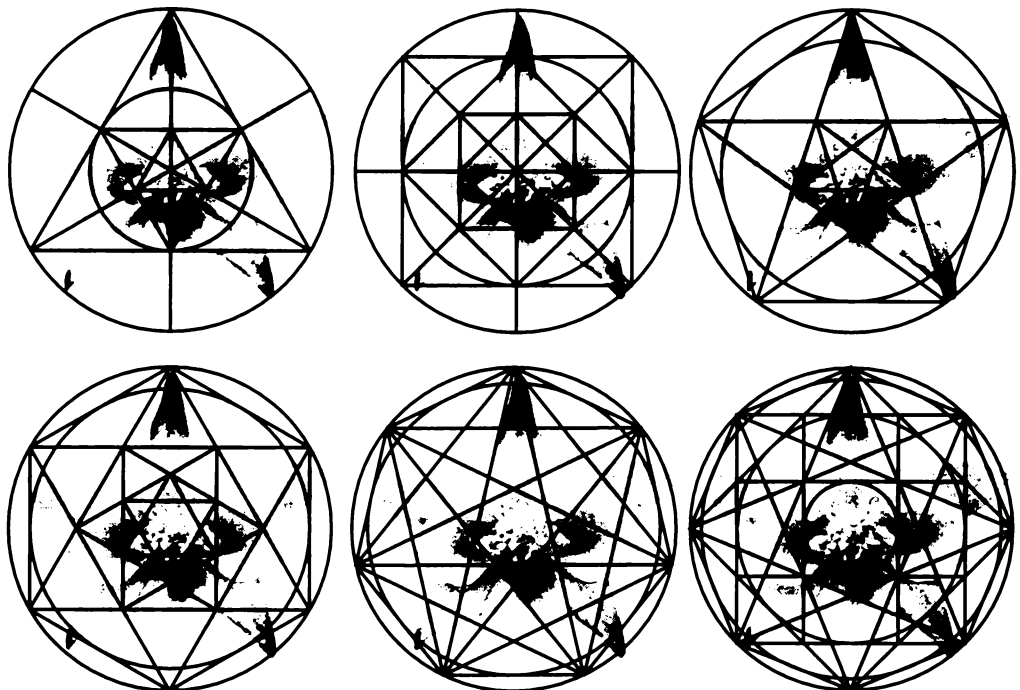
This book includes a plastic sheet with six geometric constructions printed on it. Each is called a *Secret Window* and shows a pattern made by repeating that same shape in smaller, turned, proportional sizes towards its center. After you remove the sheet from the book you can leave it whole or you can cut out each *Secret Window* within it's own square to hold and use separately.



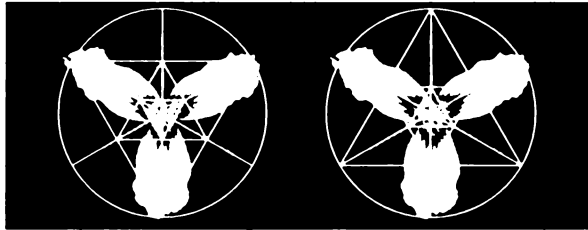
These *Secret Windows* are primarily for viewing round objects – flowers, hubcaps, some street signs, round paintings and other art. But they can also be used to view objects which aren't round yet fit within a circle, including leaves, tiles and the repeating images on wall paper.

The following pages have examples for you to practice using *Secret Windows* before you use them to view the world around you. But always first look at the object for number clues. Is there anything which repeats around it, like the number of petals of a flower? If it's the correct *Window*, parts of the object, like the flower's petals and central design will align along its lines, at their crossings and in its spaces. If it doesn't match to your satisfaction, rotate it, or try another *Window*.

In your judgment, which *Secret Window* seems to best match this Columbine flower?



Look at this White Trillium flower's three white petals and three green sepals. Three and six. It's a perfect candidate for the triangle *and* hexagon Secret Windows.



When the geometry of the triangle Secret Window is aligned with the flower's center and pointed downward, the triangle's corners come near* the tips of the white petals. Inside, the dark design around the flower's center radiates from the edges and corners of the innermost triangle. But when this Secret Window is inverted, pointing upward, a larger triangle contains the flower's whole design while the center is fully contained within its triangle. When the same is done with the hexagonal Secret Window we see its central radiance a bit differently. Both Secret Windows reveal different aspects of its beautiful design. The square and octagonal Secret Windows can often be used together as well.

With practice you'll be able to look at any natural object and easily identify its number and shape clues. Sometimes you'll know right away which *Secret Window* is best to look through to reveal its pattern. Other times it's useful to know that larger numbers like twelve can be appreciated by knowing which numbers divide into it. Since 1, 2, 3, 4 and 6 divide neatly into 12, we can look through three Secret Windows: 3 (triangle), 4 (square), and 6 (hexagon).

The following pages briefly describe something about the characteristics of each shape and their benefits, the messages each shape speaks in this universal design alphabet. This will be followed by examples organized by shape for you to practice using Secret Windows upon. Following those are examples for you to discover the geometry on your own.

* It's important to remember that the shapes of nature are never perfectly symmetric and mathematically exact, which is an ideal symbolized by the geometry on the plastic (itself an approximation of the ideal, built of piles of toner ink molecules). Nature and humans can only *approximate* the ideal forms, perhaps getting laser-close but never perfectly equaling it. Usually the smaller a natural object is, the more exact its geometry will be, as with crystals and microscopic plants, creatures and molecules. While acknowledging that the universe is One, Plato distinguished between the eternal, unchanging ideal as the World of Being, as opposed to the continually changing approximations of nature, the world of Becoming. In Buddhism they're called the Diamond World and Matrix World.

What happens when there's no obvious number or shape clue? Although many flowers have more petals than match the Secret Windows' geometries, it's likely that *one* Secret Window will reveal something interesting about it. Simply by trying different Secret Windows we discover that when the triangle is placed on this sunflower we see how the full circle surrounds the flower while the triangle surrounds its central inner circle.

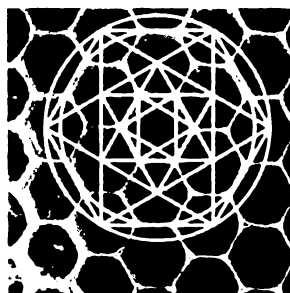
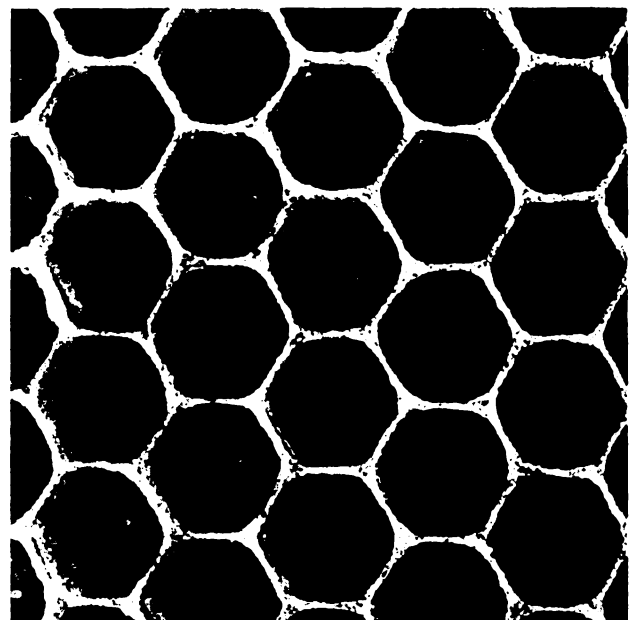


Place Secret Windows on the larger pictures and try it for yourself!

For this multi-petaled daisy with too many petals for any Secret Window, trial-and-error reveals that the pentagon nicely shows a relationship between the outer and inner circles. But this may vary among species.



Although this section of a bee hive isn't round, what clues can we find? Each cell is a hexagon, and six cells surround it. So try placing the center of a *turned* hexagonal Secret Window over one cell to see how seven cells relate. Notice how the corner points of each hexagram star rest at the center of a cell.



What's So Great About Circles?

"Things should be as simple as possible,
but not simpler."
- Albert Einstein

Since every regular geometric shape (including those of the Secret Windows) can be embraced within a circle, cylinder or sphere, we'll begin with some brief wonder at the simple circle. The circle is considered the simplest shape because it encloses an inside without straight lines or sharp corners. It can be spun around to become a sphere, or extruded to become a cylinder.

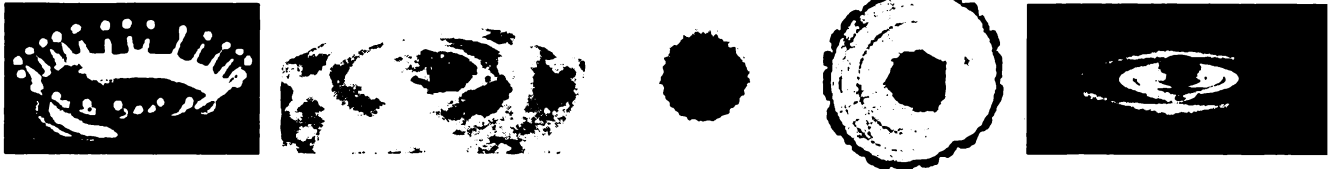
What are the circle's messages to us? Circles solve problems three ways:

By being equal, fair and balanced. Every point on a circle is the same distance from its center.

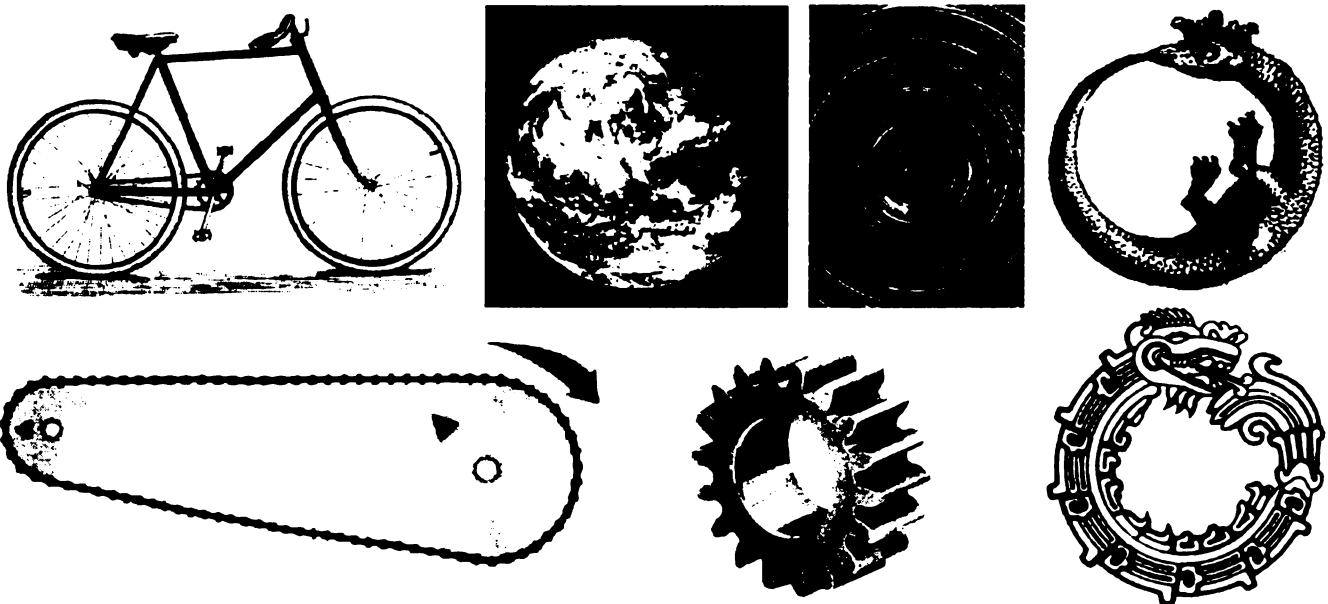
By doing the same thing over and over again. A circle rotates in a repeating cycle.

By getting the most from the least. A circle surrounds the most space by the shortest line. And a sphere contains the most inside it using the least material to surround it!

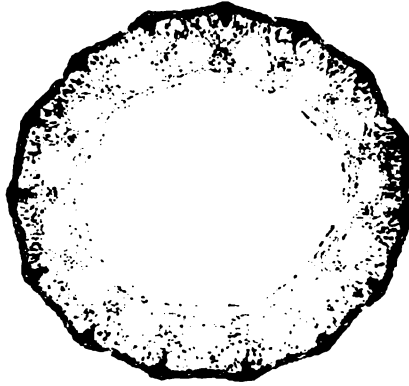
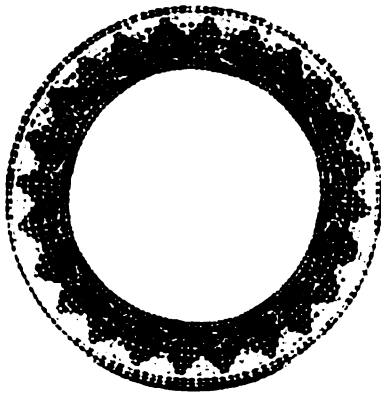
Oh, and a circular object, like a utility hole cover, won't fall into it's own hole!



Equality: A splash of milk, like ripples in a pond, a round flower, expanding tree rings and rings around the planet Saturn spread from the center equally in all directions, surrounding the most within it, balanced near their center.

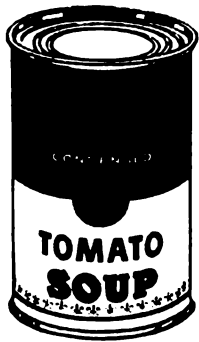


Cycles: Round wheels and gears monotonously repeat the same movement in the same space. The round earth turns in a cycle of night and day seen in the concentric time-lapse trails of stars above the North Pole. The Greek and alchemist's *ouraboros*, a serpent biting it's own tail, like the Aztec version, symbolizes the circle's endless cycles.



Most inside: A round plate will hold more food on it than any other shape having the same distance (circumference) around the outside. Notice how it resembles this stem cross-section of a Horsetail plant, the same as it's been for 300 million years.

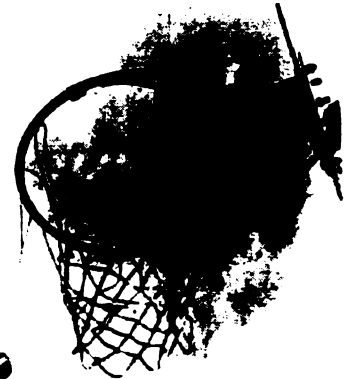
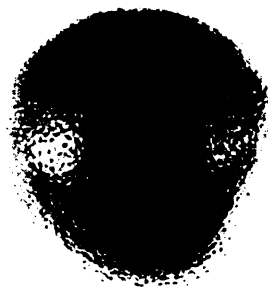
If round, square and triangular pizzas have the same length of crust, the round pizza will always hold more toppings than any other shape!



A circular painting, like the one in this Greek cup seen from above, is called a *tondo*.

Cylinders like cans, cups, buckets and bowls, hold more *inside* them using less material *around* them than squares or other shaped enclosures!

All parts of a bubble are the same distance from their center, expanding until the air pressure inside exactly equals the pressure around it. A round orange provides the most juice surrounded by the least amount of peel.



Many sports are played with circles, cylinders and spheres. How many can you think of? What would they be like using other shapes instead?



What's So Great About Triangles?



All triangles have three corners and three sides.

It's the simplest shape having an inside *and* corners!

The triangle's claim to fame is that it solves four problems:

How to be small but very, very strong.

How to balance when standing still.

How to enclose the smallest inside by using the *most* to surround it,
(making the triangle the opposite of a circle).

How to be whole: everything needs three parts, a beginning, middle and end, to be complete.

How to repeat and cover a surface leaving no gaps or overlaps.

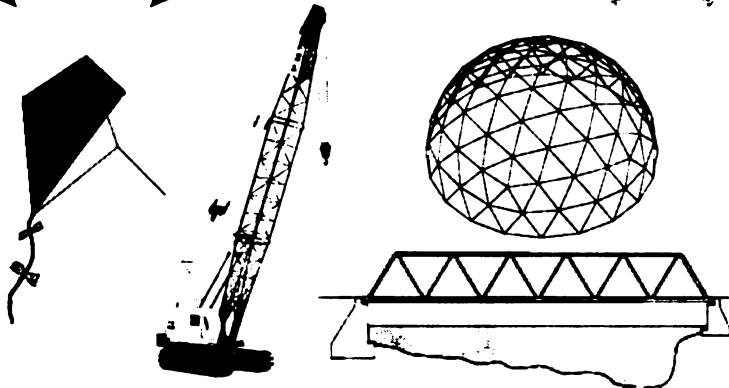
Where does the word "angle" come from?

The "ANG" or "ANK" sound in a word is a clue that it is *bent*, like an angle, ankle and anchor!

A flower, microscopic plant and a fly each enjoy the triangle's strength and balance in different ways.

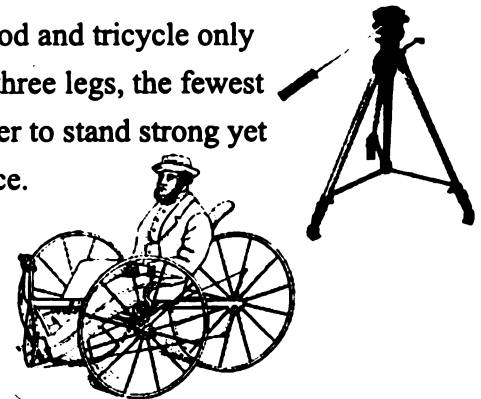


A clothes hanger and scales show how opposites can be made to balance by a neutral third point above.



Kites, cranes, bridges and domes use triangles for great strength with the fewest materials and least weight.

A tripod and tricycle only need three legs, the fewest number to stand strong yet balance.

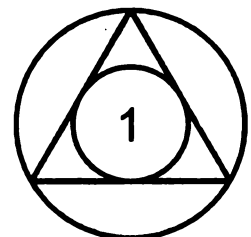


Three is a way that different parts become one complete whole: One strand of hair just dangles, two will untwirl. But three strands weave into *one braid*! When three work together as one, they become complete and very strong.



Cut across a melon and you're likely to find a "triangle" inside a big circle. The circle provides the most space, food and protection for the tight triangle of valuable seeds at its center.

Curious fact: The rim of a circle surrounding a triangle has an area *exactly three times* the area of the circle inside the triangle!



Triangles in Nature



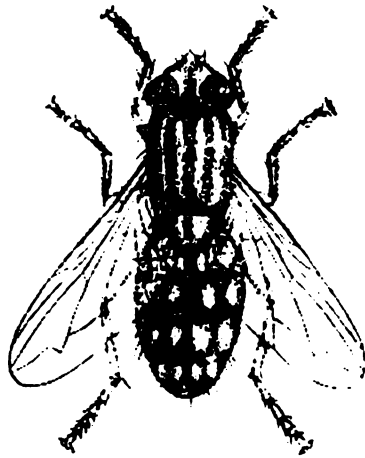
"Nature will reveal itself if we will only look."
-- Thomas A. Edison (1847-1941)

Each of these natural forms is based on the triangle, so place the *triangular* (and also hexagonal) Secret Window over each. Notice where the object aligns with the geometry's points, lines and areas. Try rotating the Window to see what else it reveals.



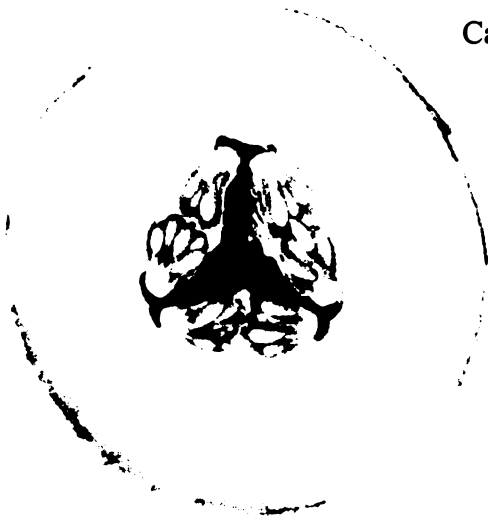
Yellow Trillium
Flower

Flower



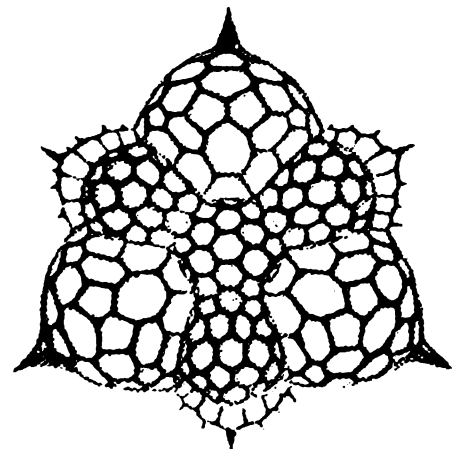
Fly

Honeybee
Face



Cantaloupe
Melon

Microscopic
Radiolarian

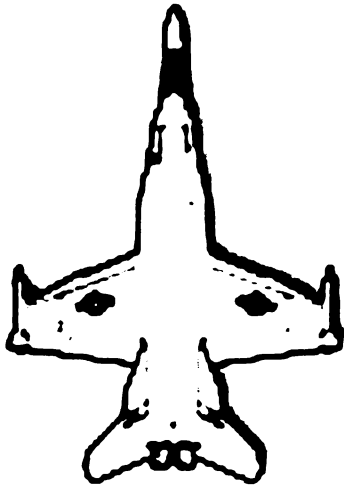


Triangles in Technology

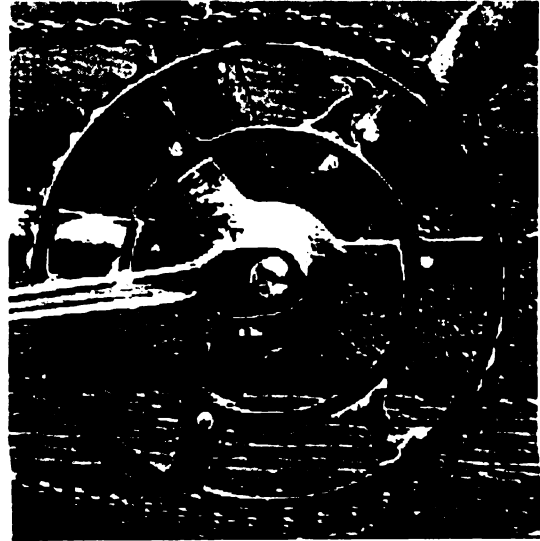


"When I am working on a problem I never think about beauty. I only think about how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong."

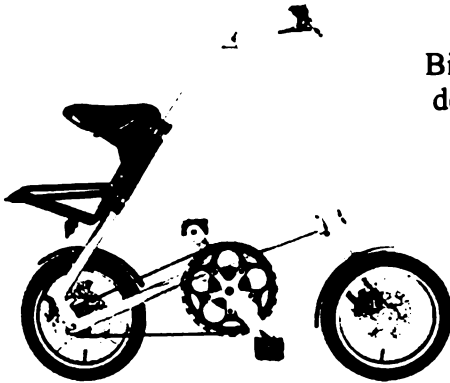
– Buckminster Fuller (1895-1983, Visionary, inventor, writer)



Jet

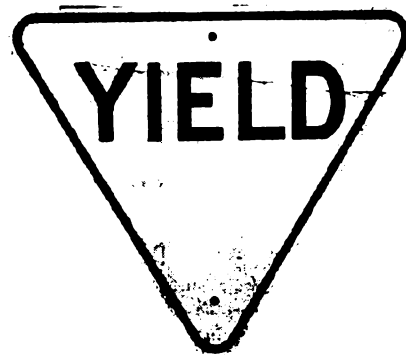


Bicycle Chain Ring

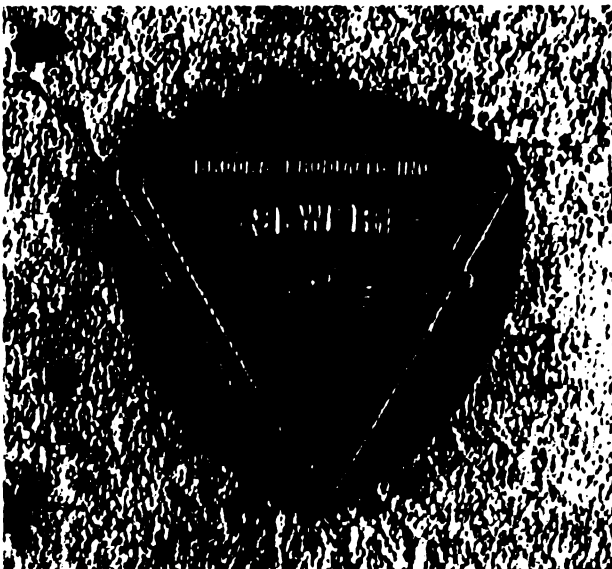


Bicycle design

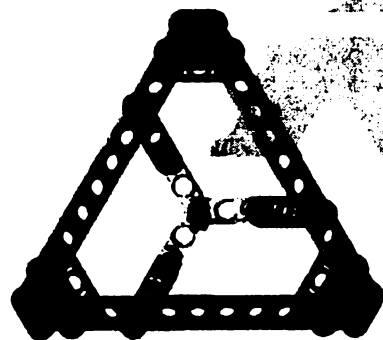
Yield Street Sign



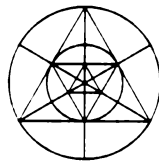
Utility Hole Cover



Triangular Gear Drive System



Triangles in Art



“... Every part is disposed to unite with the whole, that it may thereby escape from its incompleteness.”

– Leonardo da Vinci

Egyptian Pharaoh
Amenemhat III



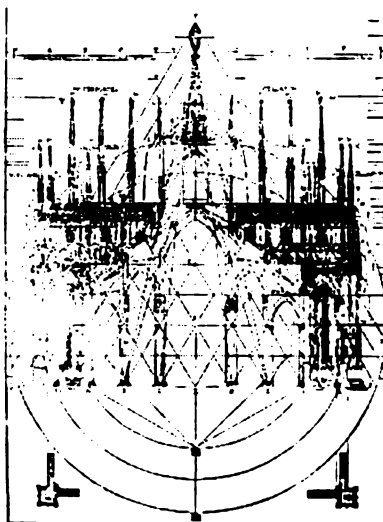
Pueblo
Pottery,
New Mexico



Greek kylix cup tondo c 500 BC

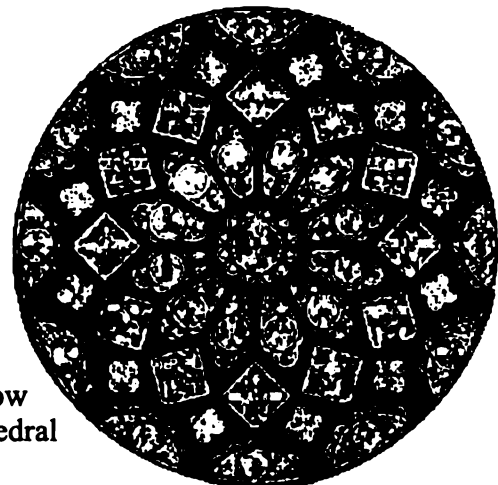


Mayan Ball Game
Goal Ring



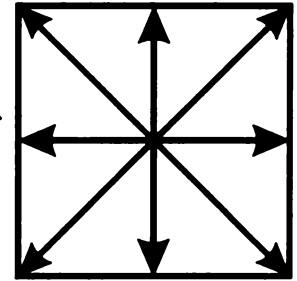
Plan for
Milan Cathedral
by Caesarino

Rose Window
Chartres Cathedral
France



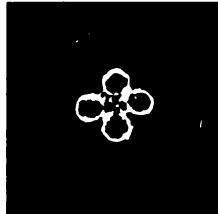
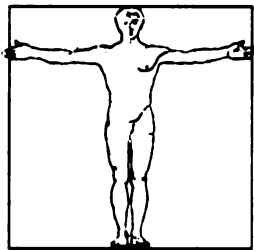
What's So Great About Squares?

Every square has four equal sides and four corners at "right" angles.



A triangle balances opposites, and a square does too. But a square has *two* pairs of opposite sides and *two* pairs of opposite corners, and so specializes in solving this problem:

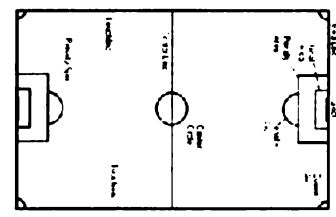
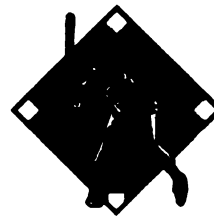
How can opposites, as well as *pairs* of opposites, balance in equality and fairness?



A jellyfish floating freely and the open dogwood flower both balance pairs of opposites by the number four and the square.



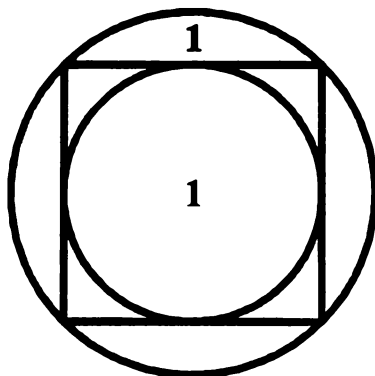
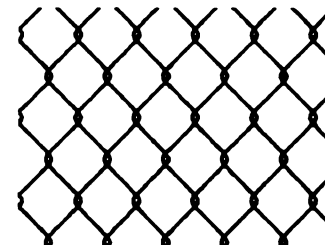
When our height equals our arm span, we fit into a square.



We "square off" against opponents on the squares and rectangles of board games and sports fields.

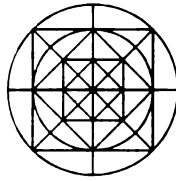
This way, both sides begin with equal opportunities, "fair and square".

A square also provides balance to a circle, dividing it's area into equal halves! The shaded rim has the same area as the white circle it surrounds, an idea used in many plates and elsewhere.



Squares "tessellate" or tile to fill space with no gaps or overlaps, like a checkerboard or chain-link fence.

Squares in Nature



“The universe is full of magical things patiently waiting for our wits to grow sharper.”

---Eden Phillpots

(1862–1960, English author, poet and dramatist)

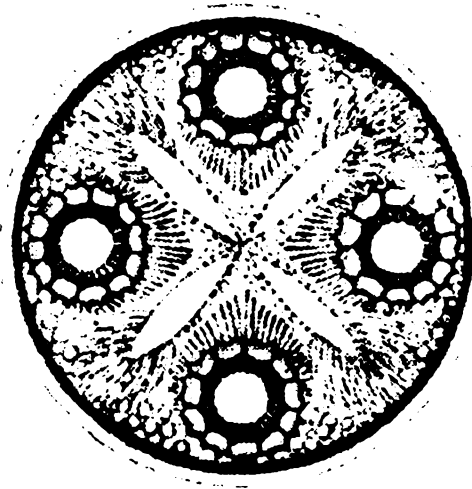
Hemerocallis
Flower



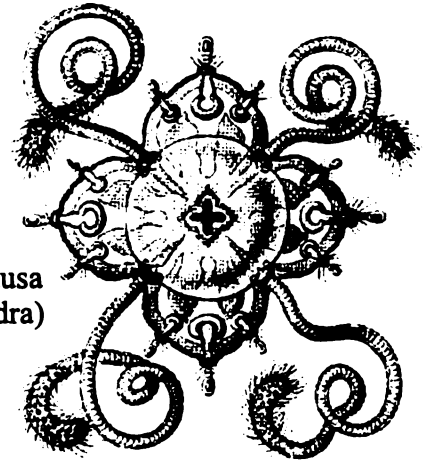
Dogwood
Flower



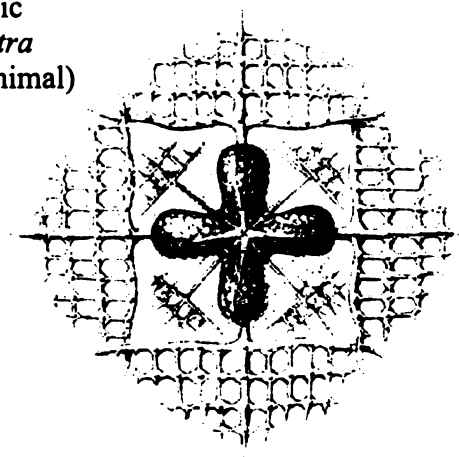
Microscopic
Diatom
(plant)



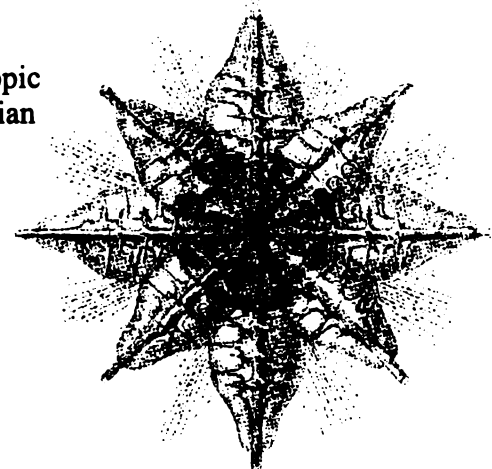
Narcomedusa
(like a Hydra)



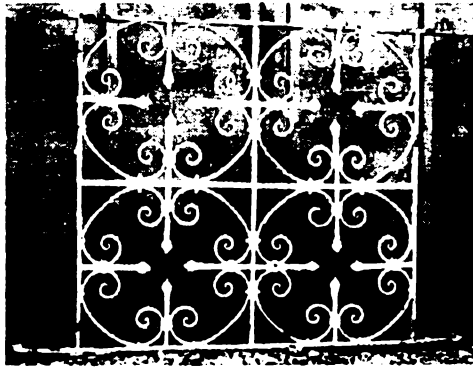
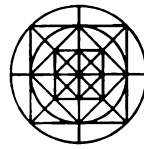
Microscopic
Acanthometra
Radiolarian (animal)



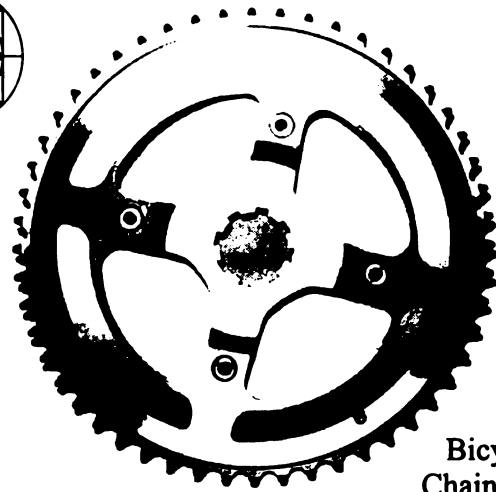
Microscopic
Radiolarian



Squares in Technology

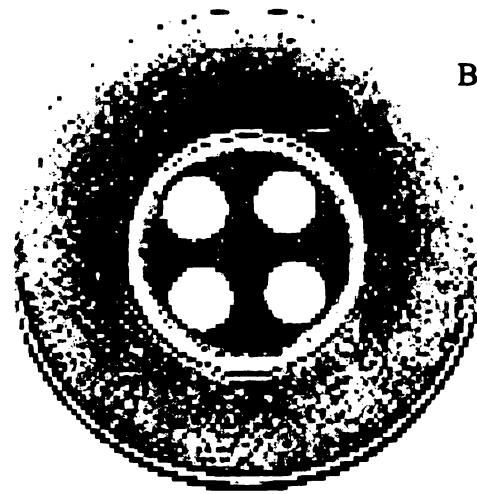
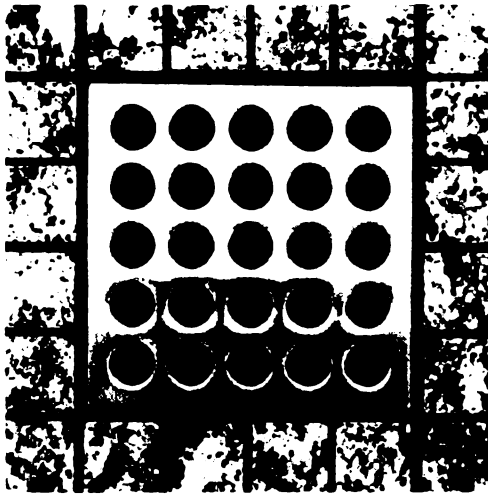


Iron Gate

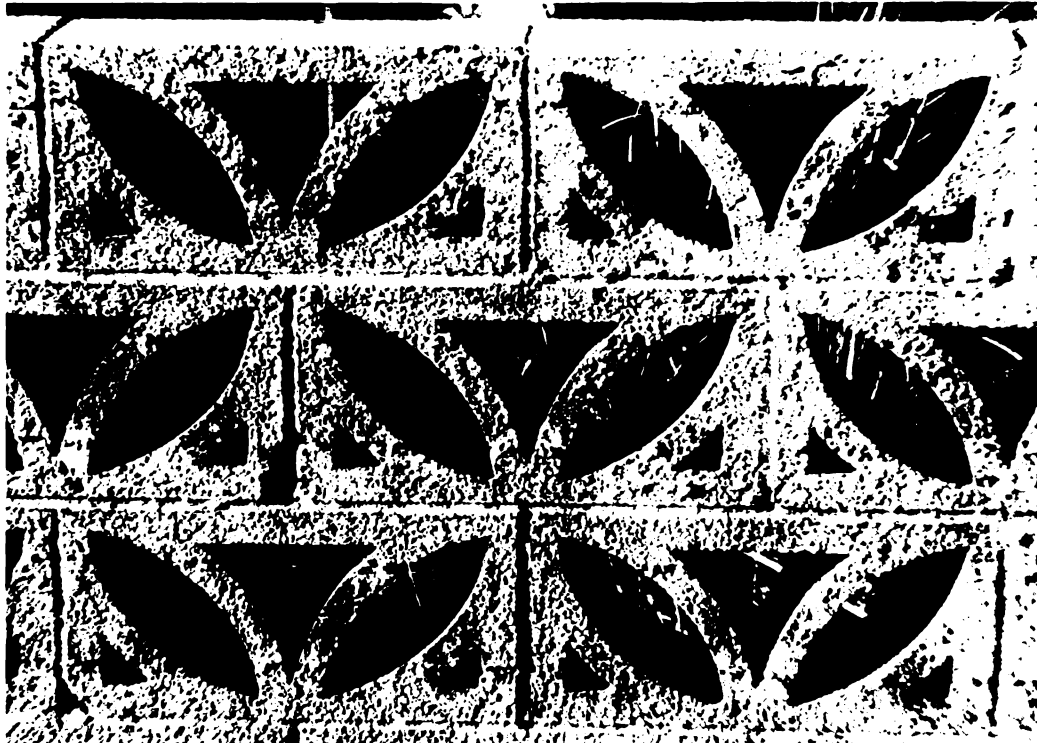


Bicycle
Chain Ring
Gear

Shower Drain

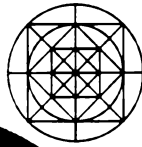


Button

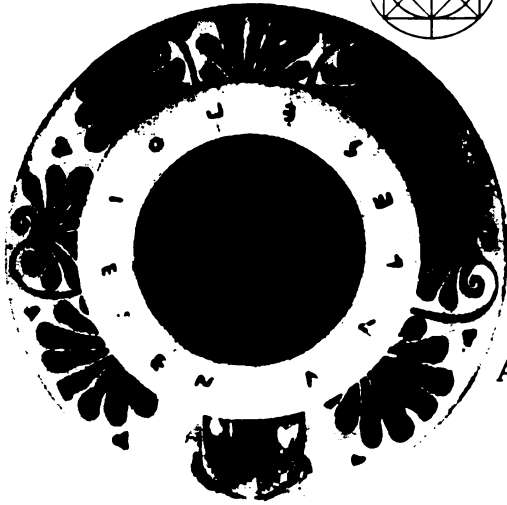
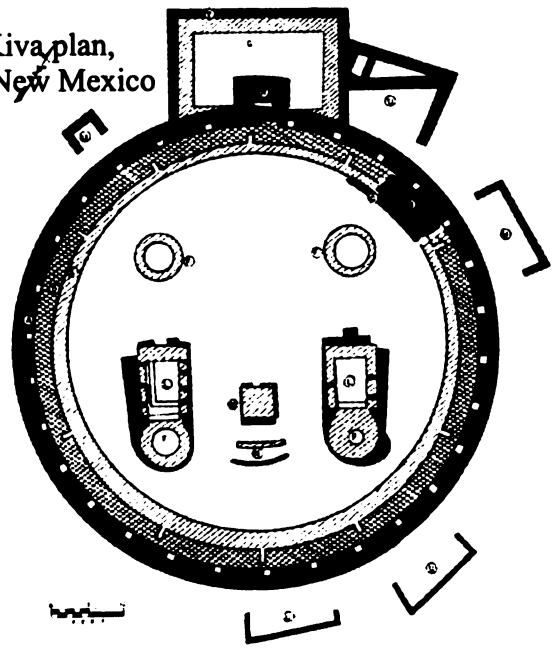


Concrete Block
Wall

Squares in Art



Chetro Kettl Kiva, plan,
Chaco Canyon, New Mexico



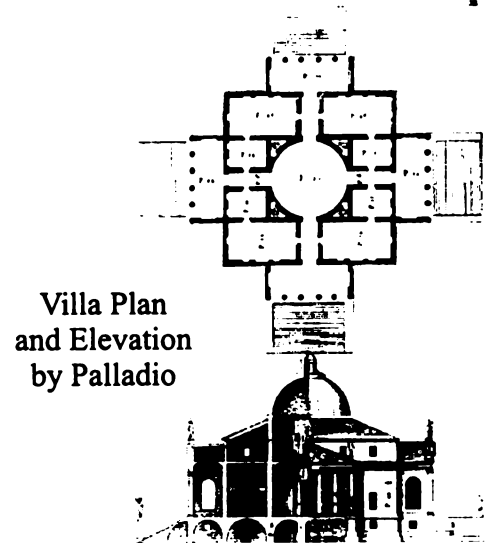
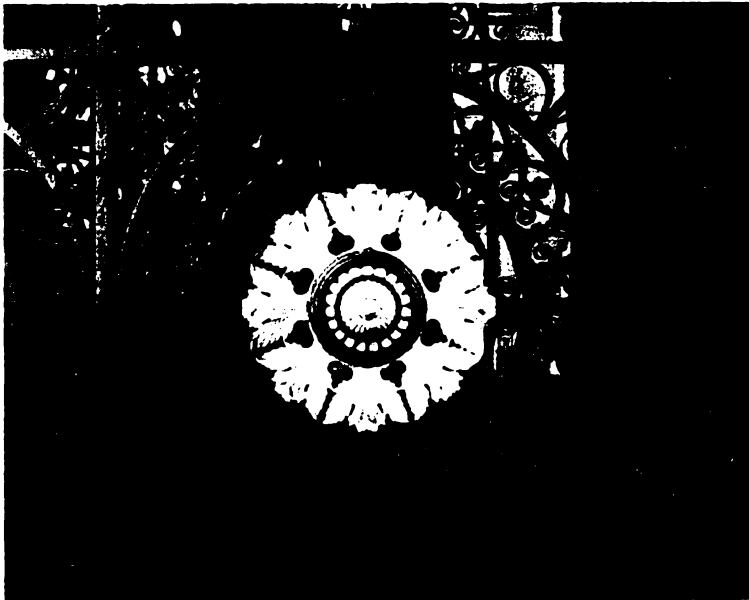
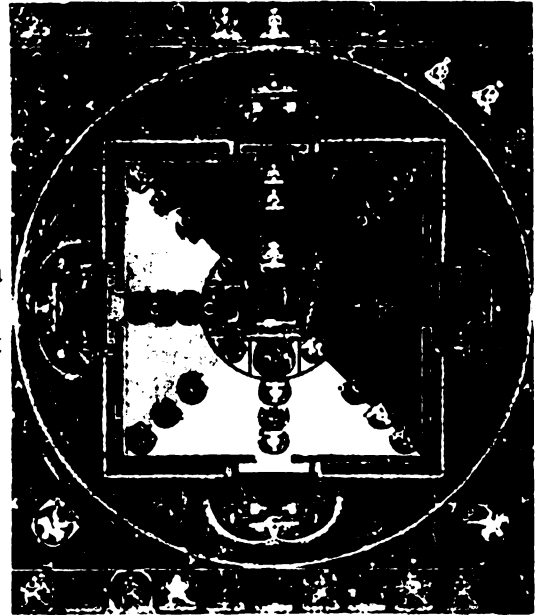
Ancient Greek
Vase
(seen from
above)

Byzantine Dome
(looking up!)
Christ Pancrator



Decorative Gate Grill (detail)
Royal Academy of Arts, London

Mandala of
Bhutadamara
Central Tibet
14th century



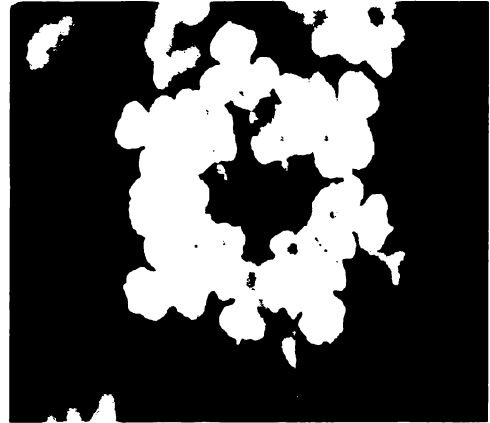
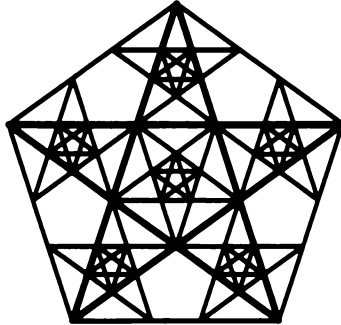
Villa Plan
and Elevation
by Palladio

What's So Great About Pentagons?

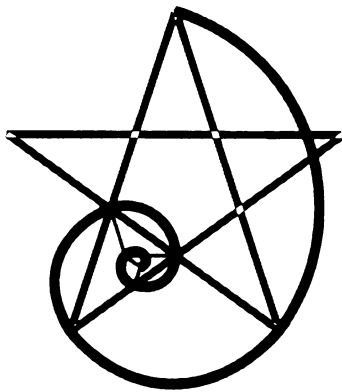
A pentagon has five corners and five sides. When they're all equal, it's called a "regular" pentagon. A regular pentagon solves two problems:

How to balance by repeating (regenerating) the same shape in different sizes so they all fit together.

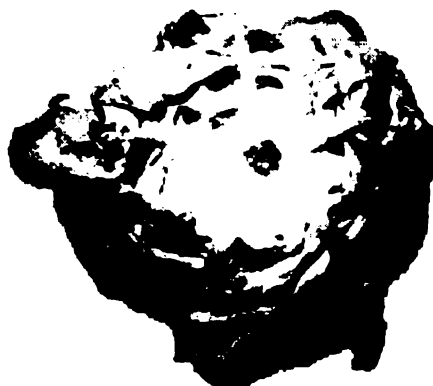
How to balance while moving or growing as a spiral.



Starfishes and plants regenerate. A starfish can regrow lost arms, and plants with five-petaled flowers have the same shape blooming in many sizes at once, yet they all fit together and the plant balances



When we see five, there may be a spiral unfolding nearby!



The bottoms of a pinecone and lettuce reveal their "leaves" to be parts of an ongoing, spiraling five-pointed star.



Connect the "eyes" on a potato and you'll see its spiraling star!

Pentagons in Nature



"The good, of course, is always beautiful, and the beautiful never lacks proportion."

- Plato

Hibiscus Flower

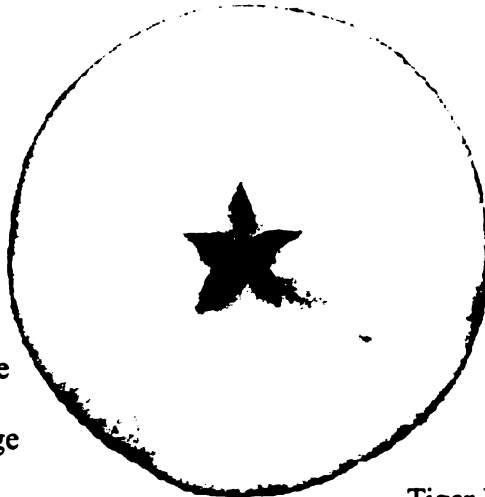


Daisy ("Day's Eye")



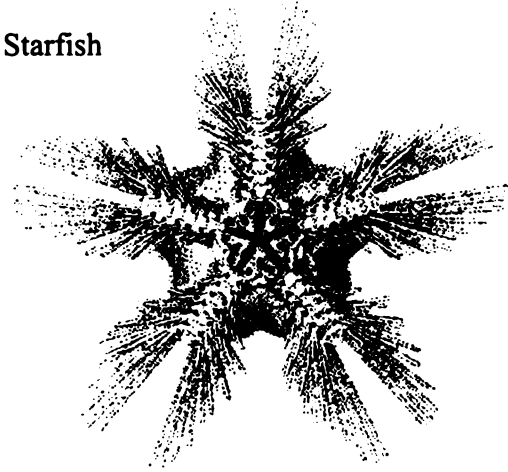
"Anyone can count the seeds in an apple, but no one can count the apples in a seed."

- Anonymous



Apple Slice showing seed package

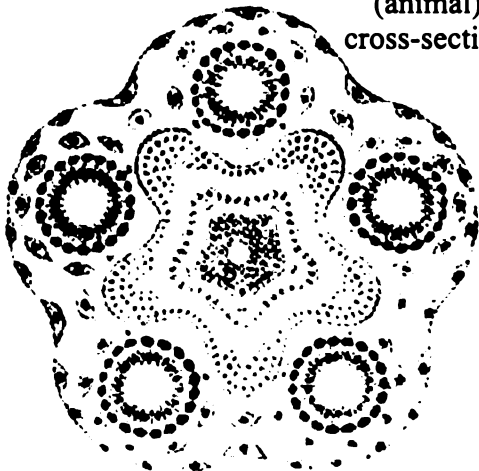
Starfish



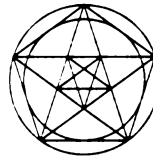
Tiger Face



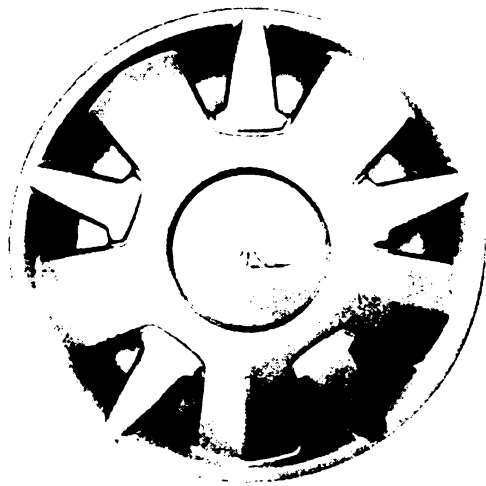
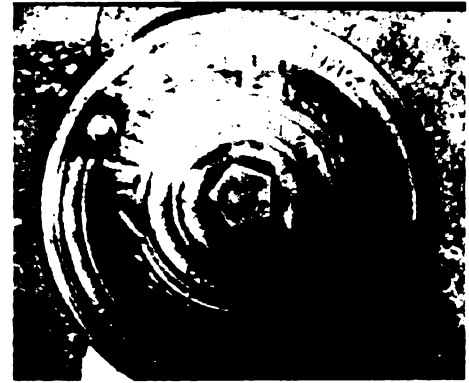
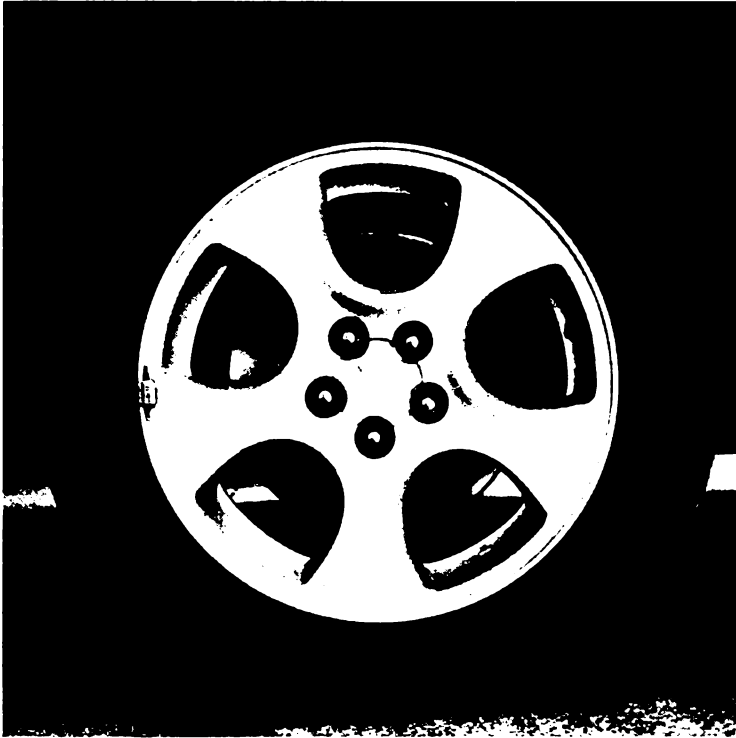
Sea-Cucumber (animal) cross-section



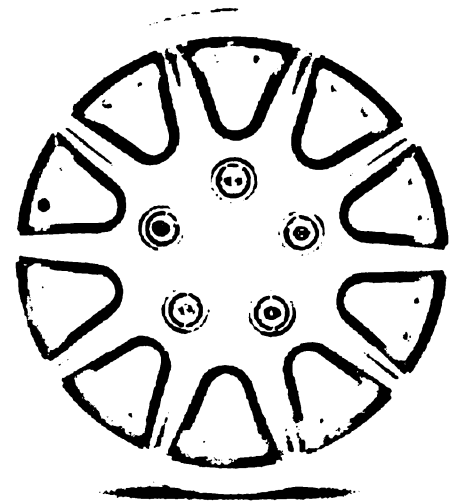
Pentagons in Technology



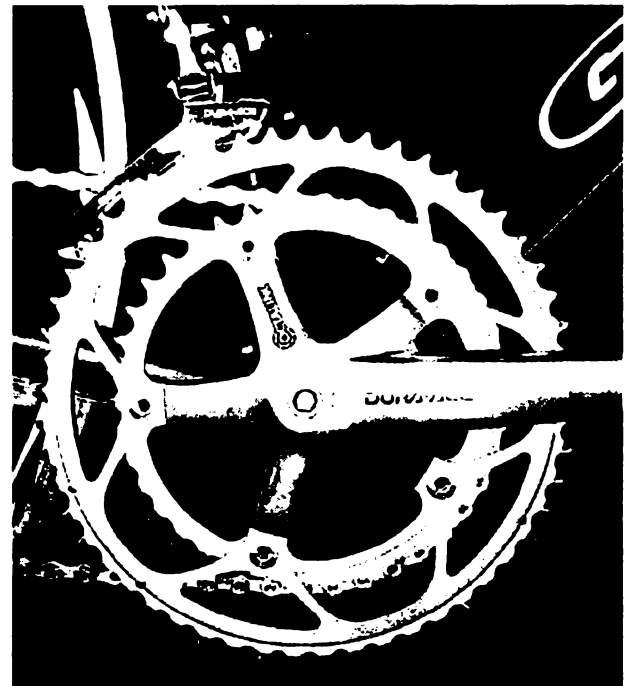
Fire Hydrant
from above



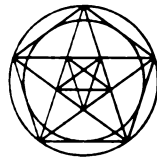
Automobile
Tire Rims



Bicycle
Chain Ring
Gears



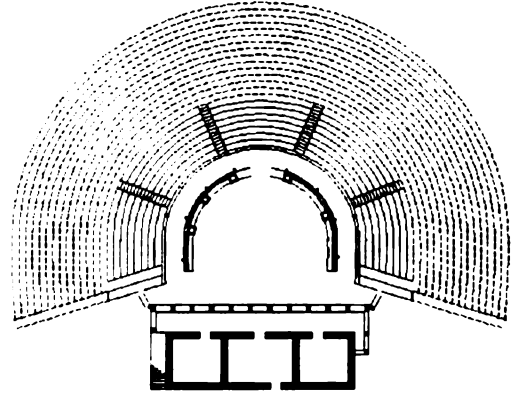
Pentagons in Art



"This symmetry cannot be used unconsciously although many of its shapes are approximated by designers of great native ability whose sense of form is highly developed."

– Jay Hambidge (1867-1924, American artist, teacher, writer)

Ancient Greek Water Canteen

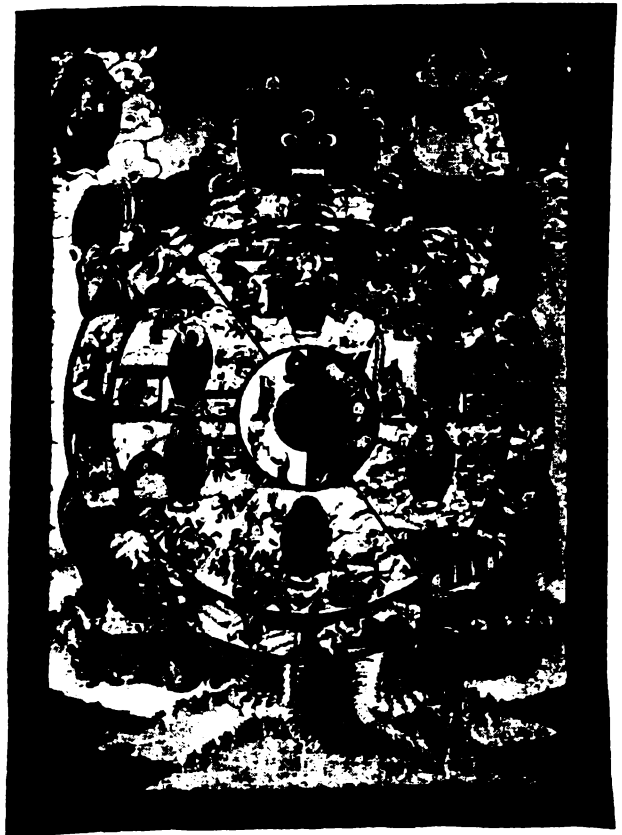


Ancient Greek Amphitheater Plan

Maize King
Mayan Plate
200-400 AD



"Alba Madonna"
by Raphael



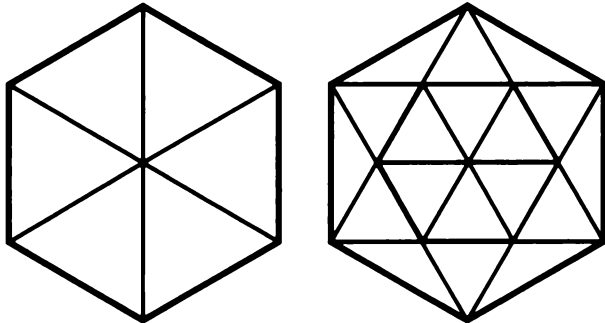
"The Wheel Of Life"
Tibetan Thangka Painting

What's So Great About Hexagons?

Every hexagon has six corners and six sides. When they're all equal, it's called a "regular" hexagon. The star inside is called a "hexagram."

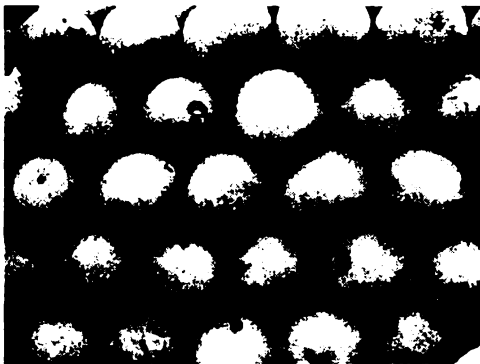
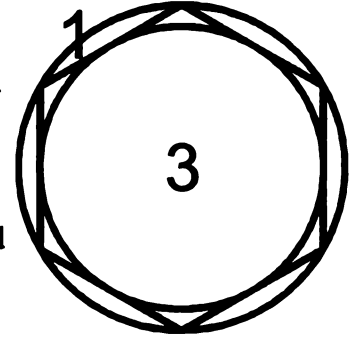
A hexagon solves four problems:

- How to be strong.
- How to balance while standing still.
- How to approximate a circle's benefits by using straight lines.
- How to pack the most into the smallest space.

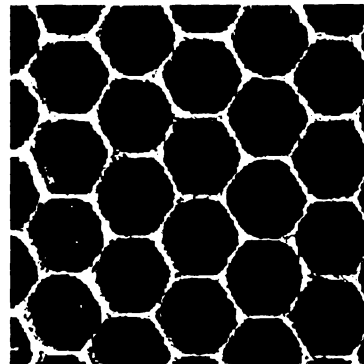


Hexagons are strong because they're supported by triangles.

The area of a circle inscribed inside a regular hexagon is exactly 3 times the area of the rim made by the circle around the hexagon.



Arranging circles or spheres as six-around-one packs the most into a compact space, stable and self-supporting.



The wax cells of a beehive are hexagons arranged six-around-one, packing the most into the least space. Three-corner joints make it strong to hold lots of heavy honey.



Look closely at six-petaled flowers and you'll see that they're actually two types of petals.

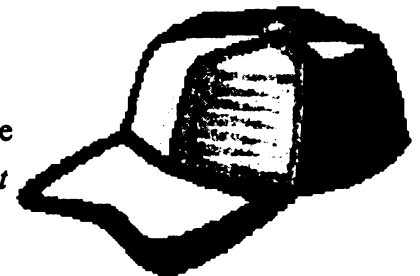


Snowflakes range from flat hexagon plates to hexagram needles and everything between. Their shape tells you about the

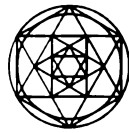


air's pressure, temperature and humidity. Colder weather makes needles, less cold makes flakes.

A baseball cap is a circle made of six *straight-cut* triangles.



Hexagons in Nature



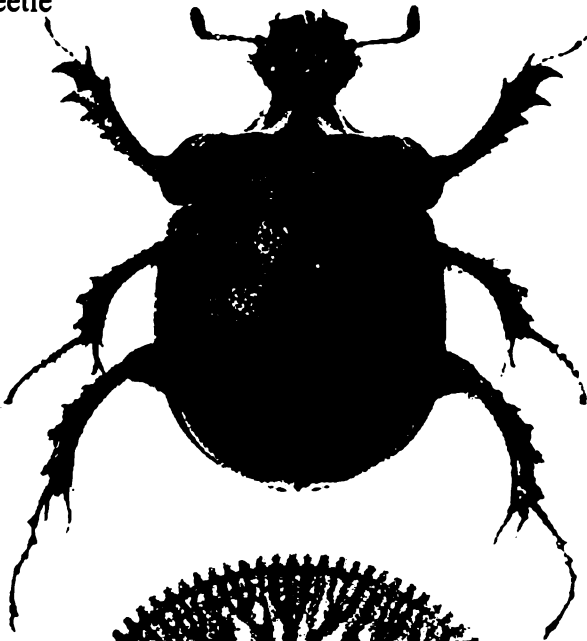
"One cannot understand... the universality of laws of nature, the relationship of things, without an understanding of mathematics. There is no other way to do it."

Richard P. Feynman (1918-1988, American physicist, teacher, writer)

Pomegranate Flower



Scarab Beetle



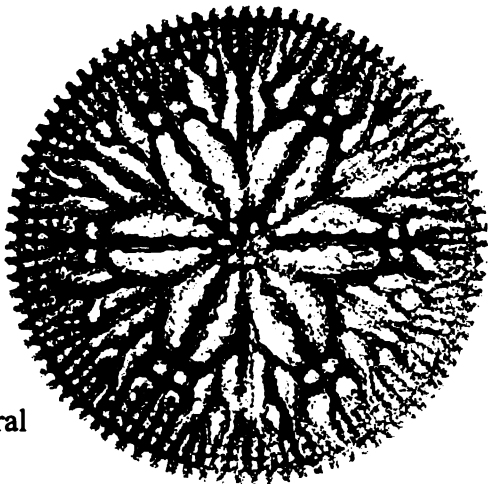
Monarch Butterfly



Snowflake



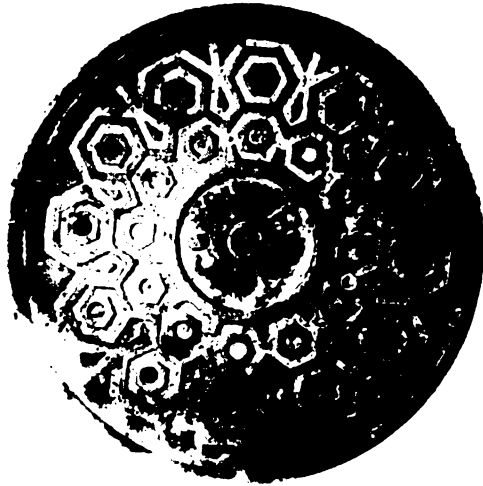
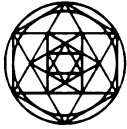
Star Coral



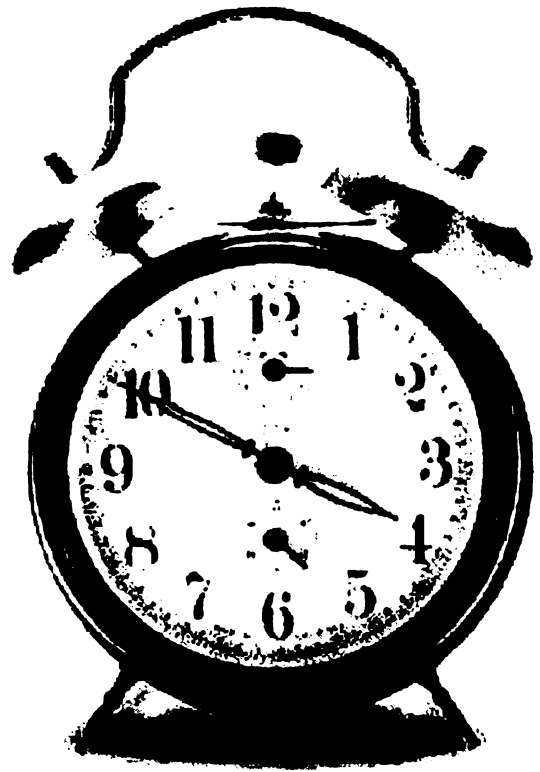
Hexagons in Technology

“Time alters fashions and frequently obliterates the works of art and ingenuity, but that which is founded on Geometry & real Science, will remain unalterable.”

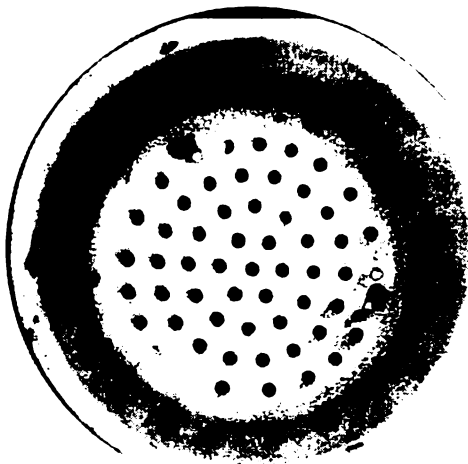
– Thomas Sheraton (The Cabinet-Maker and Upholsterer’s Drawing Book, London, 1791)



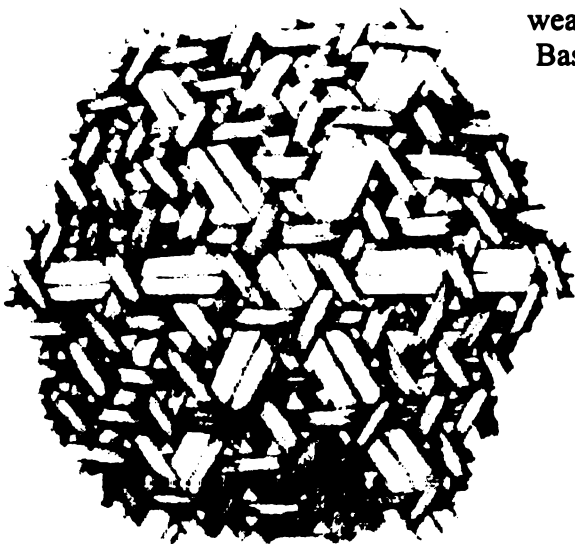
Manhole Cover



Classic Alarm Clock



Collander Strainer

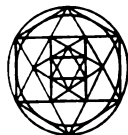


Starting to weave a Basket



CD/DVD

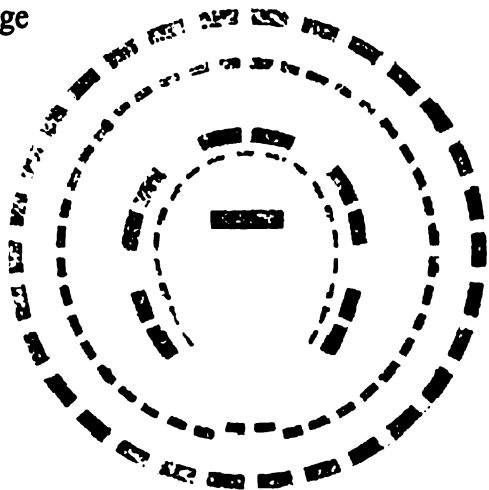
Hexagons in Art



“Geometry is to the plastic arts
what grammar is to the art of the writer.”

– Guillaume Apollinaire
(1880-1918, French poet, writer, art critic)

Stonehenge
Plan

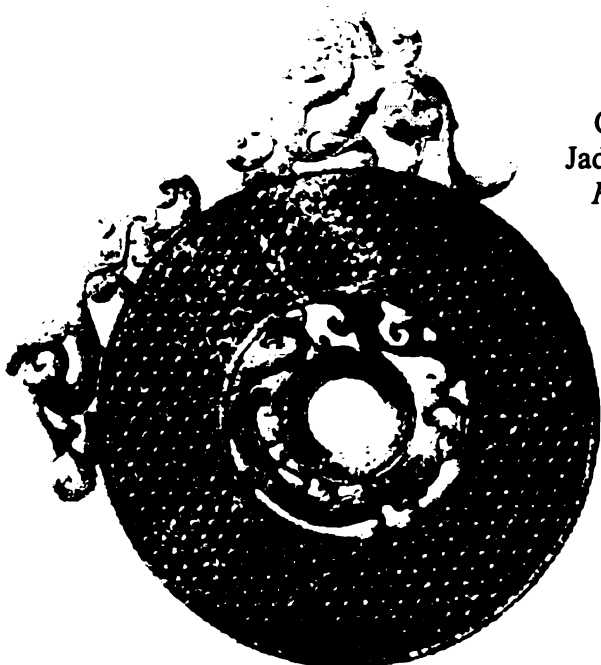


Tondo Painting
in a
Greek *Kylix*

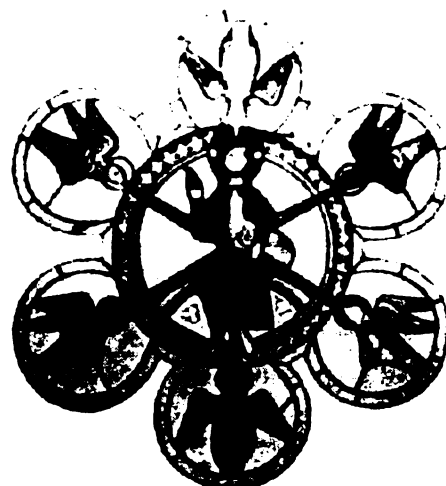
Classic Chinese Architecture



Buddha
Statue
Face



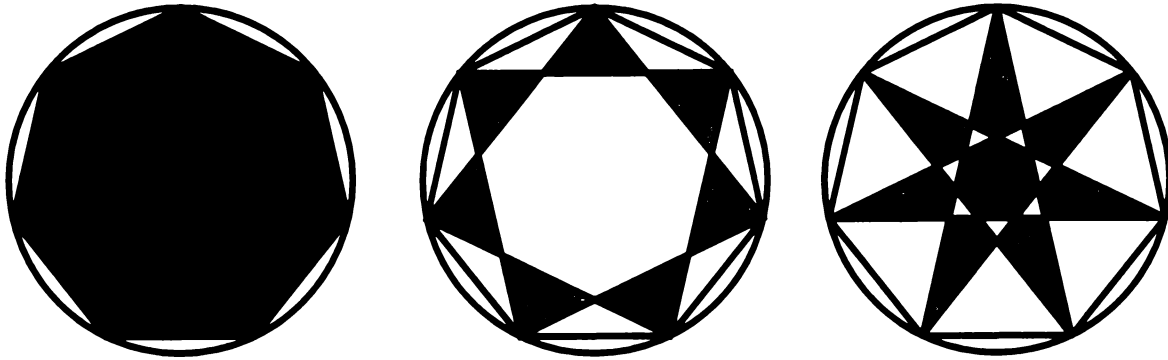
Chinese
Jade Dragon
P'i Disk



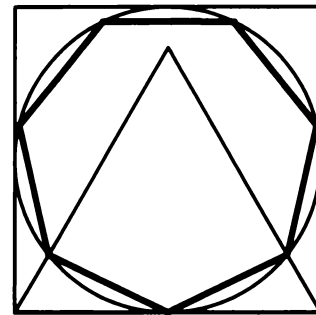
Stained Glass
Window
“Seven Gifts of
the Holy Spirit”

What's So Great About Heptagons?

A seven-sided shape is called a heptagon. When its sides and angles are equal, it's a "regular" heptagon. The heptagon contains two heptagram stars.



A regular heptagon isn't possible to construct with the traditional tools of compass and straightedge. But close approximations can be constructed with a compass by combining the circle, triangle and square.



Seven is the place where the numbers one-through-ten find balance:

When seven is there, the numbers below (and including it), and the numbers beyond (and including it), multiply to produce the same result:

$$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 = 7 \times 8 \times 9 \times 10 = 5040$$

Yet, when it's gone, the numbers on each side multiply to produce another equality:

$$1 \times 2 \times 3 \times 4 \times 5 \times 6 = 8 \times 9 \times 10 = 720$$

It doesn't matter whether seven appears or not.

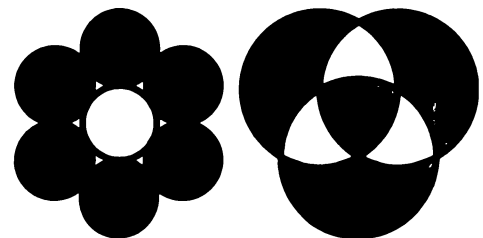
Is seven really there?

For these reasons, heptagons and heptagrams rarely appear in nature, and play unusual roles in technology.

In art, they're often associated with mysteries.

"A 7-sided figure is impossible to draw
With perfect mathematical precision;
And if you try to do it you are absolutely sure
To find your efforts treated with derision.
And yet there are philosophers who readily declare
That nothing in this world is really true,
And so I've drawn a heptagon by triangle and square
For any human purpose it will do."

– John Michell



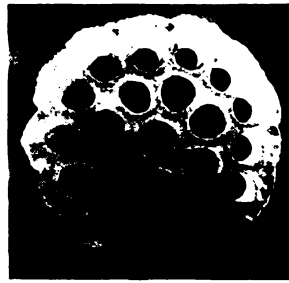
Sevens often arise by combining three (or twice three) objects.

Sevens in Nature

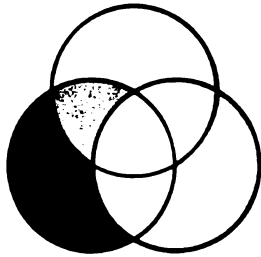
Heptagons rarely appear in nature, but sevens do.

Sevens solve this problem:

How to combine three basic elements to produce a spectrum of seven possibilities.



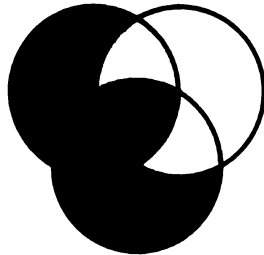
The lotus seed pod is a rare example of a natural seven-fold structure.



Light

Direct Light

ADDS to white

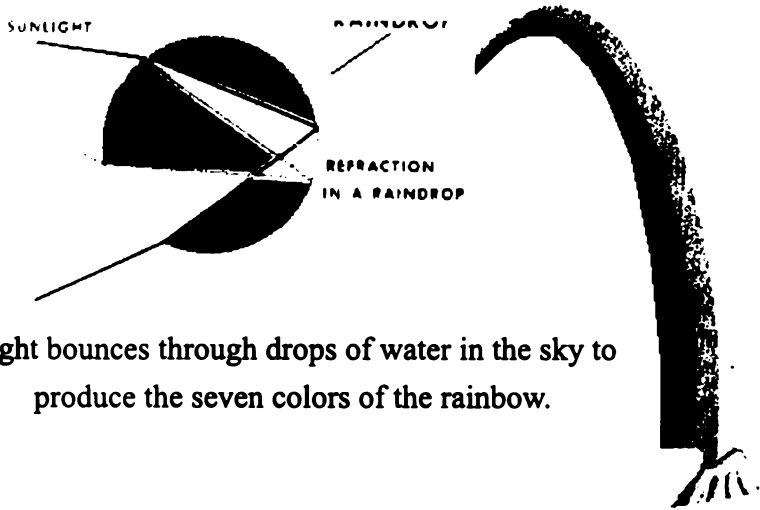


Pigment

Reflected Light

SUBTRACTS to black

Combinations of the three primary colors of light, and three primary pigments (like paint and ink), produce seven colors. Light colors add to make white, while mixing pigments subtracts into



Light bounces through drops of water in the sky to produce the seven colors of the rainbow.

PITAGORAS



Combinations of the three primary tones produce the seven notes of the heptatonic musical scale.

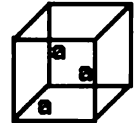


Combinations of the three dimensions of space produce the seven types of crystal systems.

Cubic

$$a = b = c$$

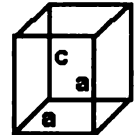
$$\alpha = \beta = \gamma = 90^\circ$$



Tetragonal

$$a = b \neq c$$

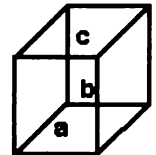
$$\alpha = \beta = \gamma = 90^\circ$$



Orthorhombic

$$a \neq b \neq c$$

$$\alpha = \beta = \gamma = 90^\circ$$



Rhombohedral

$$a = b = c$$

$$\alpha = \beta = \gamma \neq 90^\circ$$

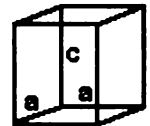


Hexagonal

$$a = b \neq c$$

$$\alpha = \beta = 90^\circ$$

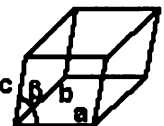
$$\gamma = 120^\circ$$



Monoclinic

$$a \neq b \neq c$$

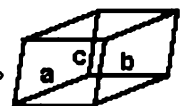
$$\alpha = \gamma = 90^\circ \neq \beta$$



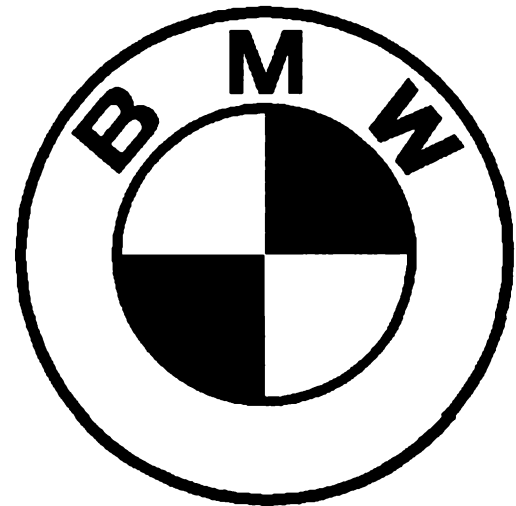
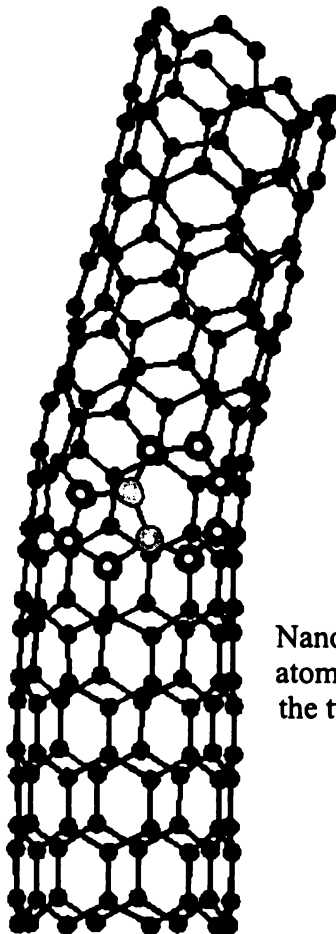
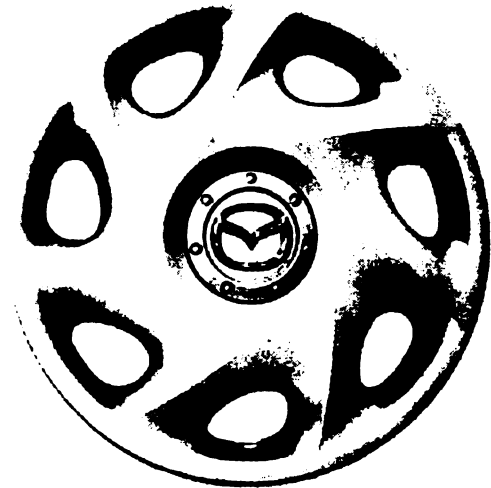
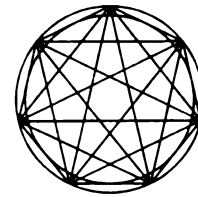
Triclinic

$$a \neq b \neq c$$

$$\alpha \neq \beta \neq \gamma \neq 90^\circ$$

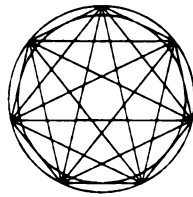


Heptagons in Technology



Nanotubes are tiny tubes made of carbon atoms arranged as hexagons. But to bend the tube some atoms must be grouped as pentagons and heptagons.

Heptagons in Art



"Regulating lines ... are ... a springboard and not a straightjacket. They satisfy the artist's sense ... and confer on the work a quality of rhythm."

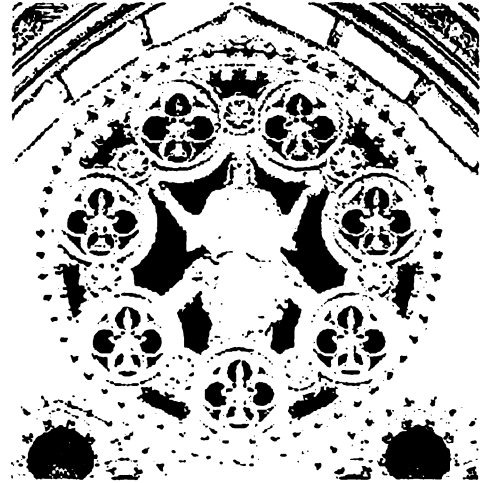
- Le Corbusier (1887-1969, Swiss-French architect, designer, urbanist, writer, painter)



Hopi Bowl

Christ With Seven Lamps

Cathedral of St. John The Divine, NYC



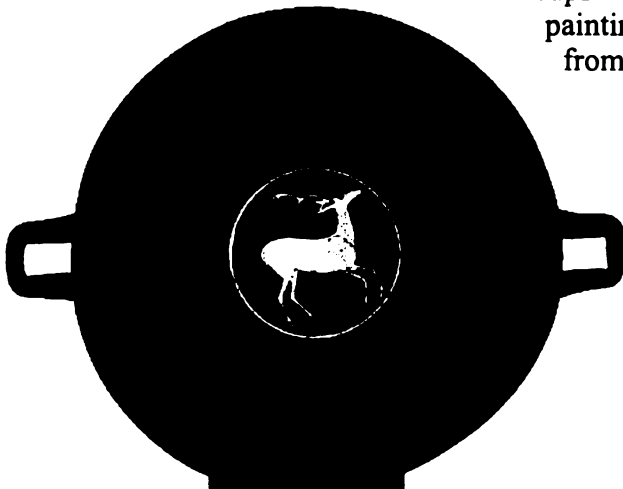
California Sheriff's Badge



Greek Sphinx tondo at the bottom of a kylix cup



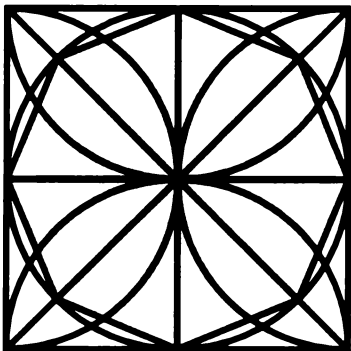
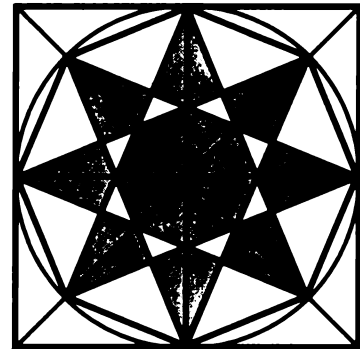
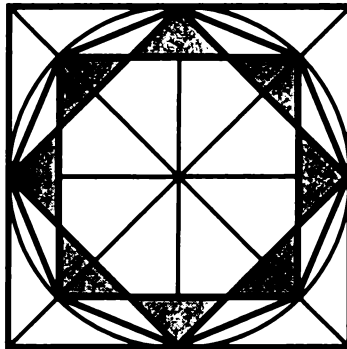
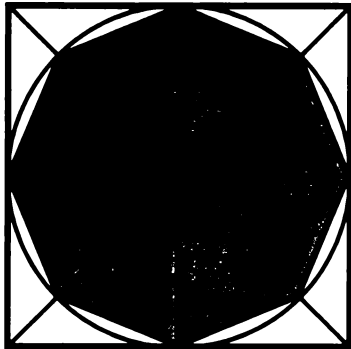
Greek kylix cups with tondo paintings seen from above



What's So Great About Octagons?

An eight-sided figure is called an octagon. When its sides and angles are equal it's a "regular octagon."

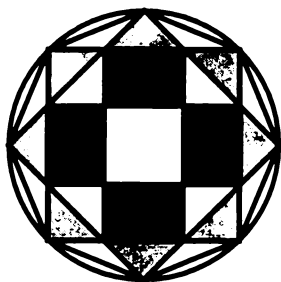
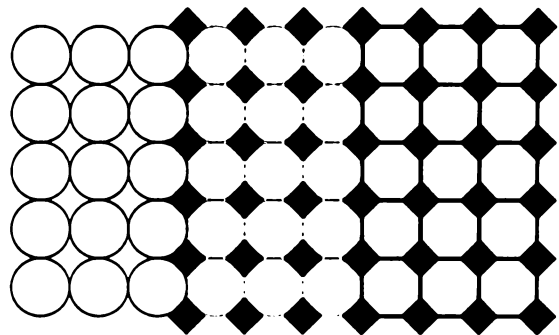
An octagon contains two octagram stars.



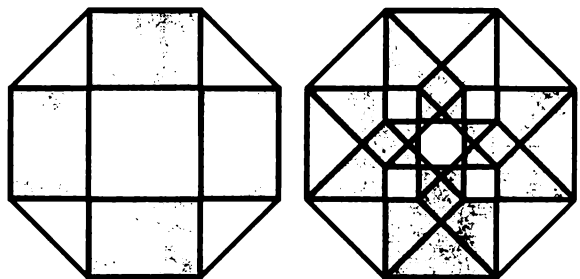
Because the octagon emerges along with the geometric construction of the square, they share similar mathematical and other properties.

Squares and octagons solve similar problems involving balancing (pairs of) pairs of opposites.

Octagons and squares combine to solve the problem of covering a surface. Circles arranged in square formation leave gaps between them. But octagons *plus* squares together "tessellate" and tile leaving no gaps or overlaps.

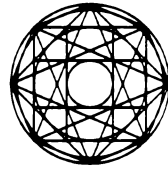


The points at the eight corners of an octagon provide opportunities for many harmonious connections among them.



Because a regular octagon is like a square that's been quarter-turned as a circle, thus partaking of both, it symbolizes their intersection, the space between the "heavenly" circle and "earthly" Octagonal compositions of art and domed architecture are symbolic acknowledgments of being situated at the crossroads between the heavenly and earthly realms, and observed by both.

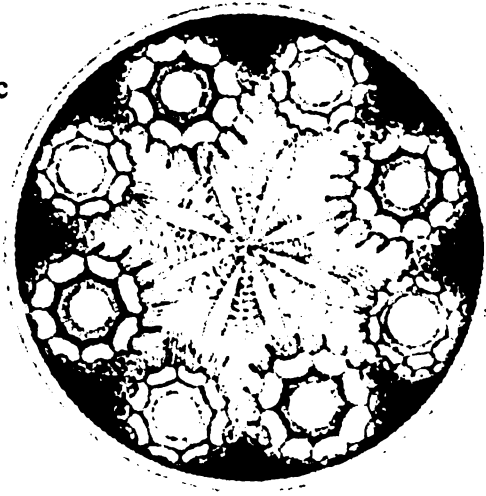
Octagons in Nature



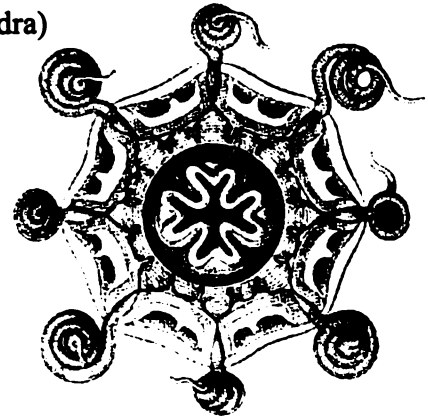
“The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful.”

– Henri Poincaré (1854-1912, French mathematician, physicist, philosopher of science)

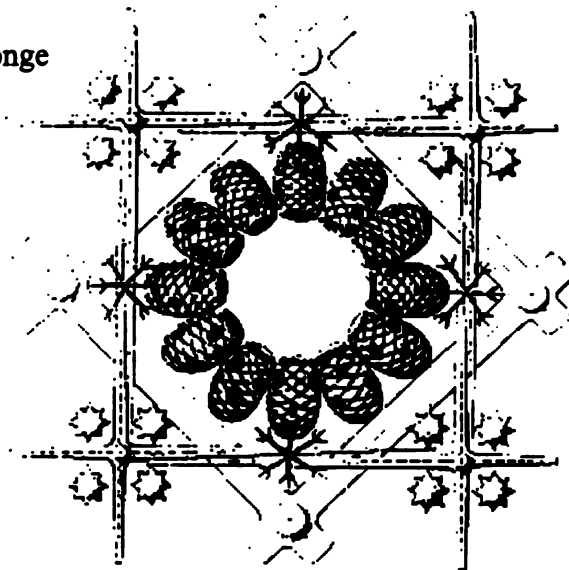
Microscopic Diatom (plant)



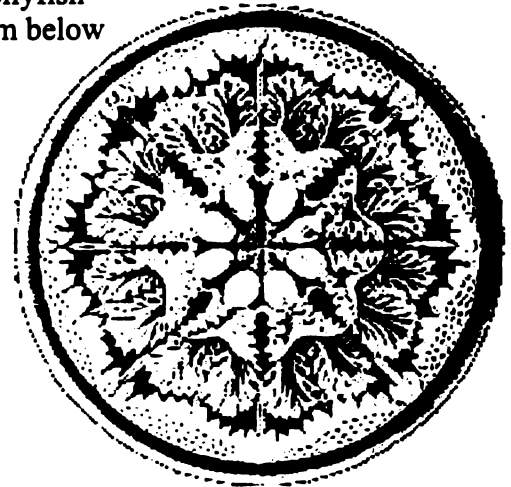
Narcomedusa (like a Hydra)



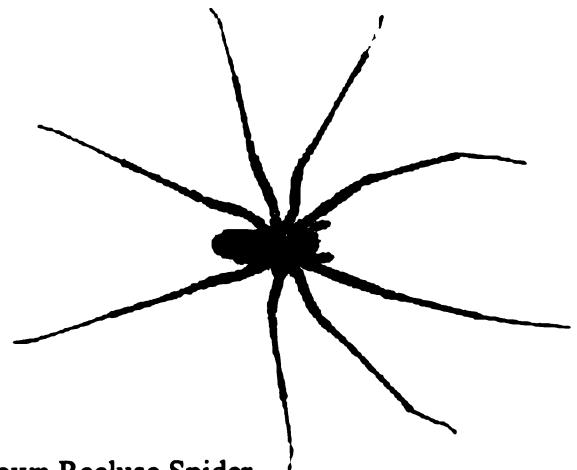
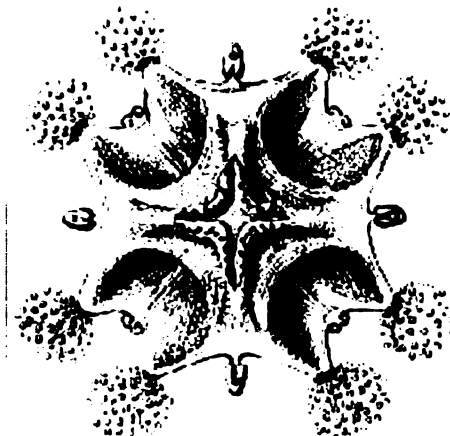
Glass Sponge



Jellyfish from below

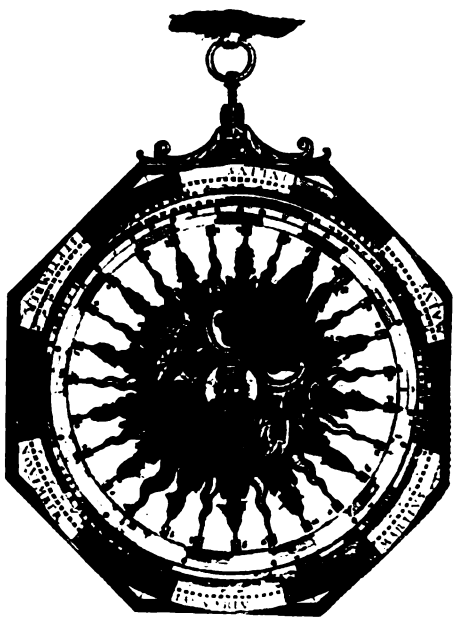
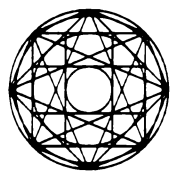


Stalked Jellyfish

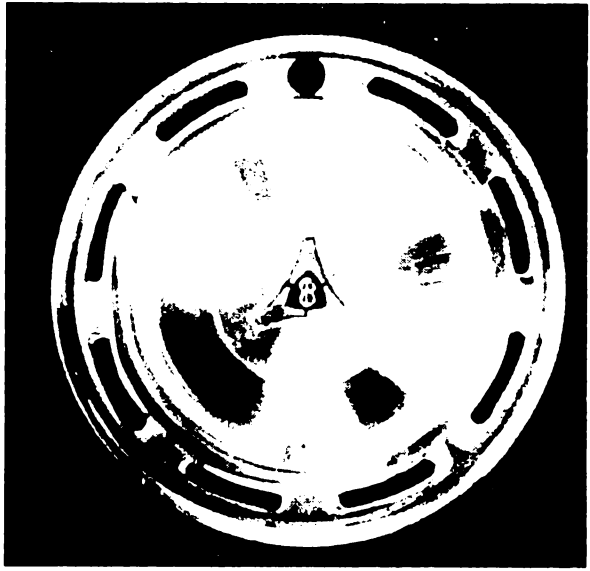
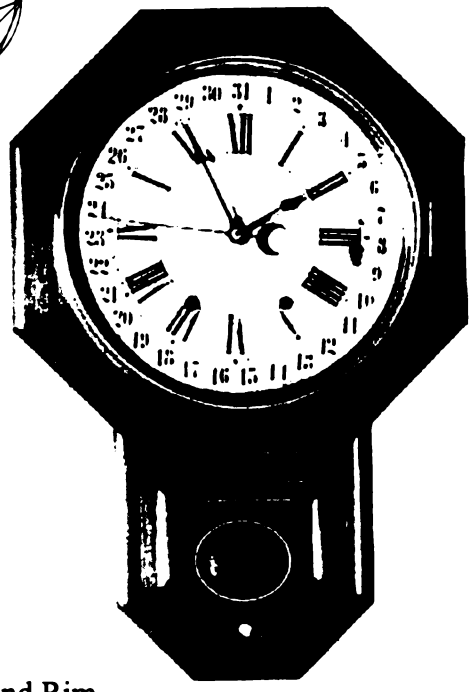


Brown Recluse Spider

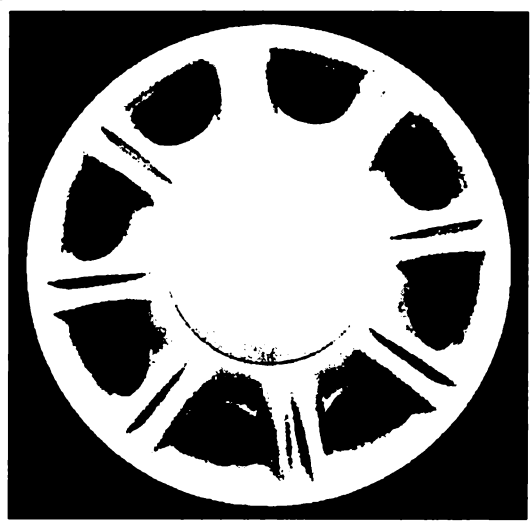
Octagons in Technology



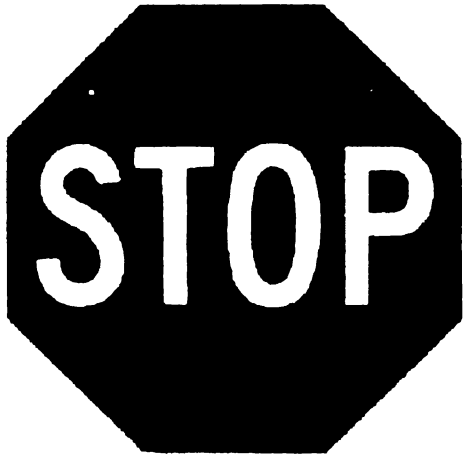
Timepieces



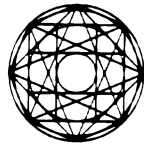
Tire Hubcap and Rim



Street Signs



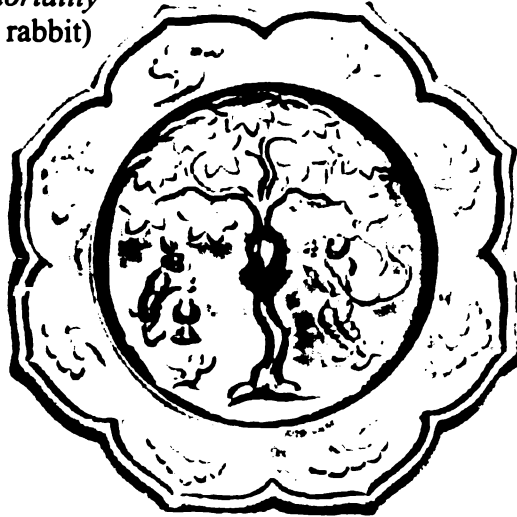
Octagons in Art



"Knowledge of a basic law gives a feeling of sureness which enables the artist to put into realization dreams which otherwise would have been dissipated in uncertainty."

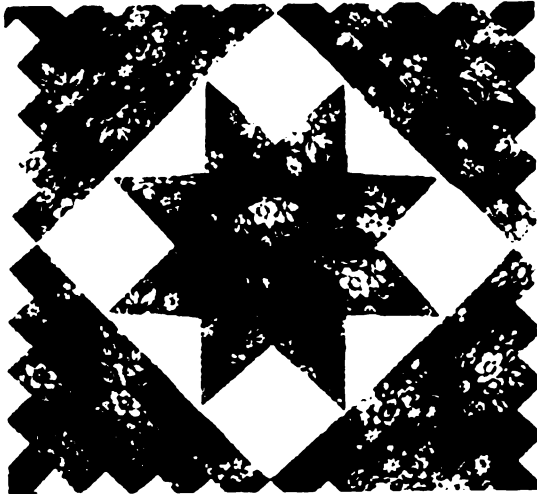
– Jay Hambidge

Chinese Plate
Tree of Immortality
(with lunar rabbit)



Persian Tile
13th Century

Quilt Design Module



Plan of
Castel del Monte
Southeast Italy

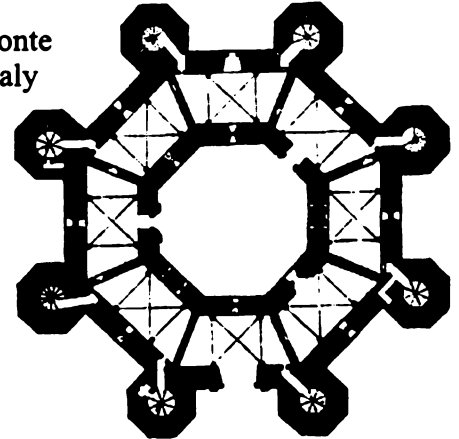
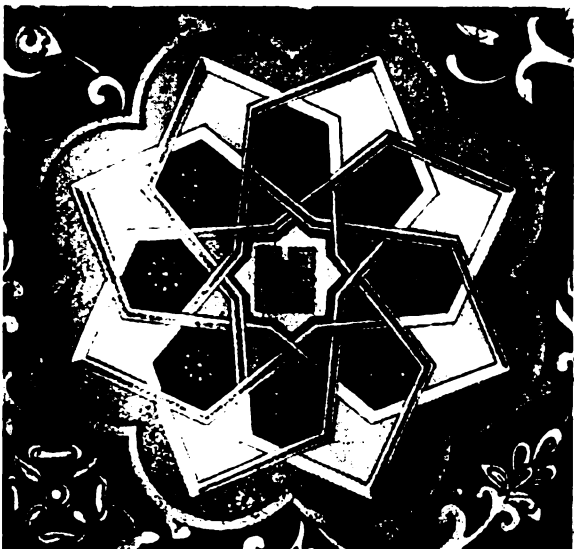
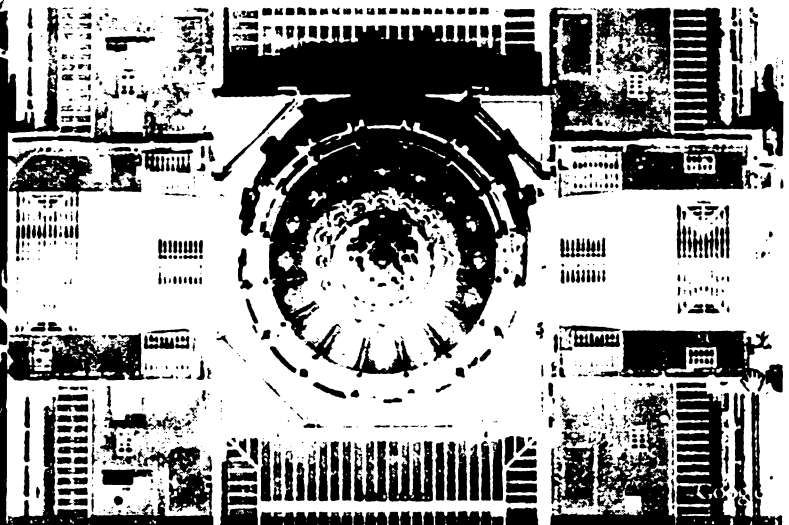


Fig. 404. Plan of Castel del Monte.

Islamic Tile Pattern



San Francisco City Hall dome seen from above



Test Your Geometric Vision

"The real voyage of discovery
consists not in seeking new lands
but seeing with new eyes."

Be A Shape Detective!

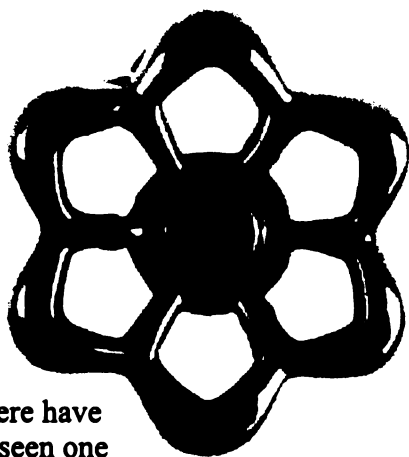
– Marcel Proust
(1871-1922, French novelist)

Now that you've practiced using each of the Secret Windows on different objects of similarly-shaped forms, you may be ready to test your geometric eyes on objects and creatures grouped randomly. Remember to begin by looking for number and shape clues.

More than one Secret Window may reveal something to you about them.

Which Secret Windows reveal the geometry of these natural and human forms?

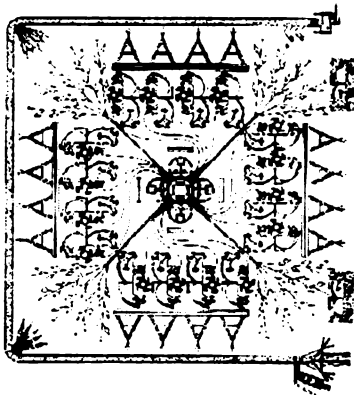
("Answers" on page 46)



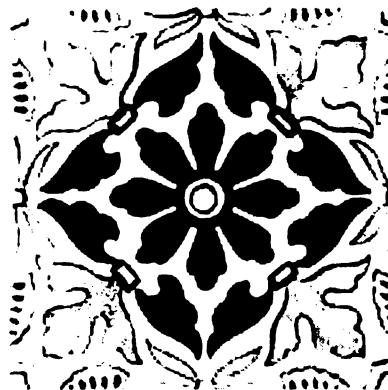
Where have
you seen one
of these?



Ivy Leaf

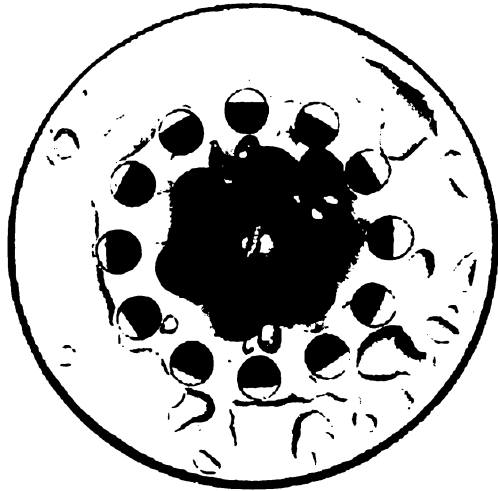


Navajo Sand Painting "Buffalo People"



Wall Tile

Shower Drain



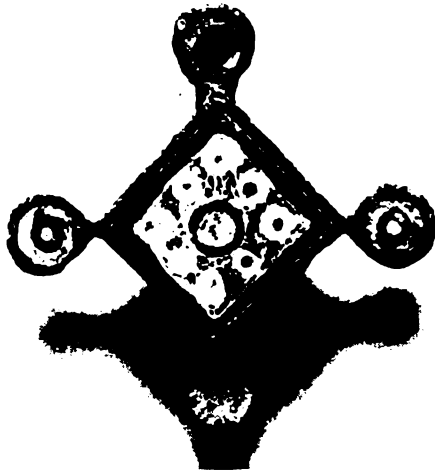
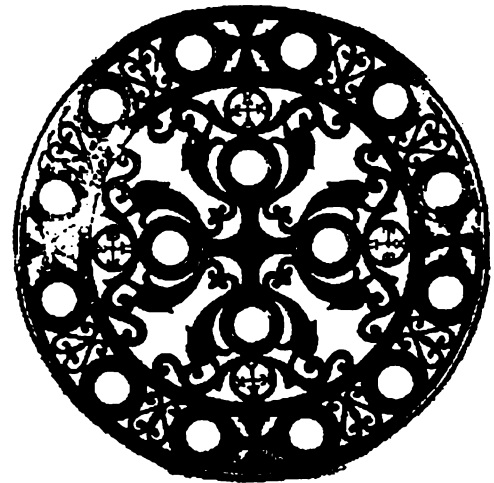
Looking straight onto the leaves on a branch



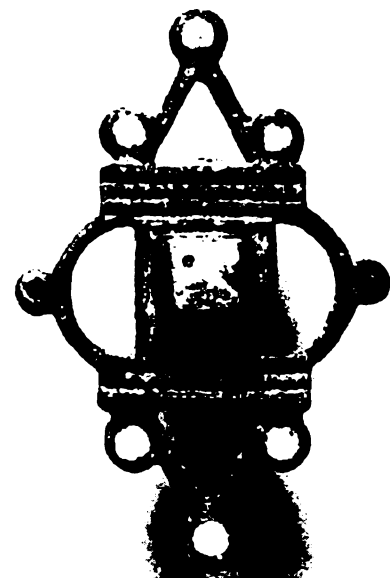
Greek *kylix* cup
tondo painting



Byzantine Brooch



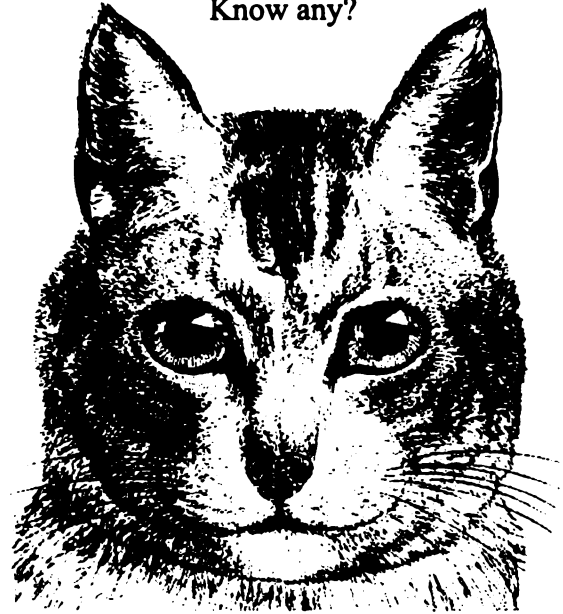
Roman-Celtic
Brooches
2nd Century



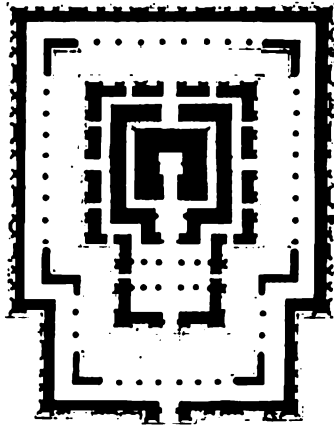
Heraldry



Know any?



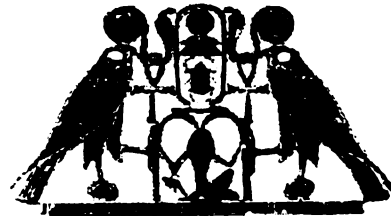
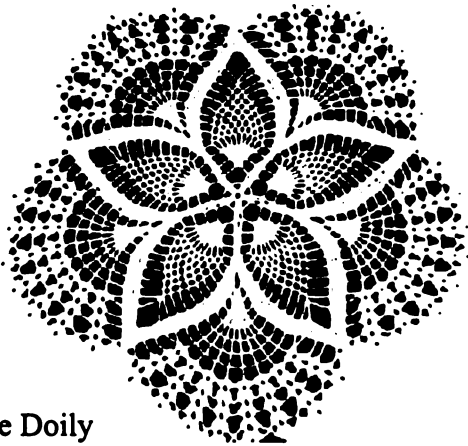
Hindu Temple Plan



Modern British Coin

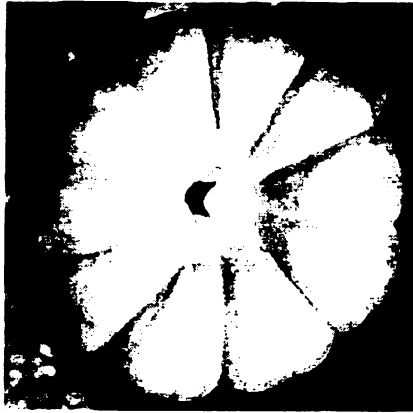


Lace Doily

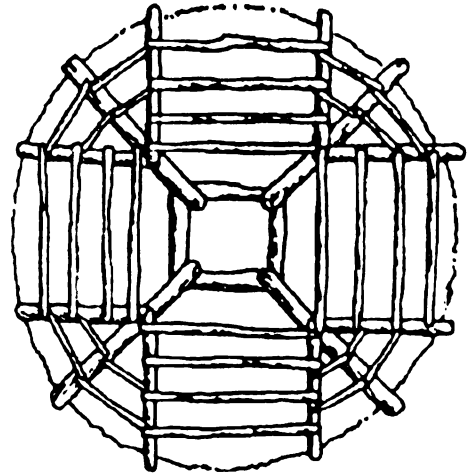


Egyptian Pectoral
of
Princess Sit-hathor-yunet
c 1900 BC

Pumpkin



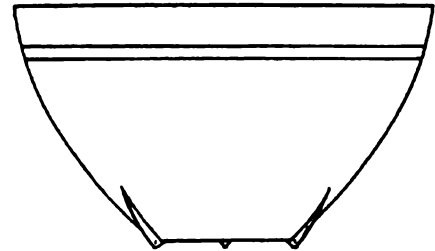
Naive American
Kiva Roof



Celery Bunch
Cross Section



Ancient Greek Cup



Alhambra Palace Tile
Spain



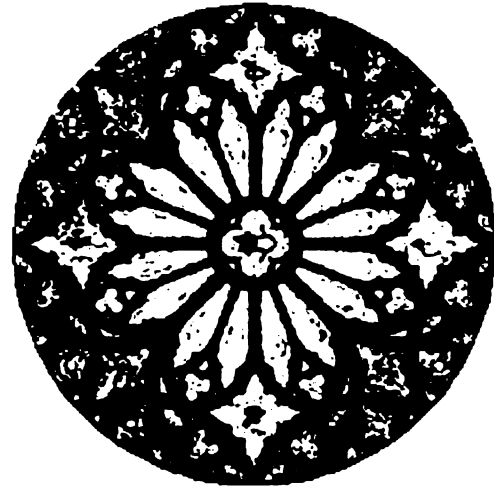
Pectoral of
Pharaoh Tutankhamun



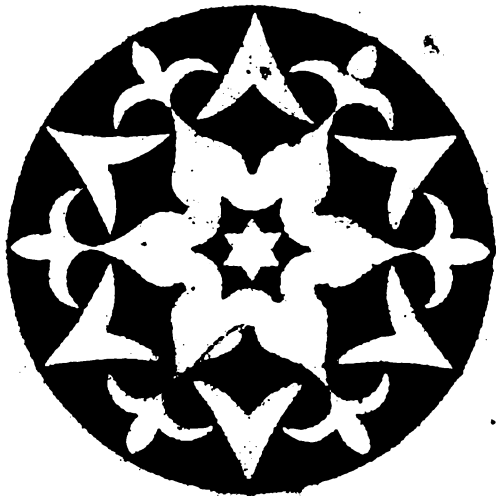
Greek *kylix* cup
tondo painting



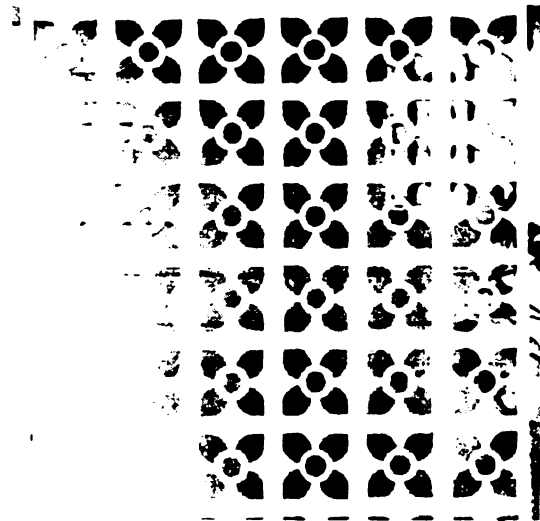
Rose Window
Cathedral Of St. John The Divine, NYC



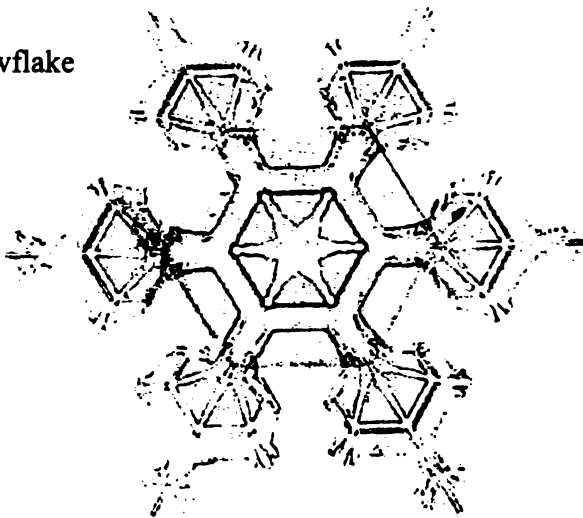
Decoration by the
architect Alberti - 15th Century



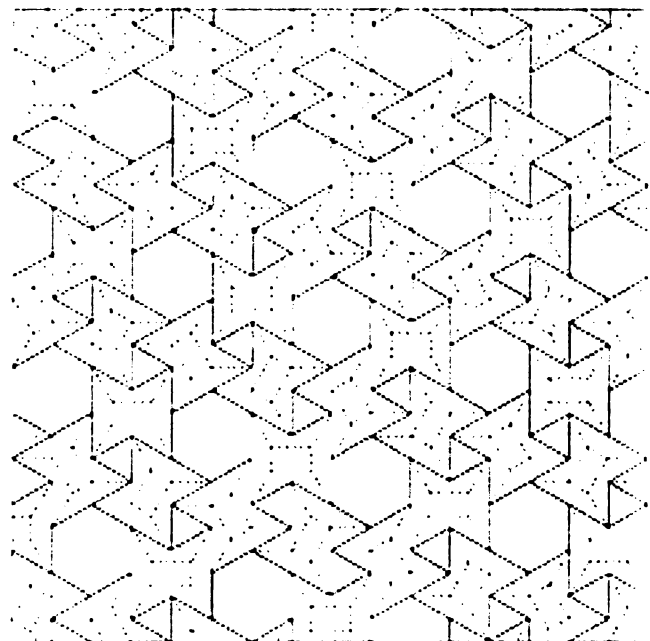
Concrete Block Wall



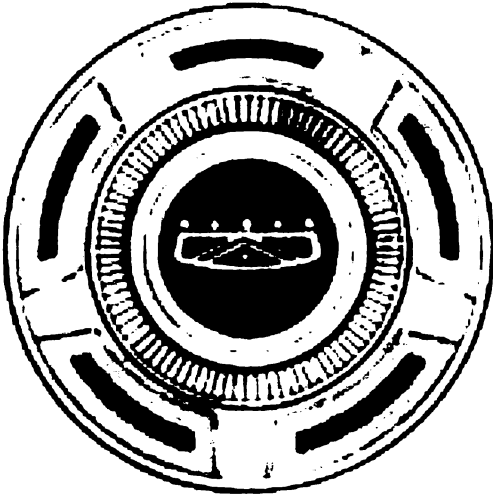
Snowflake



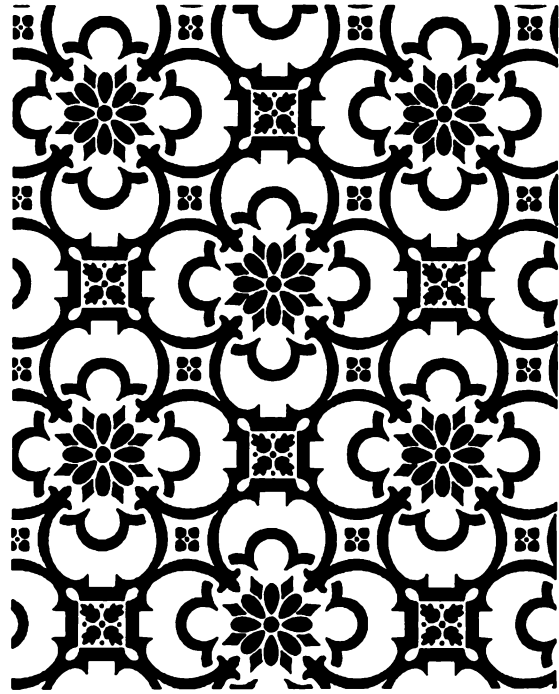
Tile Pattern



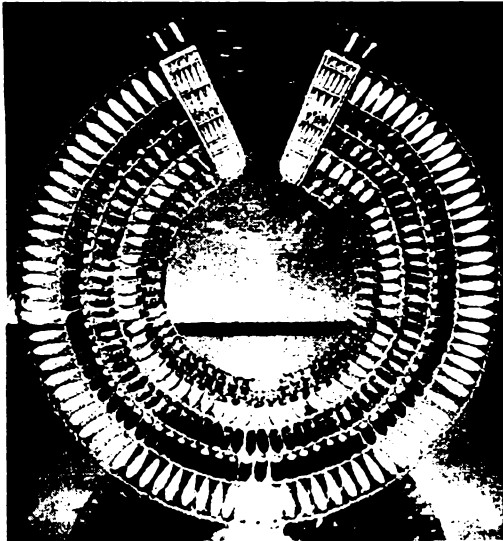
Classic Cadillac Hubcap



Classic Wallpaper Pattern



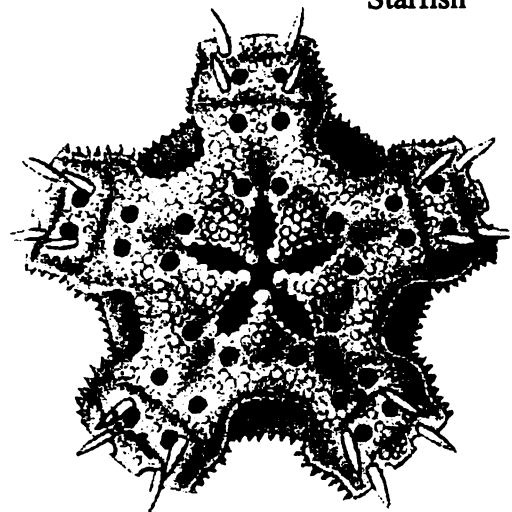
Ancient Egyptian Necklace



Islamic Illumination of Archangel Gabriel

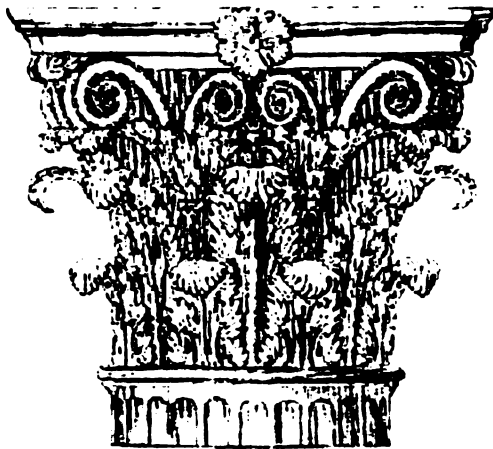


Italian Altar Triptych



Starfish

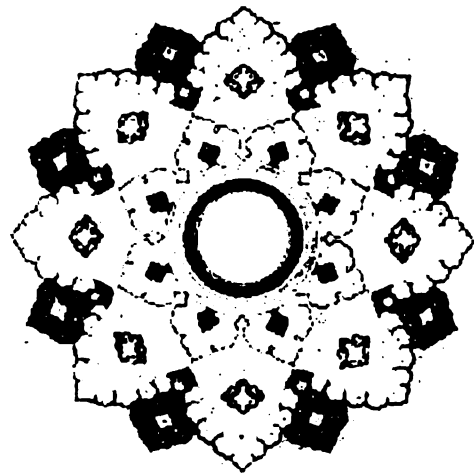
Greek Column
Corinthian Capital



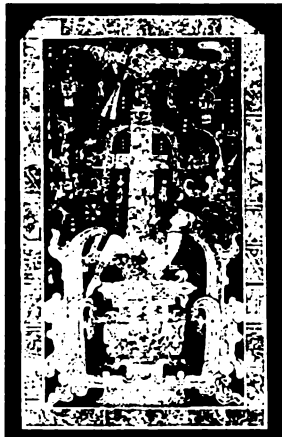
Ethiopian Painting
15th Century



Islamic Illumination



Sarcophagus Lid of
Mayan King Pacal

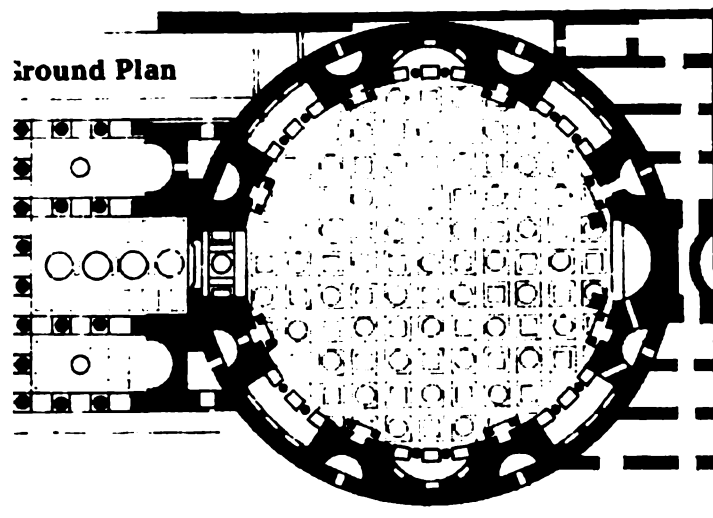


Silver Byzantine Plate
David Anointed By Samuel



PANTHEON

0 10 20 yards
0 10 20 metres



Different cultures applied the same geometry to their plate proportions. Are yours the same?

Ancient Etruscan Plate



Mayan



Ancient
Greek plate and
kylix cup tondo

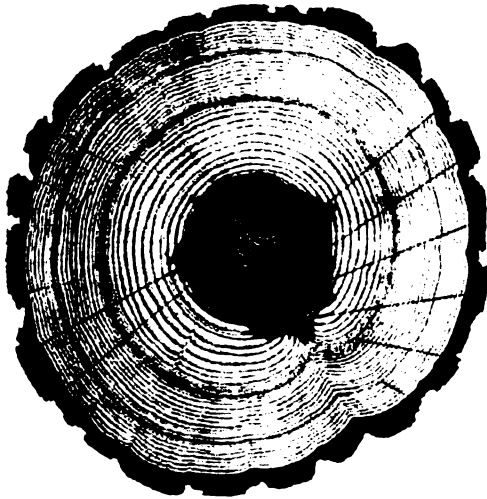


English Wedgwood

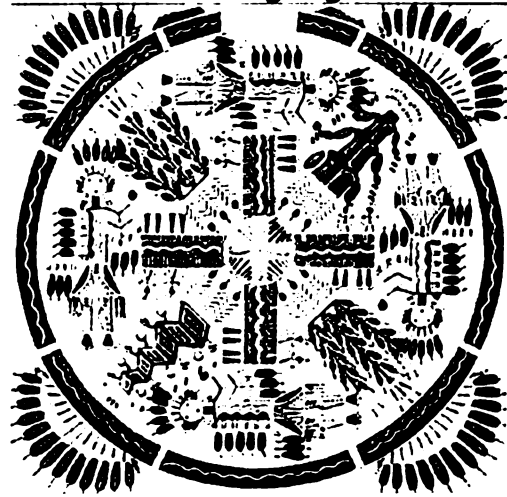


Plate of St. Denis
France

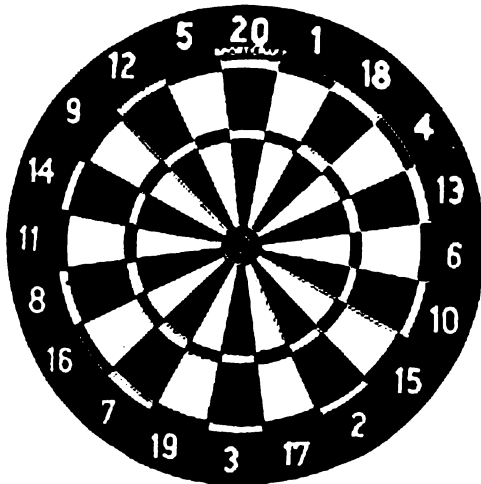
Pine tree trunk cross-section
(Bark to core)



Navajo
Sand painting
"Whirling Logs"



Dart Board



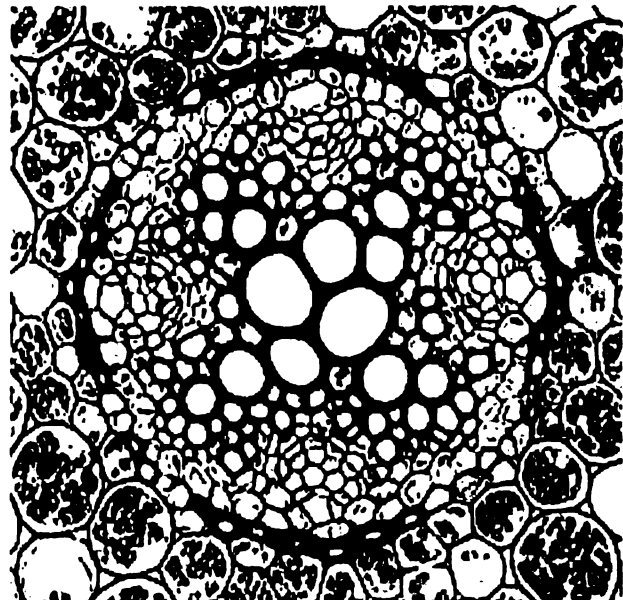
Chinese Emperor's
Dragon Robe
Hint: the correct solution will put
the Pearl of Wisdom at its center.



Greek Coin
circa 350 BC
Apollo Seated on *Omphalos*

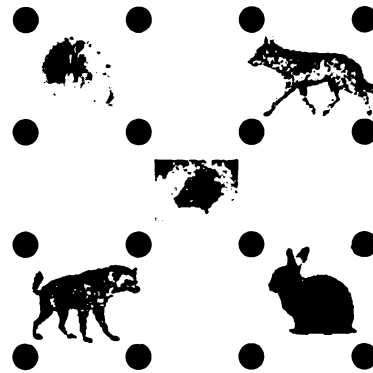
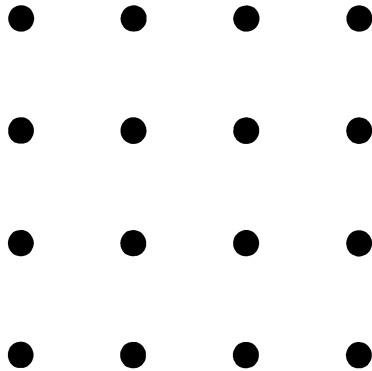


Buttercup Root Cross Section



Sambálu's Clever Path

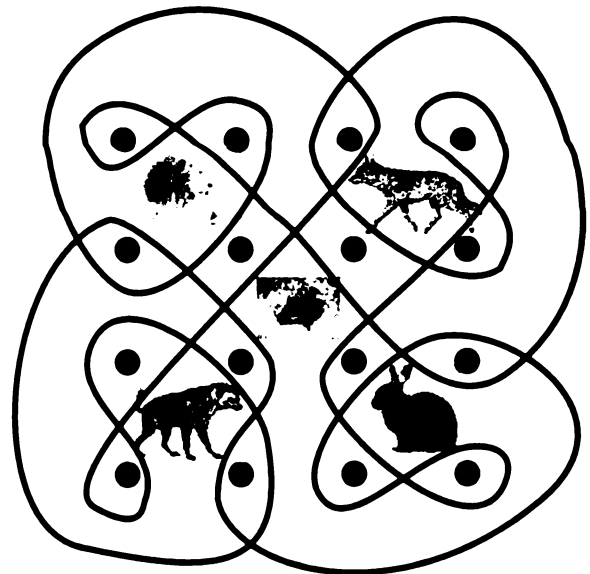
Geometry can be used to tell interesting stories, like this African tale about a clever rabbit named Sambálu. It begins by making sixteen points in the sand (like this) to show trees in the jungle.



While hopping around one day, Sambálu (at bottom right in the jungle) discovered a salt mine in the middle of all the trees. Suddenly a lion, jaguar and hyena appeared, roaring, growling and howling, trying to scare Sambálu away from it! Although Sambálu couldn't roar back, he was very clever. He kept hopping around, swinging up and down through the jungle vines, pulling them along behind him. Before they realized what was happening, the lion, jaguar and hyena found themselves woven into separate areas by a fence made of vines which kept everyone but Sambálu away from the salt mine!

Use a stick and the earth, or a pencil and paper, or pebbles and chalk on the sidewalk to tell the story of Sambálu's clever path. See if you can draw Sambálu's path without lifting your pencil from the paper or repeating a line. Can you learn to show and tell the tale from memory?

Which *Secret Window* best aligns with the trees and the pattern of Sambálu's clever path?



Sambálu's path

Answers to *Test Your Geometric Vision* (on pages 36 - 45)

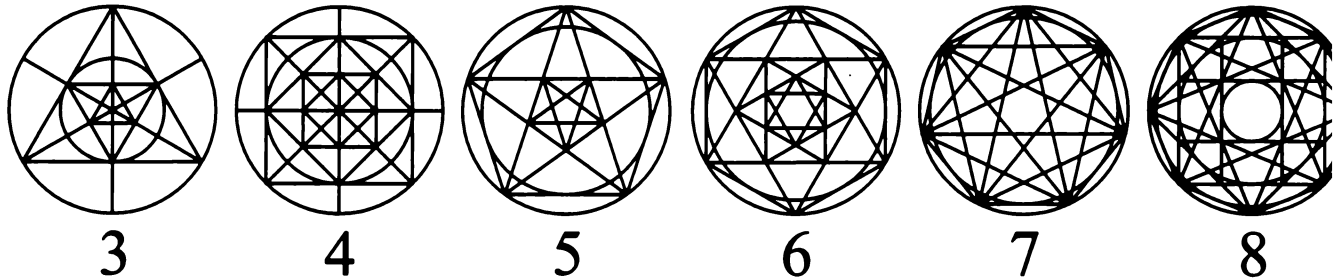
Under each page number below are numbers representing the Secret Window shapes (3 = triangle, 4 = square, etc.) in the layout of the page.

If the Secret Window doesn't reveal much, try *rotating* it!

Also, where one Secret Windows works, another might too:

Triangle and Hexagon, Square and Octagon often work together.

Twelve-part objects can be understood differently by the Triangle, Square *and* Hexagon.



Page	<u>36</u>	<u>37</u>	<u>38</u>	<u>39</u>	<u>40</u>
		6 5	6 5	5 4	5 4
	6 5	5 4	4 7	5 6	6 4
	8 4	4 6	5 6	4 6	6 6

Page	<u>41</u>	<u>42</u>	<u>43</u>	<u>44</u>	<u>45</u>
	5 4	5 6	4 4	5 4	
	5 6	6 8	4 4	4 5	4
	6 5	6 8	4 4	7 4	

Looking Through Secret Windows Beyond This Book

Now that you've practiced using Secret Windows with the pictures in this book, perhaps you're learning to see things geometrically. You know how to notice number-clues and shape-clues in the forms of nature, technology and art, and you've seen how rotating the Secret Windows can show you more about its design. Now it's possible to use what you've learned to look beyond pictures and see the entire world with new eyes.

In the book you placed the Secret Windows directly on top of the pictures. But when using them beyond the book you'll need to hold one Secret Window in your hand and look through it at a flower, hubcap, plate or anything you choose. Stand near the object and look at it "straight-on." Bring the Secret Window closer to you or away towards the object you until the outside circle (or an inner shape) matches what you're looking at. Then notice whether any other parts of the object align with the Secret Windows geometry. If so, enjoy seeing how the rest of the object's various parts fit together in the harmonious geometry of the Secret Window.



Look around for good examples. Find shapes in nature, technology and art in your home, around your neighborhood and in art museums which match each of the *Secret Window* patterns. Observe the faces of people and pets through Secret Windows. Look around your neighborhood for hubcaps, signs, wall and wallpaper patterns, textile designs and anything else the Secret Windows can help you to view.

Take your Secret Windows to an art museum. Stand in front of a round painting, pottery, plate, jewelry or whatever you can find. It's best to look directly at it from above its middle. Usually one Secret Window will best identify its scheme and proportions.

Keep a record of what you discover. Make drawings in a sketchpad or notebook, and take photos of the forms which reveal their secret patterns to you! Organize your discoveries in your notebook by their shape, or group them as natural, technological or artistic.

Make drawings and rubbings of the leaves you find. To do that, place a piece of paper or aluminum foil over the leaf and rub it carefully with a crayon or pencil to make a permanent picture of its vein pattern. Collect the different types "leaves" this way.

Show others what *Secret Windows* have shown you!



Design Your Own World!

“And since geometry is the right foundation of all painting,
I have decided to teach its rudiments and principles
to all youngsters eager for art...”

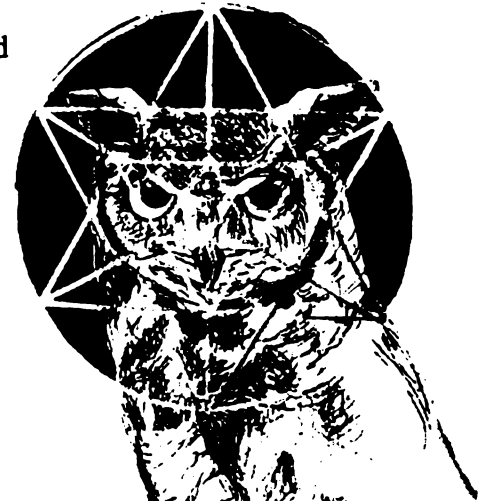
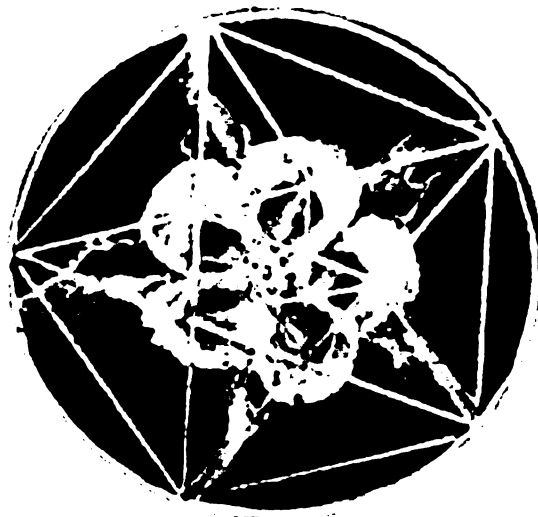
– Albrecht Dürer

(1471-1528, German painter, printmaker, theorist and teacher)

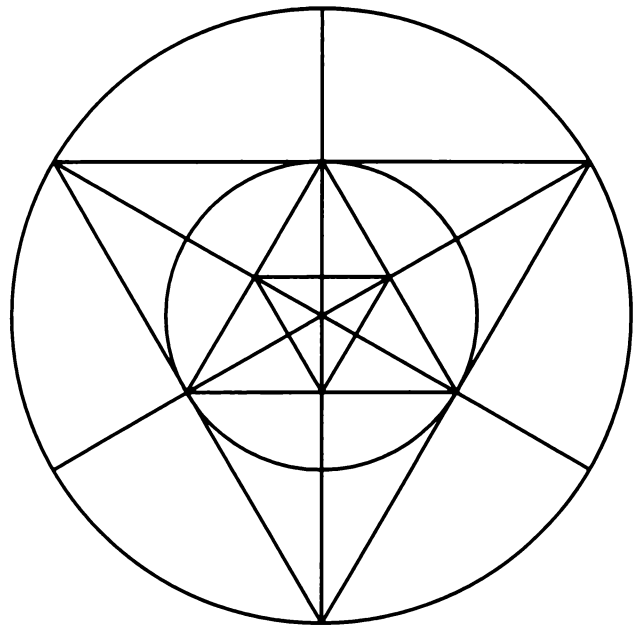
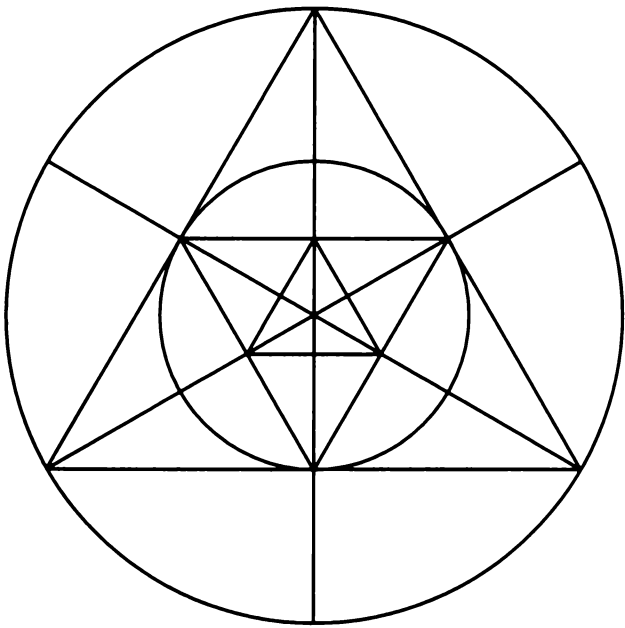
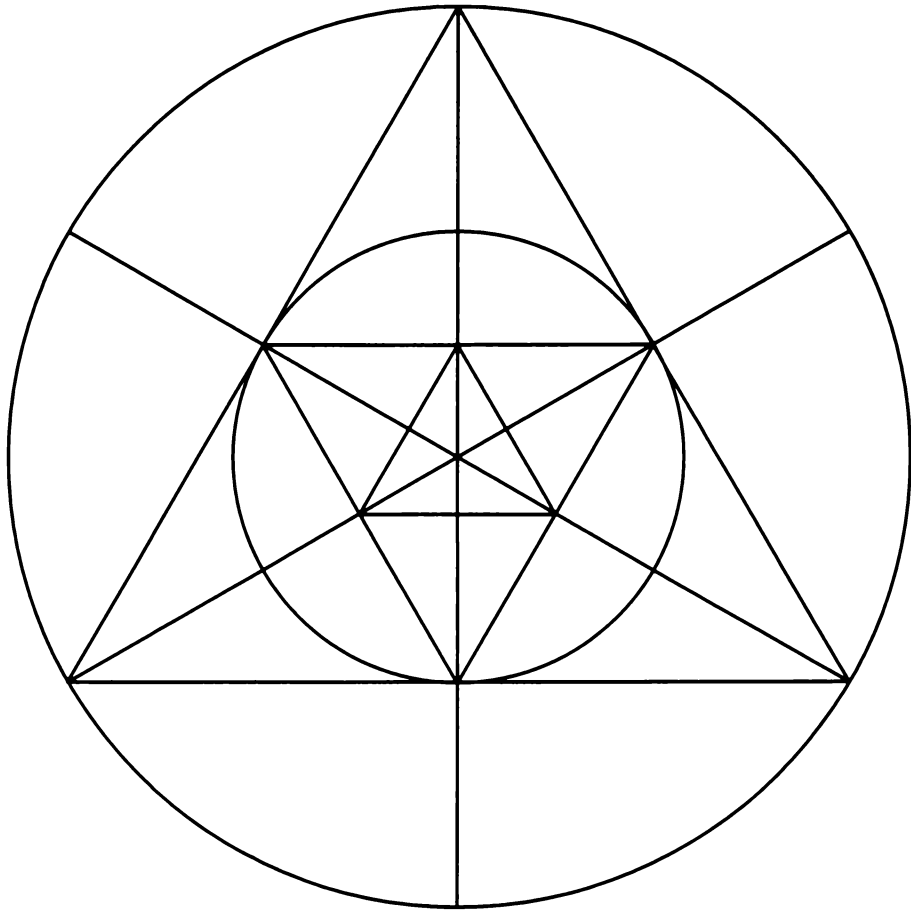
When you can see nature, technology and art with geometric eyes, you might want to design the elements of a world of your own imagination. Maybe something you saw in this book, in your home or outdoors inspires you to design and draw a new version of it. Not all objects are, or need to be, designed with regular geometric patterns. But if you're creative you can use your imagination and *Secret Windows* to design and draw new versions of anything you can think of! What new leaves, flowers, fruit, insects, animals, faces, snowflakes and other forms can you imagine?

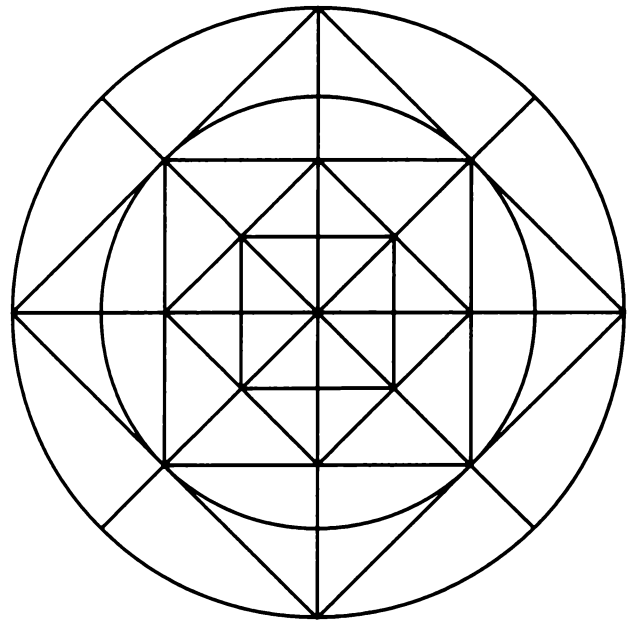
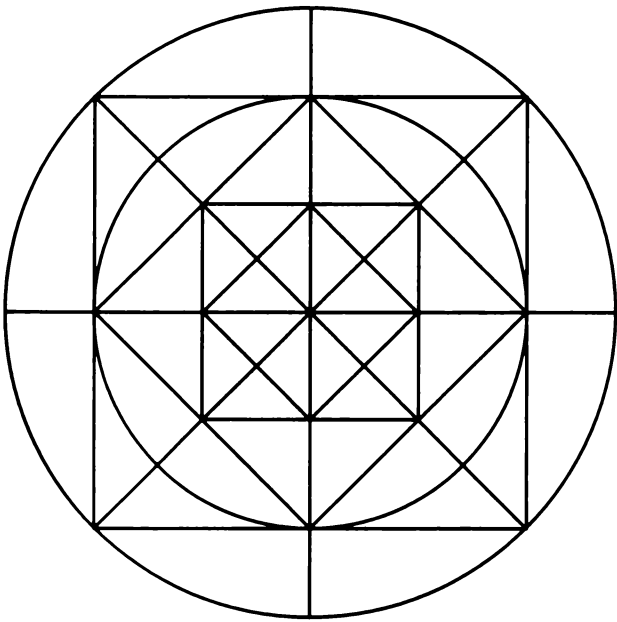
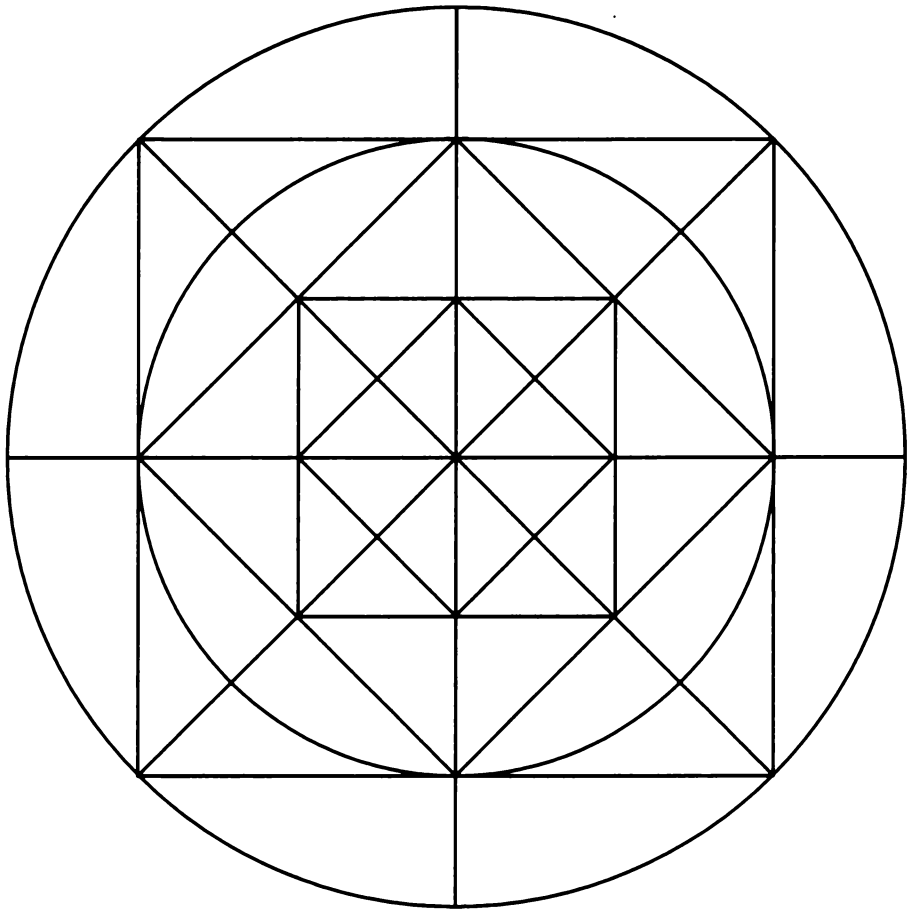
The following pages have three versions of each of the *Secret Windows* patterns printed on them. You can draw directly on them or place tracing paper over them. Use their lines, crossings and areas as guides, along with your imagination and colored pencils, to design your own realistic or whimsical plants, creatures and art. Let the lines suggest to you how to arrange your ideas in space.

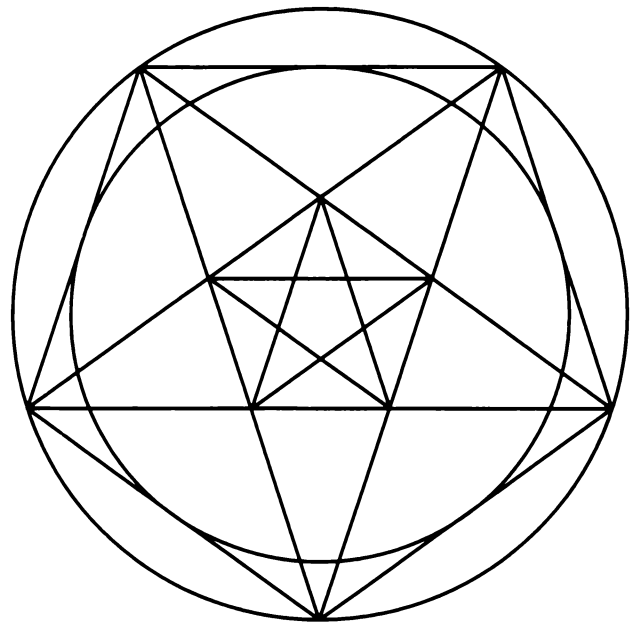
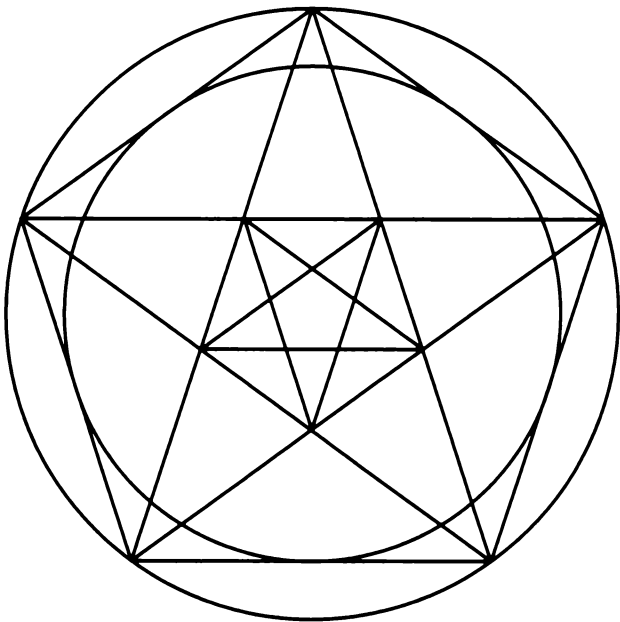
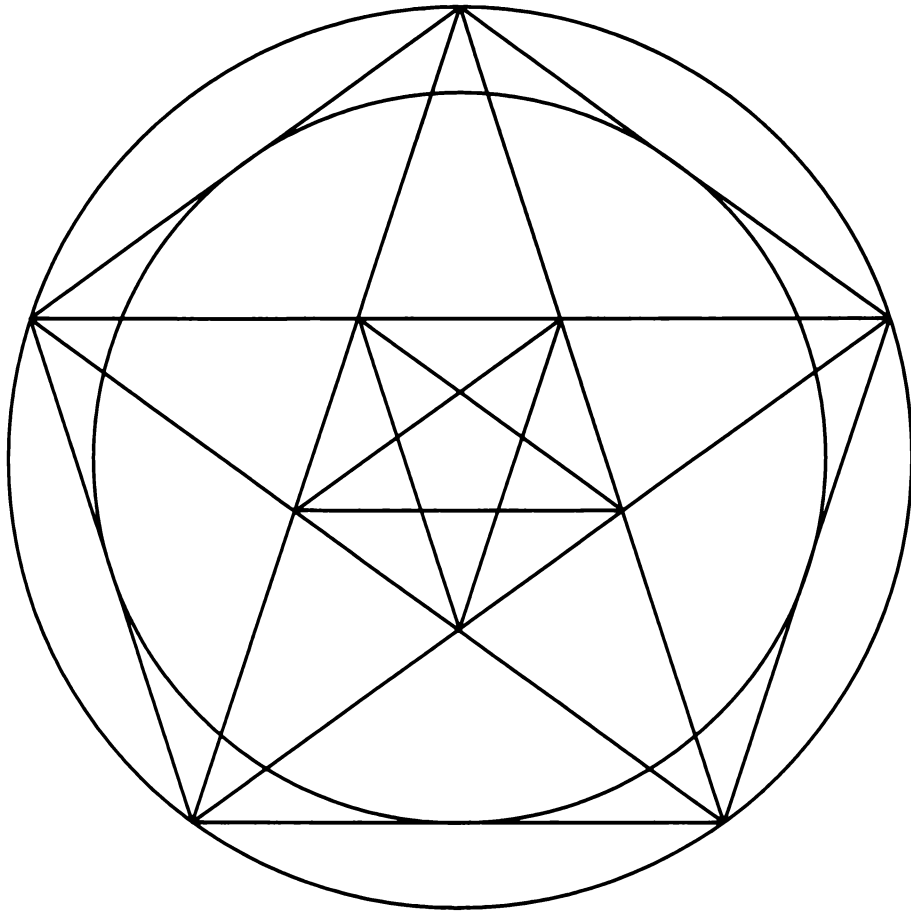
Remember: the lines are only *guides* to show you where to draw. Please don't be perfectly exact because nature isn't! You don't have to stay "inside the lines" any more than nature does. If you need some inspiration, just look around you at nature, around your neighborhood and in museums! There are no rules except to let the *Secret Windows* help guide your design, to use your imagination and to have fun!

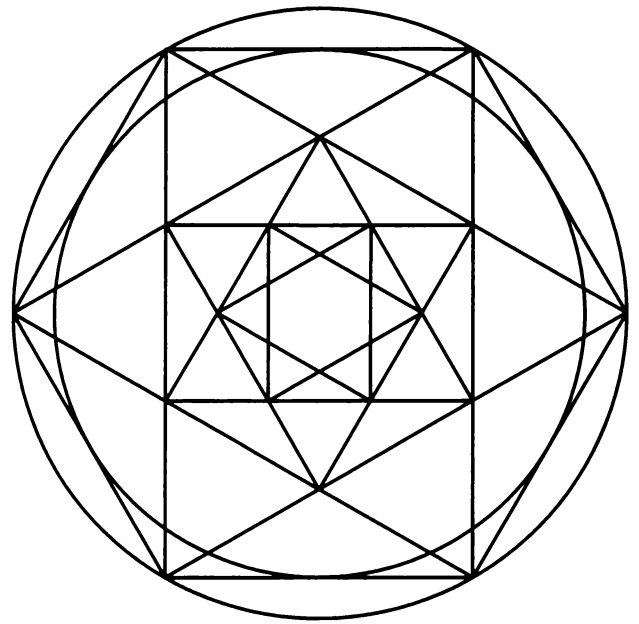
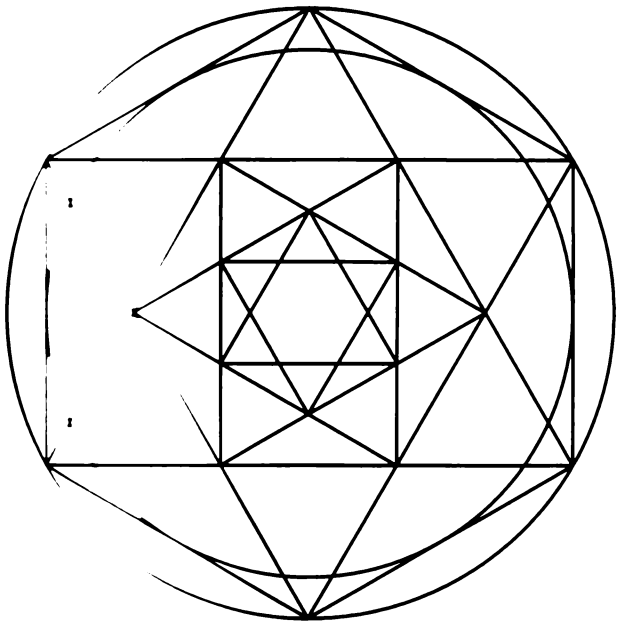
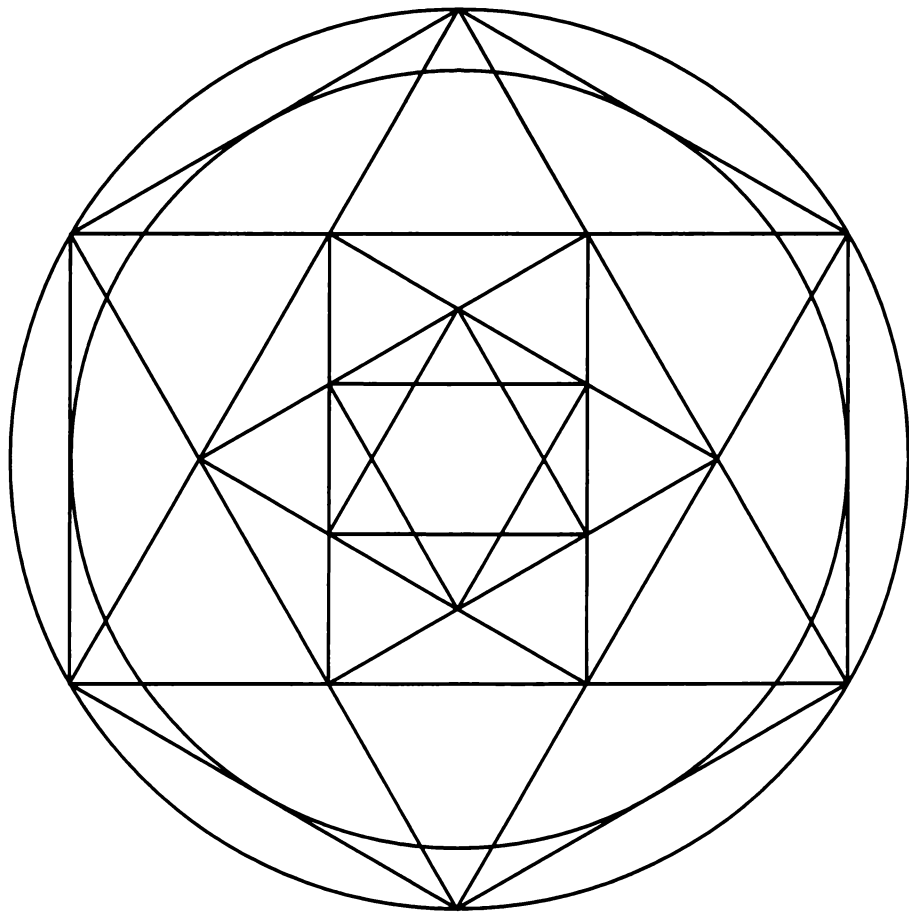


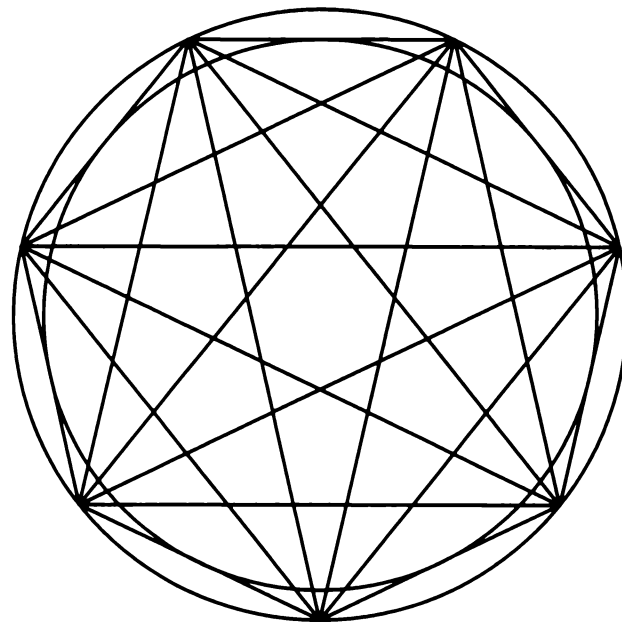
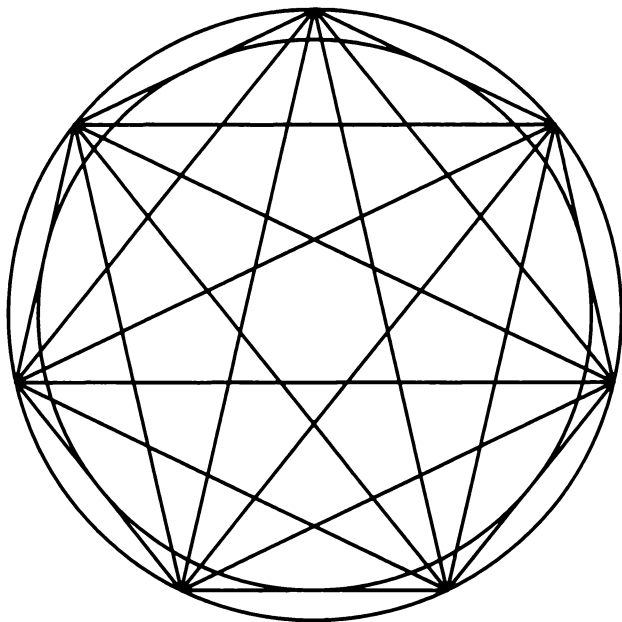
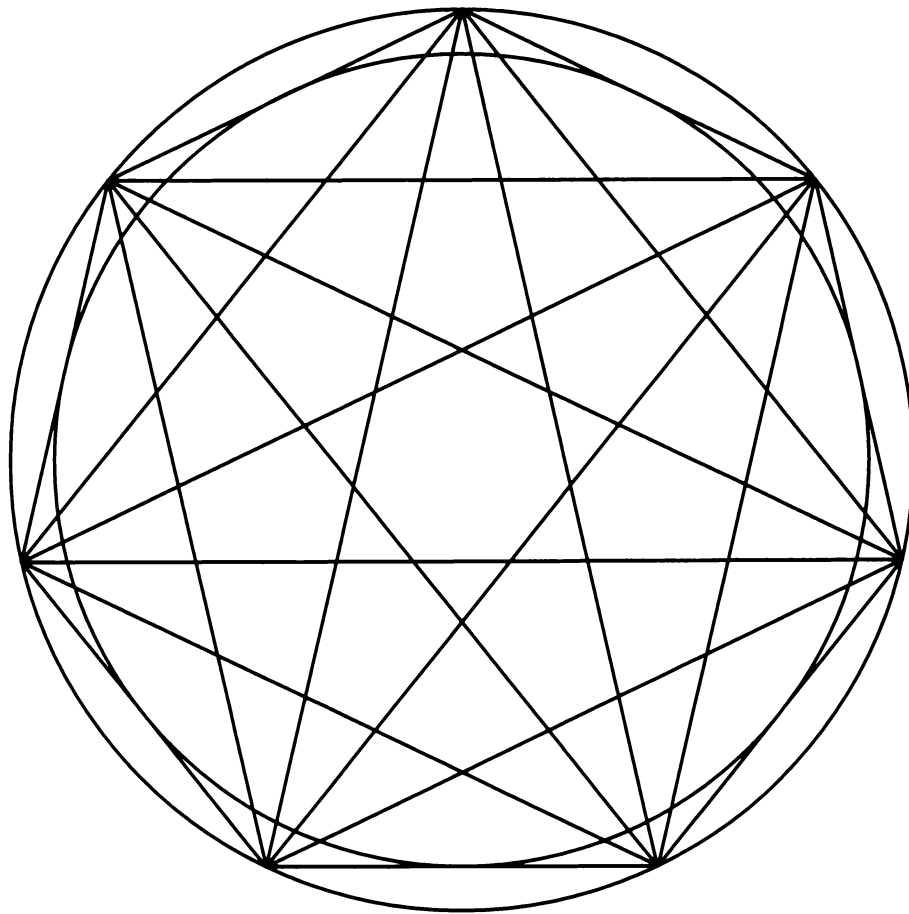
Paintings by Olivia Wise

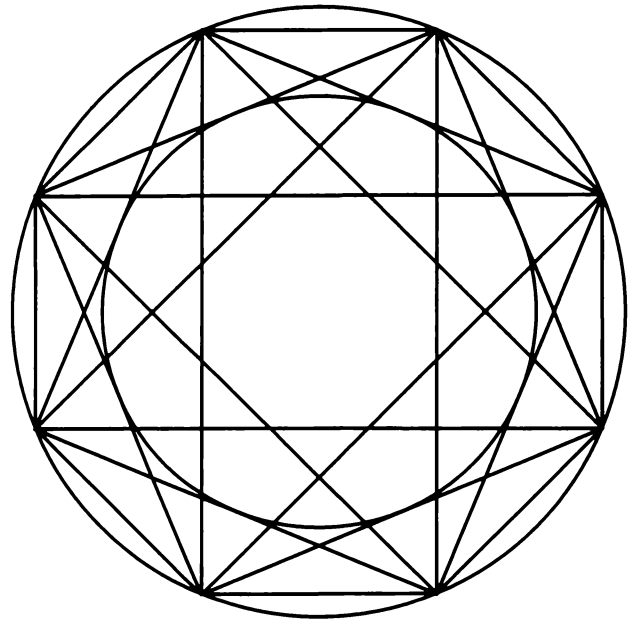
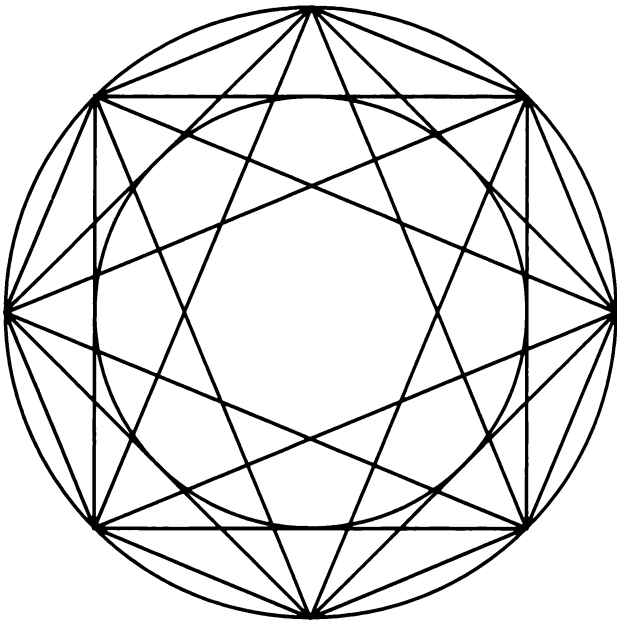
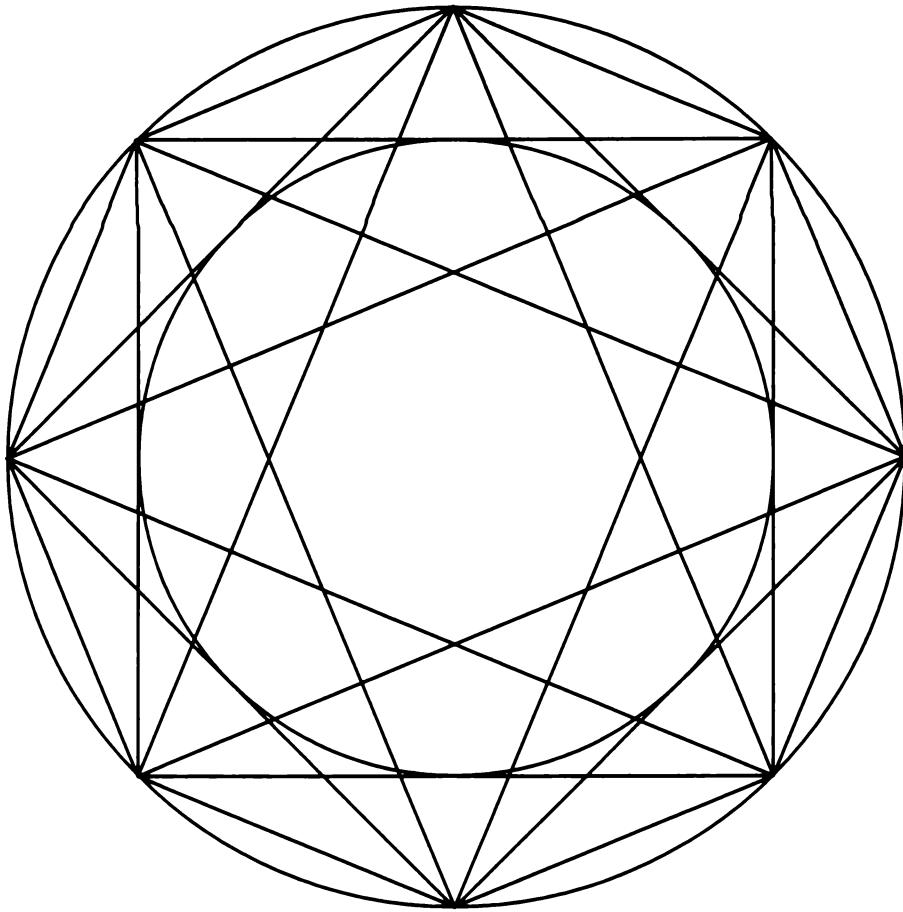






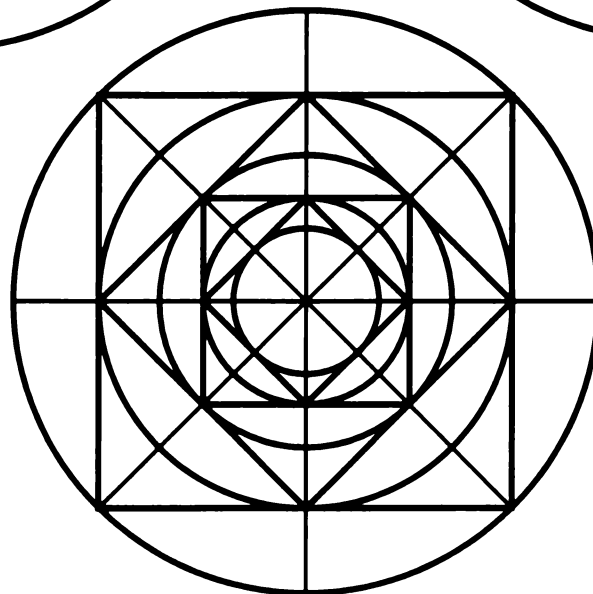
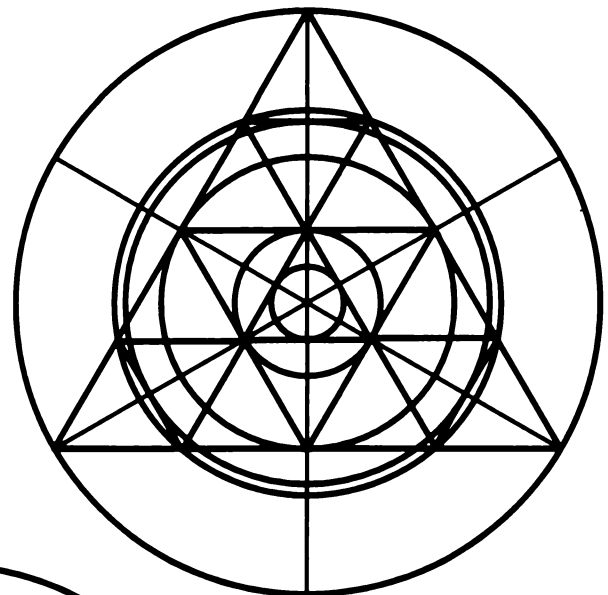
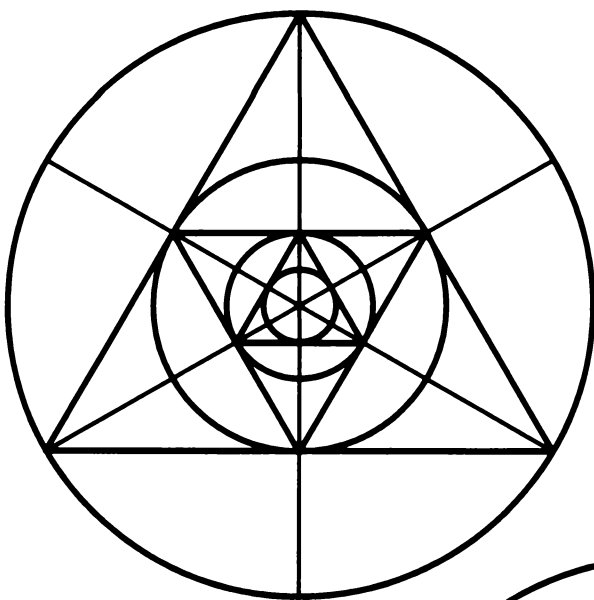


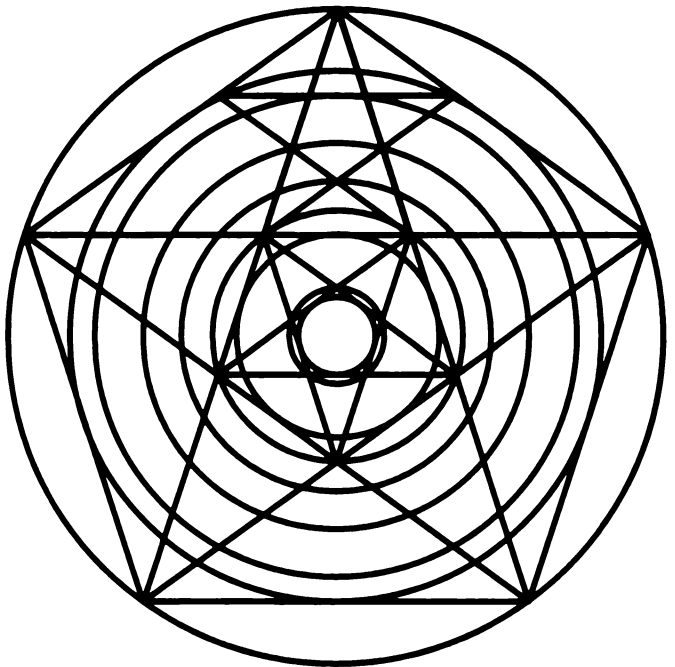
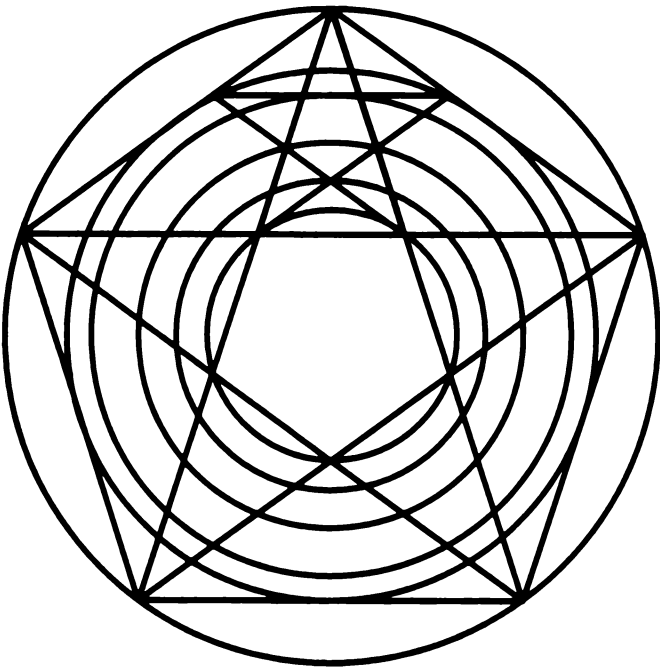
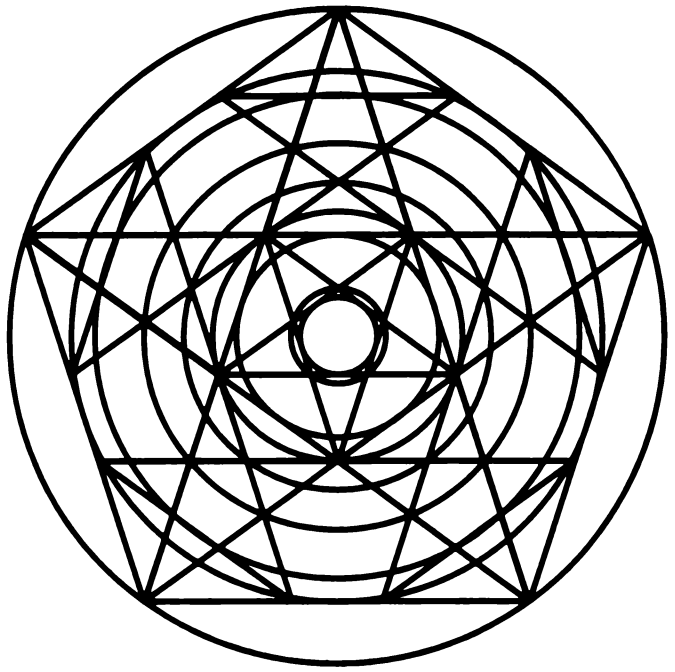
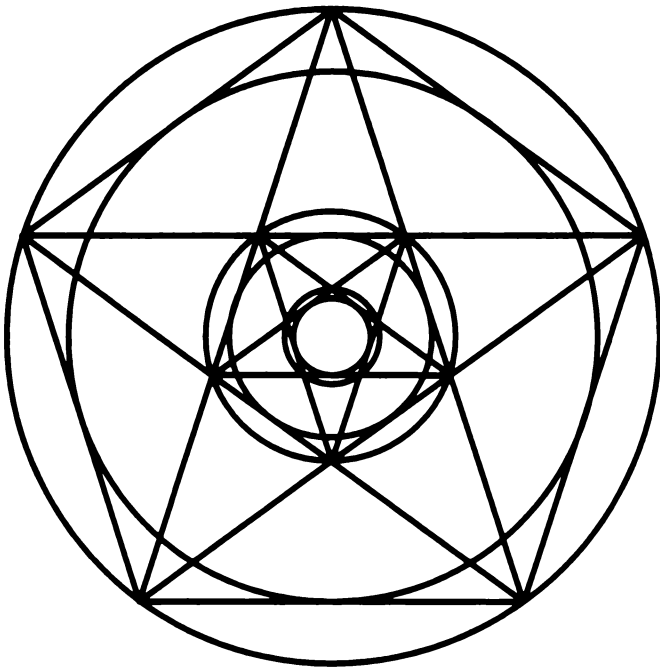


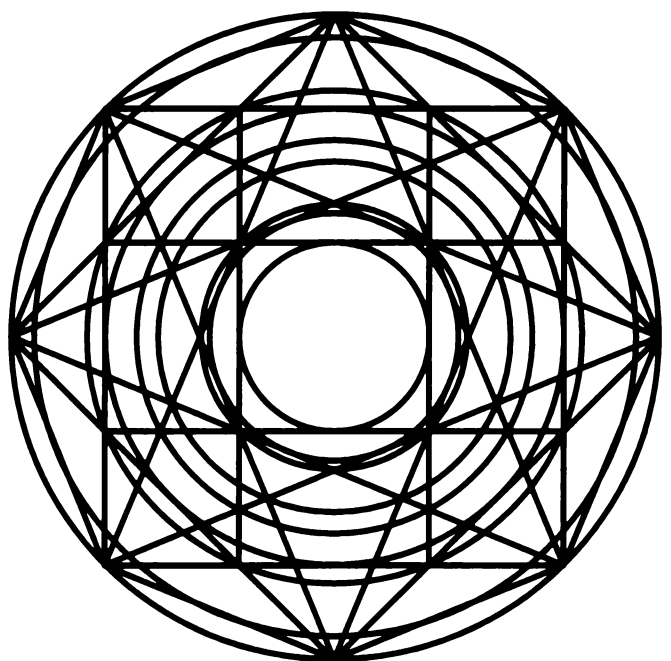
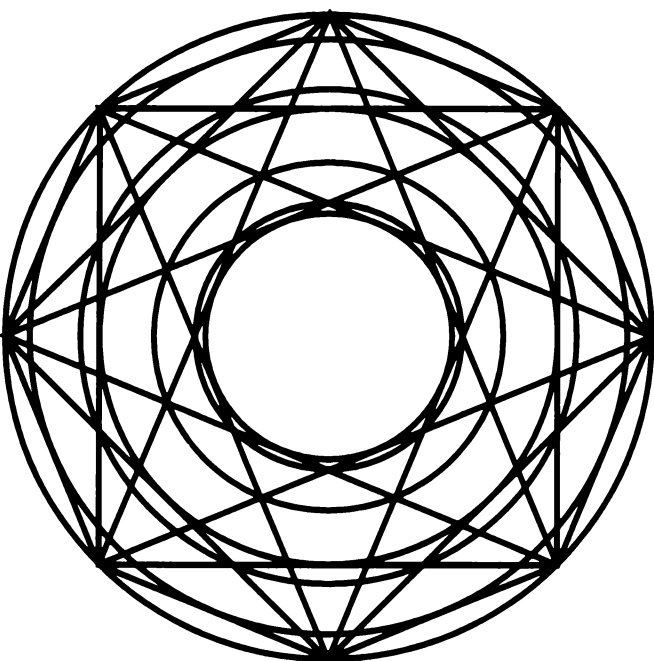
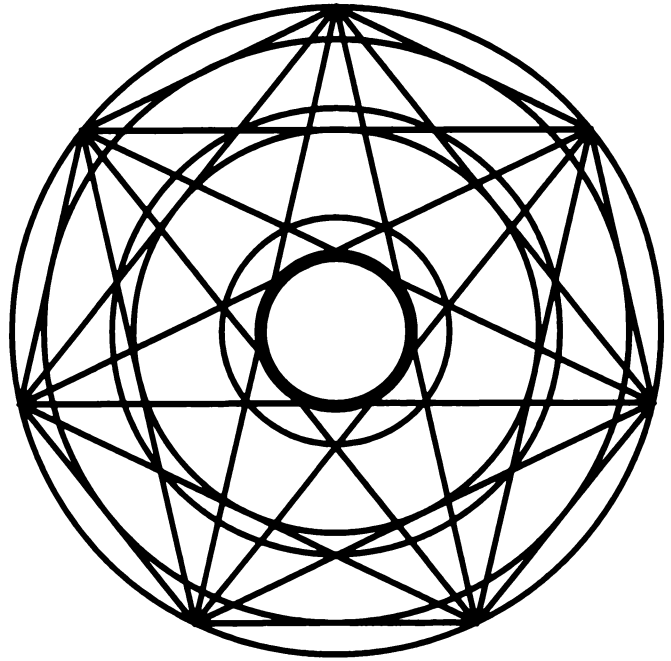
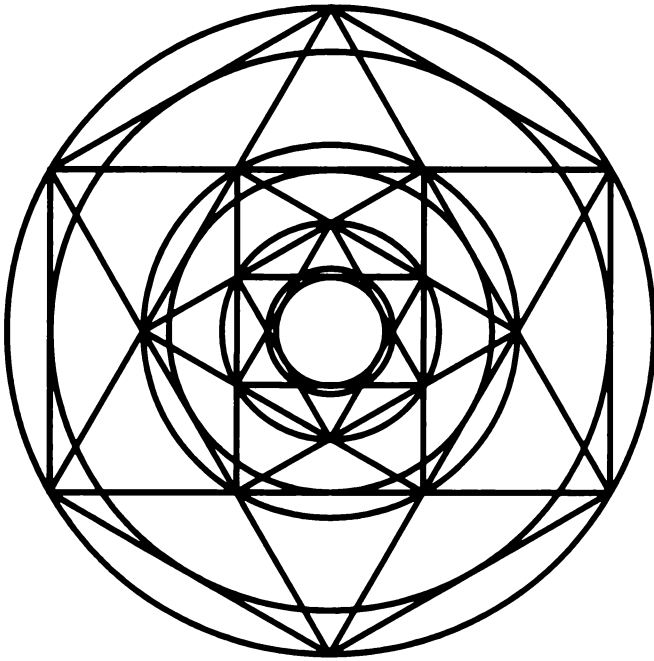


There's More In There!

Each of the Secret Windows has from three to eight points equally spaced around their circles. Lines connect them directly all around to make the different basic polygons visible. Other lines connect them in different cycles to reveal their various "star" patterns. Further connections at their crossing points reveal more lines. In each, a circle surrounds the entire shape and another circle is inscribed within it. All points, lines and circles are related to each other by the polygon's dominant mathematical proportion. Secret Windows make these harmonies visible. But there are more harmonious circles, lines and areas waiting silently in potential, and available for designers to use. Perhaps you've already noticed them used in the book's examples. They're made visible by connecting line segments and arcs at various harmonious crossing points already existing within the design. Here are more of their lines available for use in your original designs, or to simply to color!

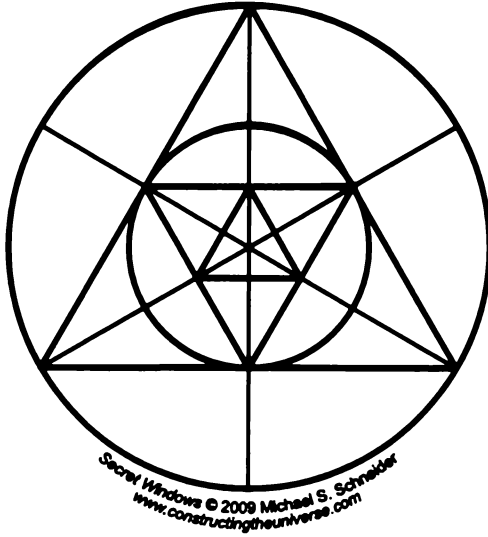




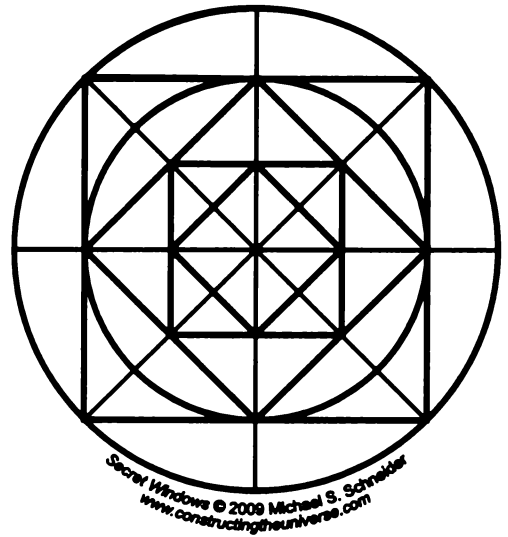


cut along this line

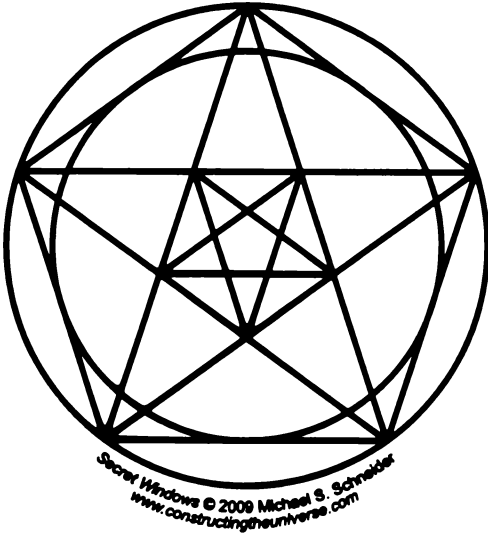
Triangle



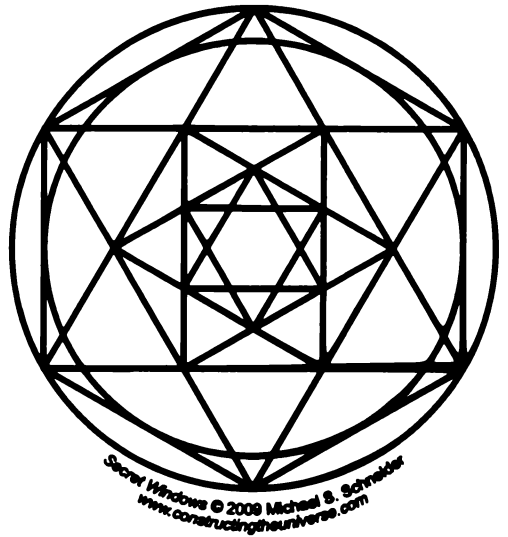
Square



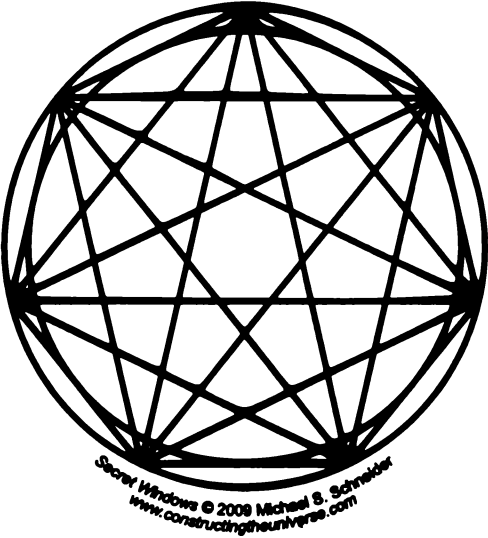
Pentagon



Hexagon



Heptagon



Octagon

