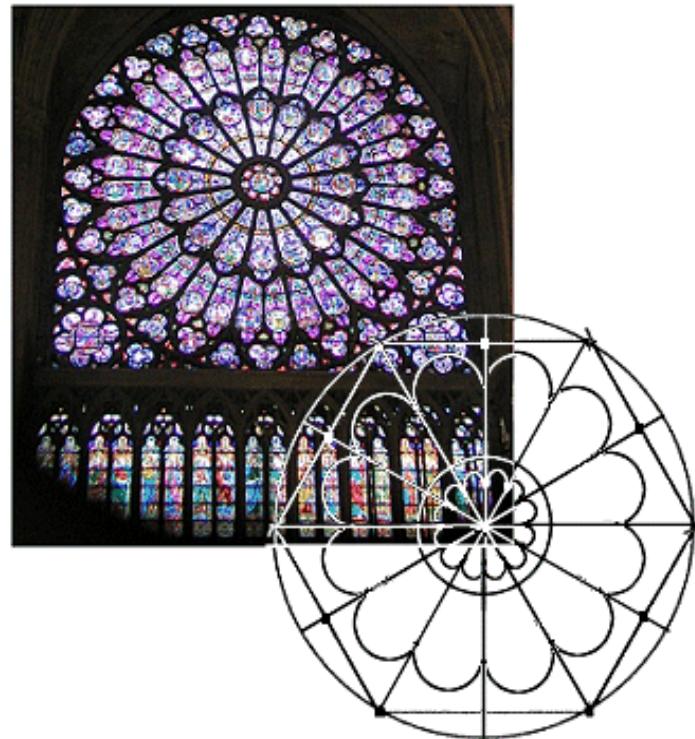


TIPS & TRICKS TO GOTHIC GEOMETRY



by Joe Chiffriller

New York Carver

TIPS & TRICKS TO ~~GOTHIC~~ GEOMETRY

An expanded supplement to the [online course](#) on the World Wide Web

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I

ntroduction

About the author: Joe Chiffriller - the stone carver behind NewYorkCarver.com, holds certification in stone masonry from City & Guilds of London Institute and apprenticed at the Cathedral of St. John the Divine. Joe currently lives in New York City with his wife, Margaret, to whom he is indebted for her tremendous support and inspiration in making this e-book possible.

Ideal geometric shapes in architecture have imparted a feeling of order and harmony since the Greeks.

The Romans, using only geometry and the repeated use of the semicircular arch, later built an empire.

New innovations followed in the Middle Ages.

The medieval flying buttress was born from the desire for building higher; and the pointed arch arose from the necessity to efficiently transfer the extra weight from above.

Surprisingly, "Gothic" was first used as a term of derision by Renaissance critics who scorned the architectural style's lack of conformity to the standards of classic Greece and Rome. A closer look, however, reveals that the underpinnings of medieval architecture are firmly rooted in the ancient use of geometry and proportion. It's seen in the overall cruciform shape of a cathedral; in the rhythmic, intricate patterns found in stained glass windows; and in the rib vaulting that criss-crosses the ceiling.

Up ahead, you'll discover several hallmarks of Gothic design, along with tips and tricks to their construction. These include Rose windows, arches, tracery, typical moldings, and a handful of historic examples.

For most of these designs, you will need paper, pencil, ruler and compass. A Zen-like contemplation of line and curve will naturally follow. From there, you can build on your experience to actually construct something of your own from the plans that you've mastered!

Sacred or Gothic geometry serves as a door into the minds of Gothic masters, so it's strongly recommended that you give this historical reenactment a try - on paper at least, and where all great design begins...

GOTHIC ARCHES

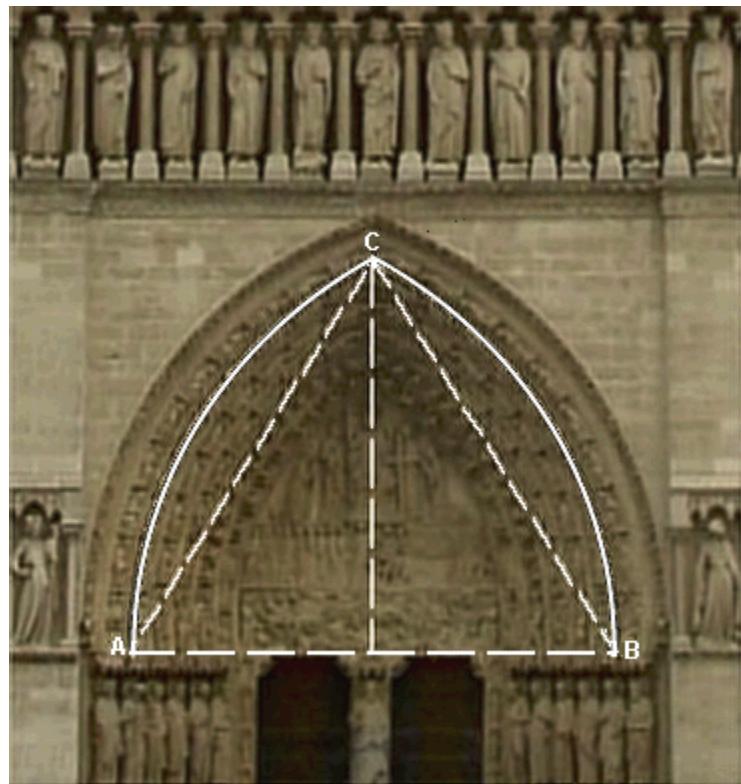
The Equilateral Arch

This revolutionary design first gave rise to the Gothic in the 13th century.



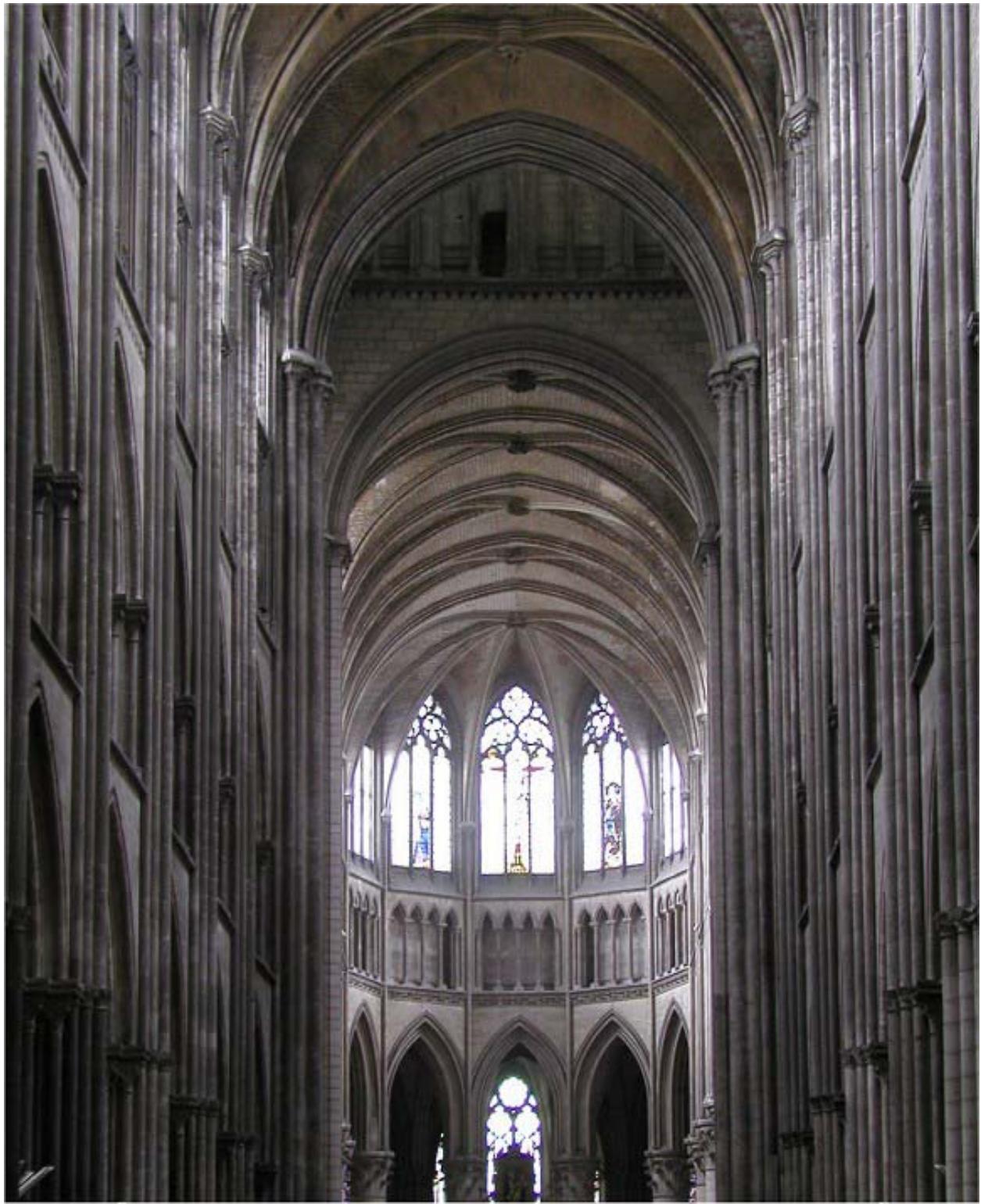
It was first seen at the Abbey of St. Denis, just outside Paris, where Abbot Suger had a master plan for transforming the squat, heavy Romanesque style into an architectural wonder of the age...

The basic Gothic arch begins simply enough with a straight, horizontal line.



1. Construct the baseline A-B, and extend your compass out to the exact same length.
2. With your compass needle at point B, construct arc A-C.
3. With your compass needle at point A, construct arc B-C.

Voila - Gothic architecture. Above, the main portal at Notre Dame, Paris.



The equilateral arch: a repeated theme at the Abbey of St. Ouen, Rouen.

Ogee Arch



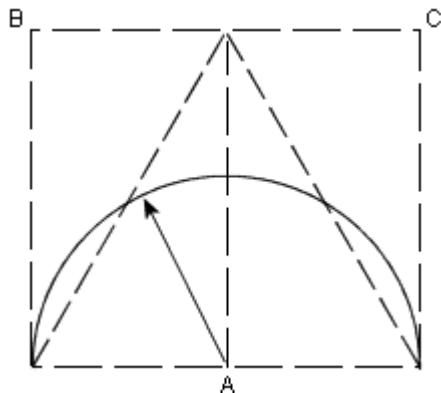
The double 'S' curve ogee (*oh-jee*) was introduced from the Arab world in the 14th century and became popular throughout medieval England. It was also a favorite in Venice, Italy from where it derived its other moniker, the Venetian arch. It can also be referred to as a keel arch for its apparent resemblance to ship construction.



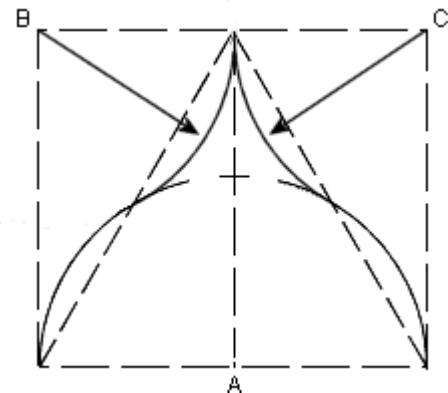
Campo Bandiera e Moro, Venice.



The World Trade Center, New York.



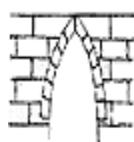
Construction begins with an equilateral triangle (note: baseline=height). Now, adjust your compass to half the length of the baseline and from point A, construct a semicircular arch.



Next, with the compass still adjusted to half the length of the baseline, construct an arc from point B.

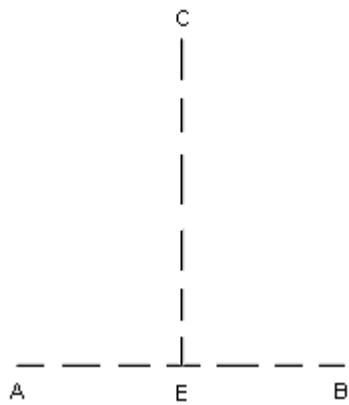
Repeat at point C.

Lancet Arch

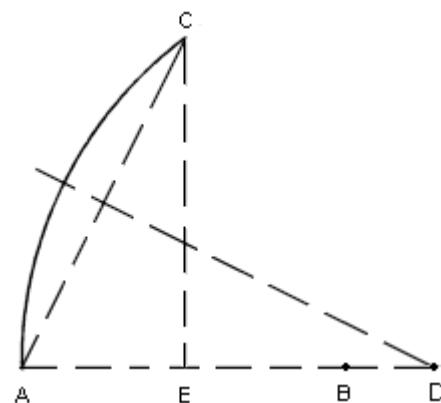


Shaped like the tip of a spear or lancet, this construction is most often associated with the Early English Gothic style.

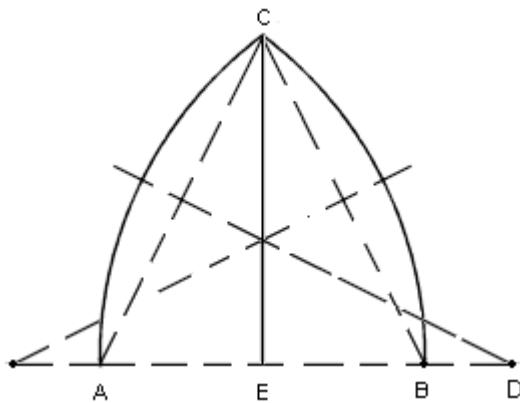
Unlike the equilateral arch, it is struck from centers that lay outside the arch:



Construct the baseline A-B to equal the rise C-E.



Join A-C. Bisect it to intersect with the springing line at D. With your compass spread to the length of A-D, place your compass needle on D and construct the first arc.



With a corresponding center, construct the opposite arc.

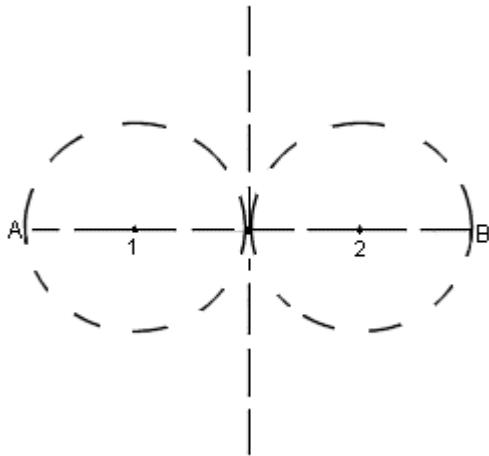


Above, a row of lancets at Lincoln Cathedral, UK.

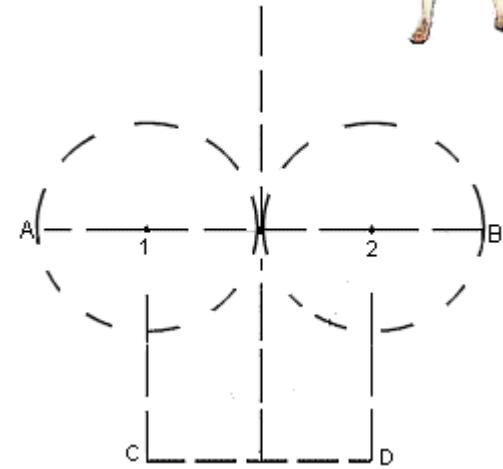
Tudor Arch



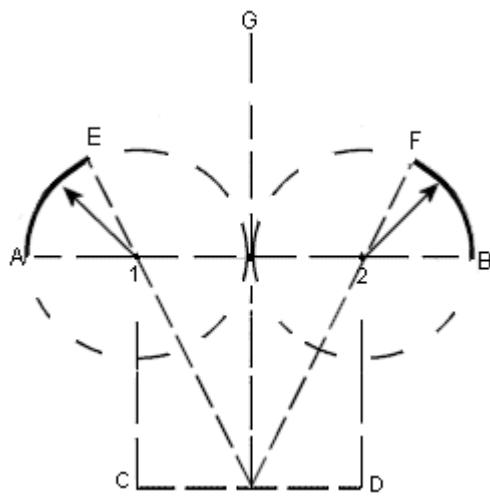
Tudor architecture began with Henry VII and continued through the reign of Elizabeth I. Today, the style is usually associated with Elizabeth's father, Henry VIII, during whose colorful reign extra-wide doorways and arches made for a grand entrance.



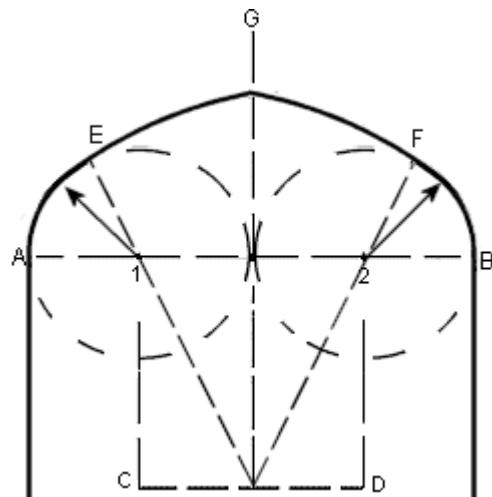
Construct the span and height as shown and divide baseline A-B into four equal parts. Set your compass to the length of half the baseline and draw a circle using center 1. Repeat at center 2.



Now set out the bottom square 1-C-D-2 as shown.



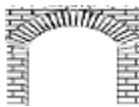
Construct a line from the bottom center, striking through point 1 to point E. Now strike through point 2 to point F. Set your compass to the length of A-1 and draw the arc A-E. From 2, draw the arc B-F.



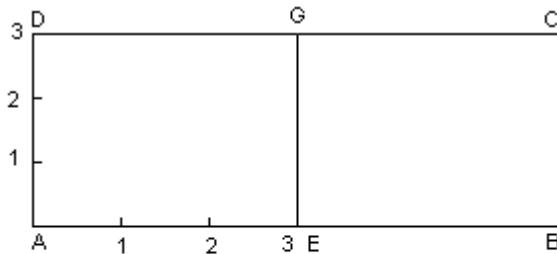
To complete the arch: set your compass to the length of D-E and draw arc E-G; from C-F, draw arc F-G.

Above right: The great Tudor window at King's College Chapel, Cambridge.

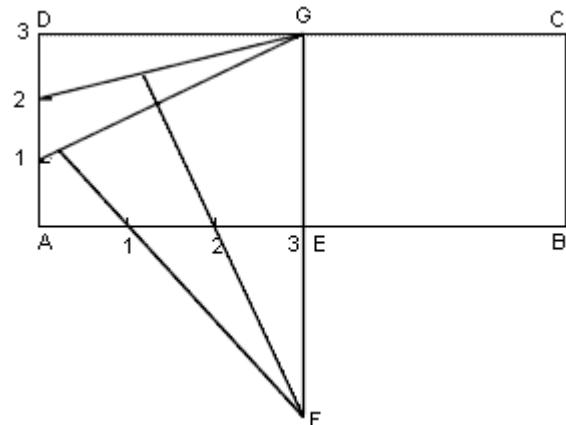
Elliptical Arch



Many city gates and bridges of the Middle Ages were based on a true ellipse, or oval. Although the geometric plan makes it easy, the arch requires a sure hand and must be completed freestyle:



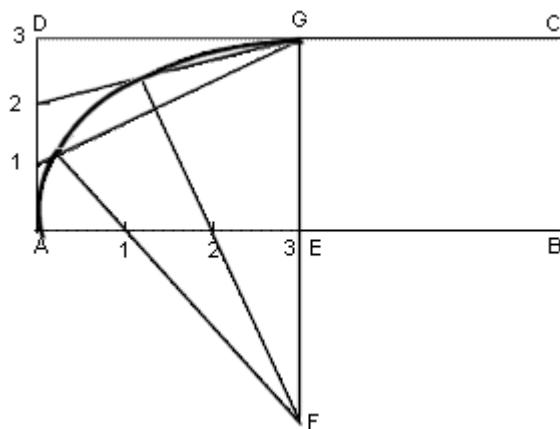
Set out rectangle A-B-C-D as shown and divide in half. Mark off A-D and A-E into thirds.



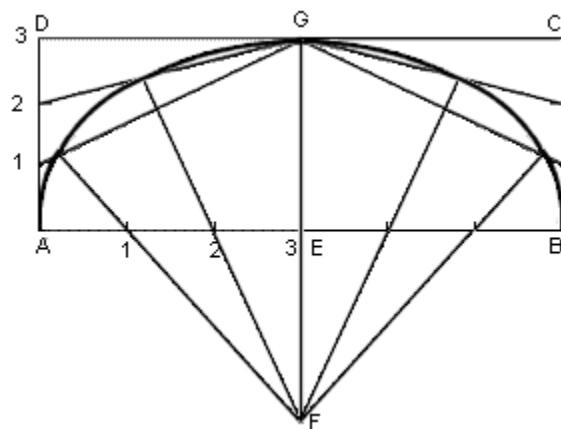
Next, extend a line equal to E-G downward to find center F. From G, construct lines to meet with AD-1 and AD-2. From F, construct lines radiating through 1 and 2 to meet with G-1, G-2.



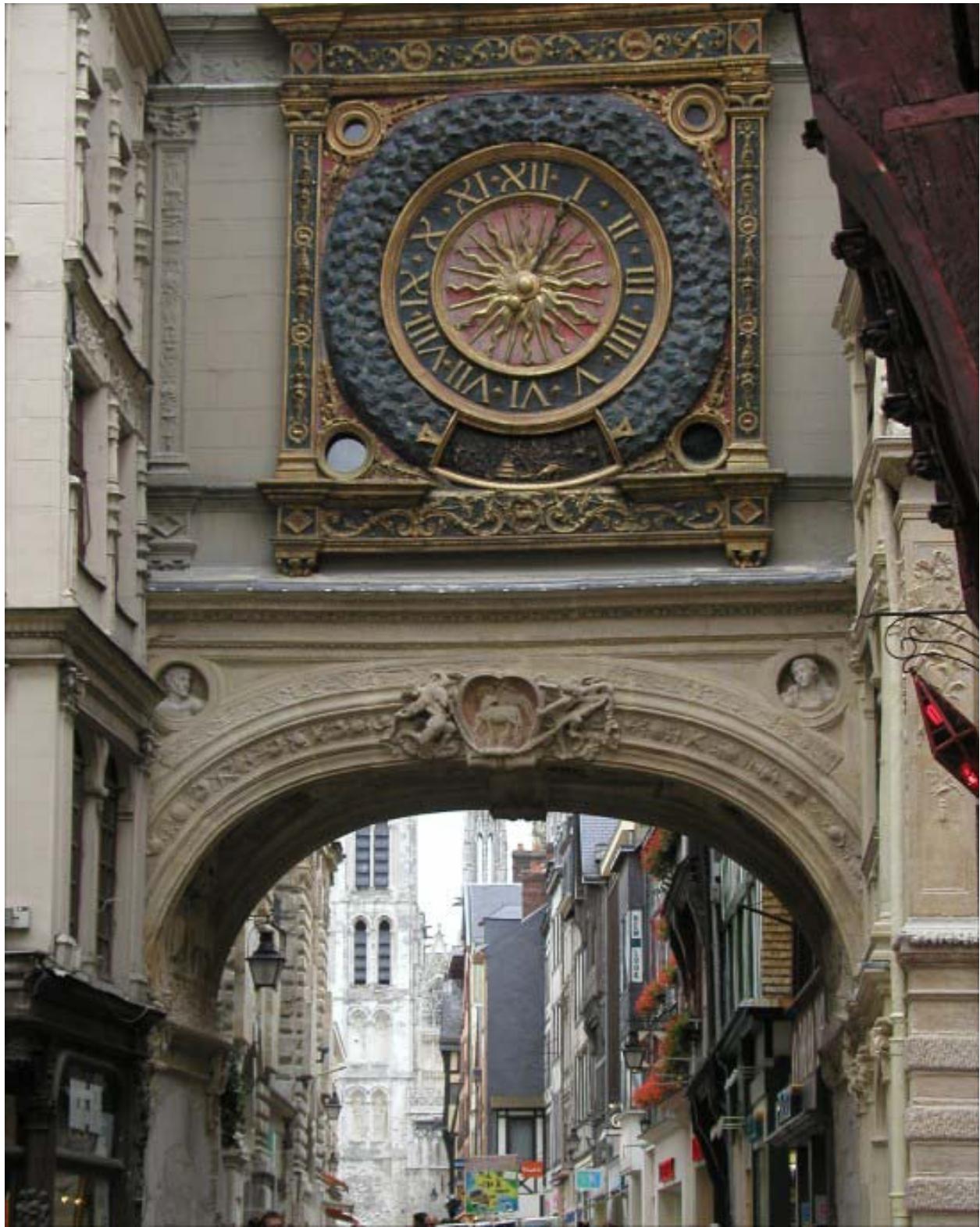
Later destroyed by flooding, Pont d'Avignon was among the most famous chapel bridges of the Middle Ages - having 20 elliptical spans crossing the Rhone when completed in 1187.



Now it's simply a matter of 'connect the dots' to draw the required curve.



Repeat the steps, opposite, to complete the arch.



Detail of a city gate, built on an elliptical arch. Rouen, France.

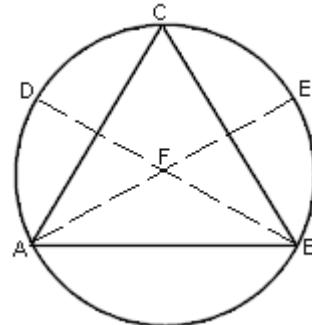
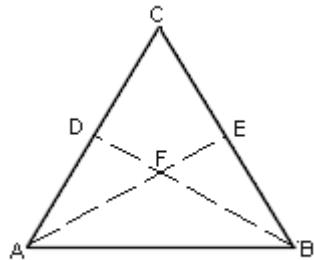
GOTHIC TRACERY

An instantly recognizable feature of Gothic is the stonework tracery that decorates fan vaulting, rose windows, arcaded cloisters, to simple windows and doorways. Many of the following shapes morph and grow from an interesting variety of *other* shapes - including triangles, pentagons, hexagons, circles, or circles within circles.



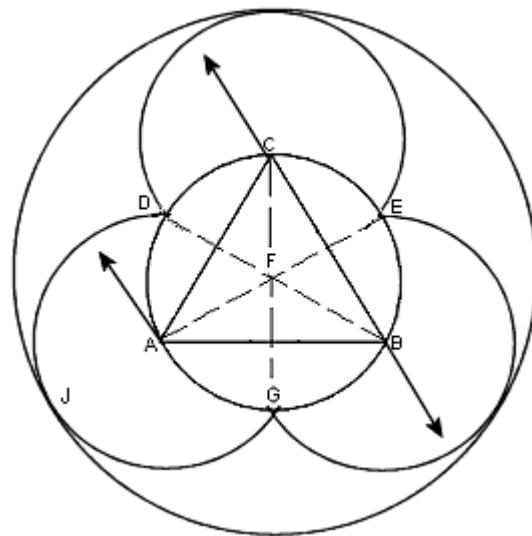
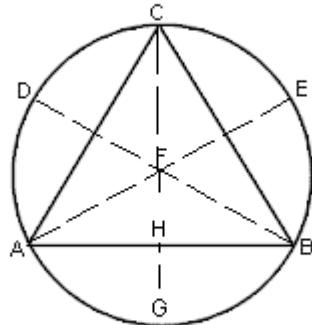
Trefoil

The trefoil or *trifol* begins with a simple equilateral triangle:



Set out an equilateral triangle. Measure half the length between A-C to find point D. Now measure half the length of line B-C to find point E. Draw a line from points D-B and E-A, to find center, F.

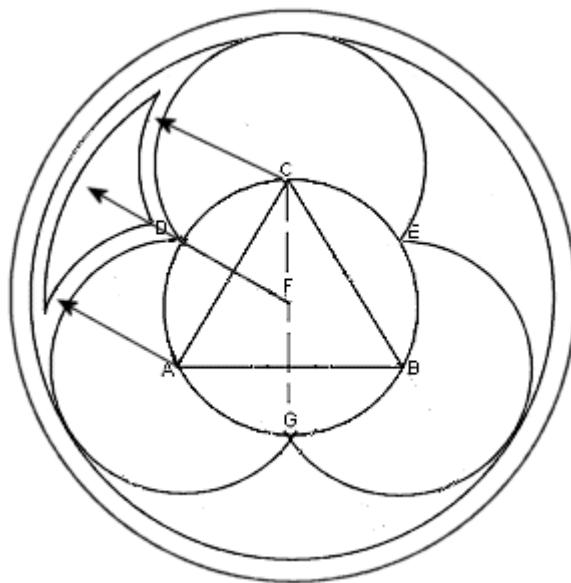
Place your compass needle on center F, and extend compass to point A to complete the outer circle. Extend lines B-D and A-E.



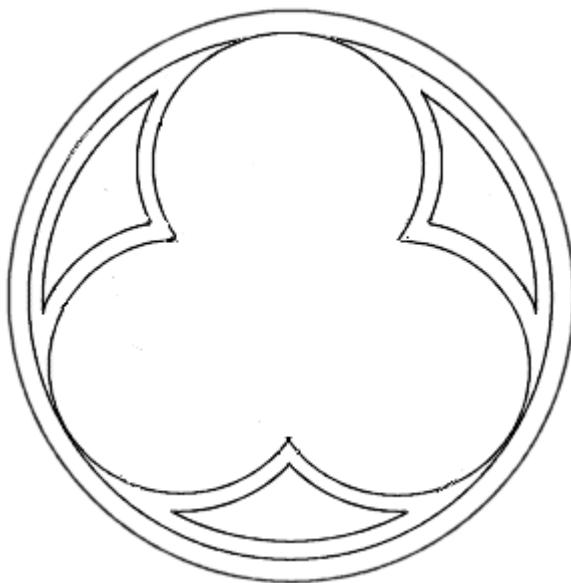
To construct a horizontal center line, divide A-B to find point H. At point C, extend the center line down through F-H-G.

Now use centers A, B and C to form the three arcs.

Extend your compass from F-J to complete the outer circle.



The outer, triangular 'piercing' that surrounds the arcs is accomplished by using center F and one center of each of the three 'eyes'; for example: from centers A, C and F as shown in the left piercing, above.



Continue around until the design is complete.

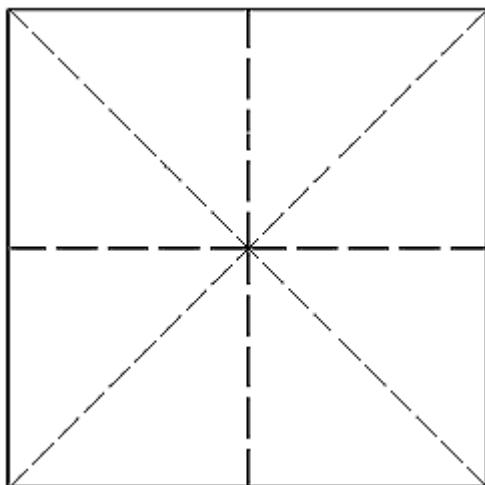


Trefoils decorate the clerestory at St. Denis, Paris.

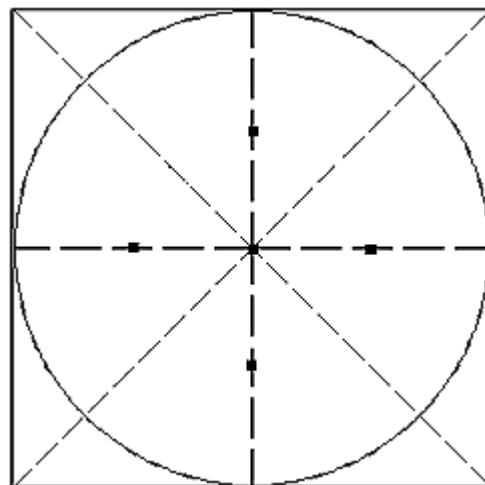


Quatrefoil

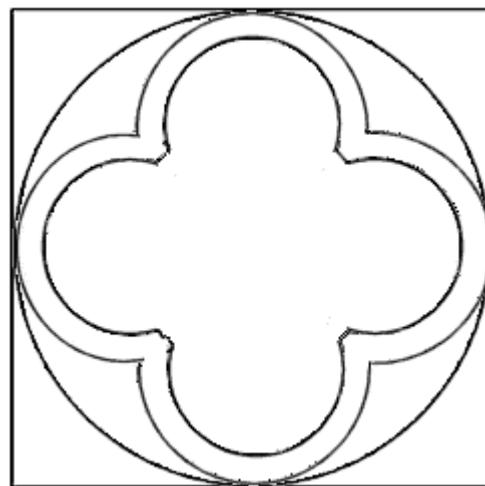
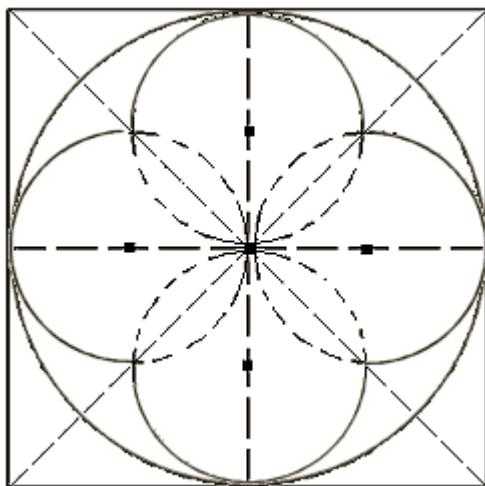
Typical of Gothic and Moorish architecture, the quatrefoil is based on circles within circles...



To find your center point, divide the width and length of a square; then divide again by joining the four corners to arrive at eight sections as shown.



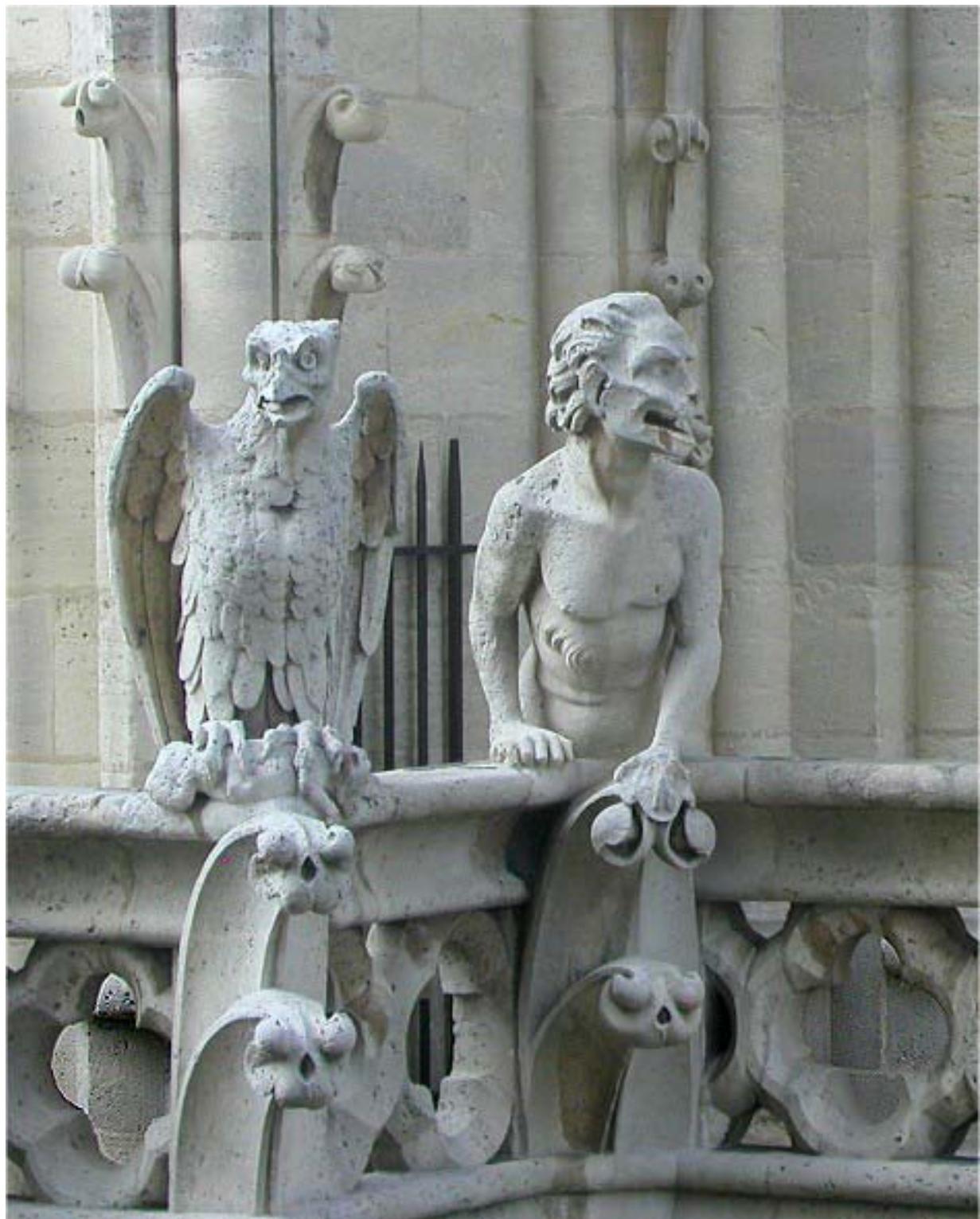
From the center point, inscribe a circle. Now divide the horizontal and vertical center lines into equal quarters.



Use these center points to inscribe the four foils.

GOTHIC TRACERY

Quatrefoils lead the way up and down a Gothic staircase. Rouen Cathedral.



Gargoyles and quatrefoils. Notre Dame, Paris.

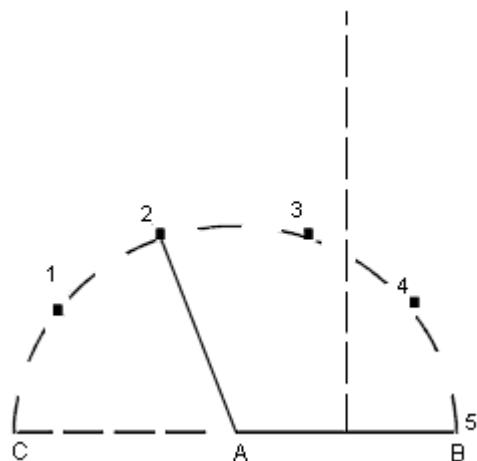


Cinquefoil

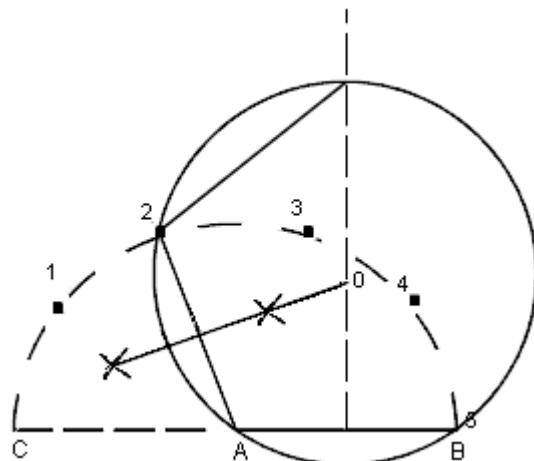
The cinquefoil has five foils, based on the construction of a pentagon:



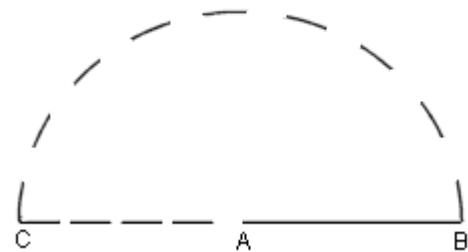
Draw the baseline C-B as shown.



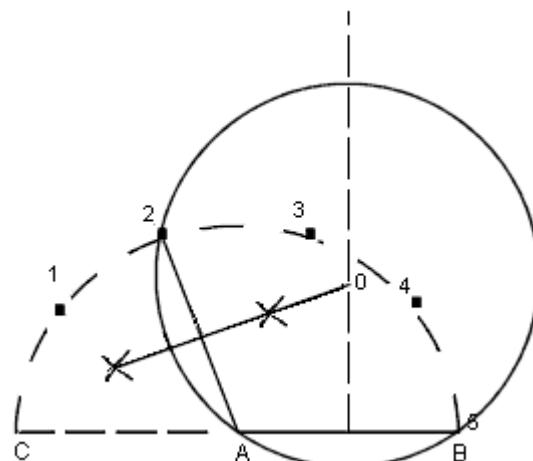
Bisect A-B as shown. Now divide the semi-circle into 5 parts, and from point A draw a line to point 2.



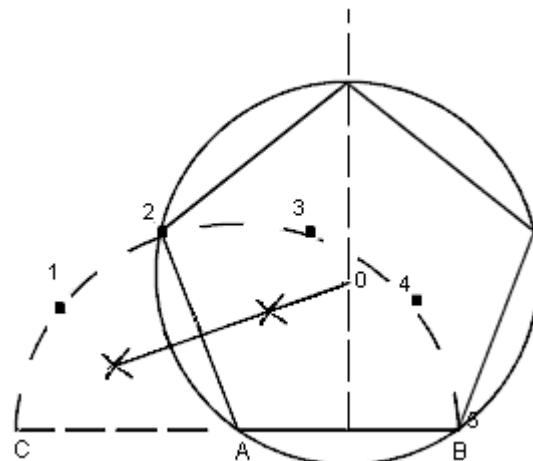
Connect point 2 to the vertical center line as shown.



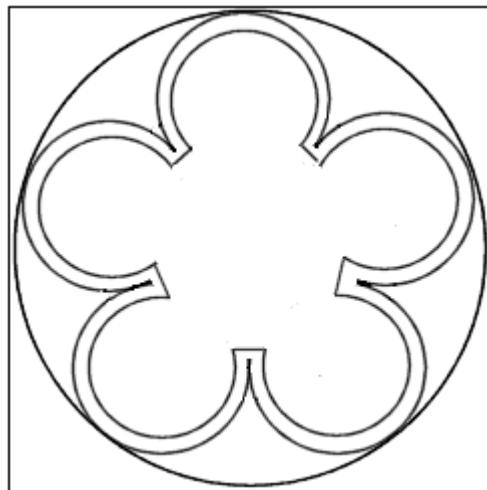
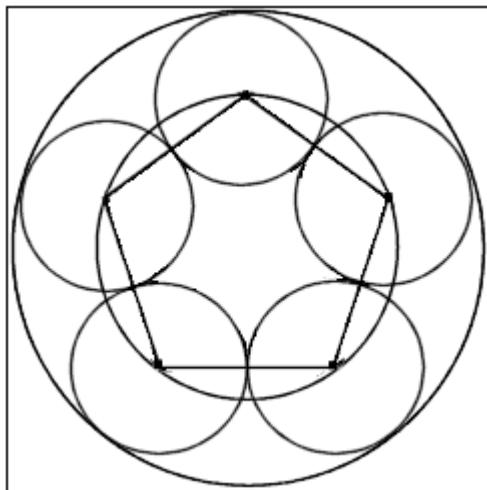
With A as center, draw a semi-circle.



Divide A-2 and A-B to establish point 0. Construct the circle from 0, touching points B-A-2.



With your compass set to the length of A-2, step around the circle to establish connecting points opposite.



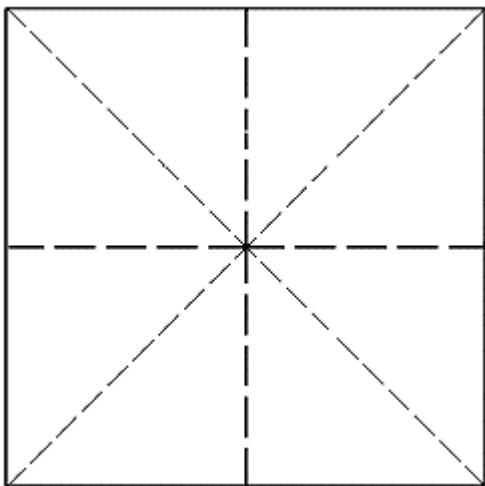
Finally, use the points as centers for the 5 foils.



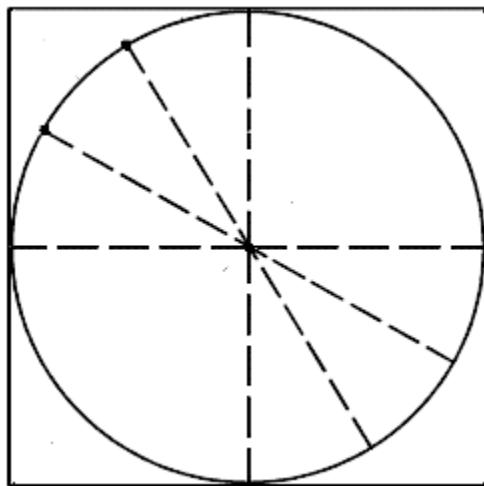
A cinquefoil, center, surrounded by quatrefoil tracery. Rouen Cathedral.



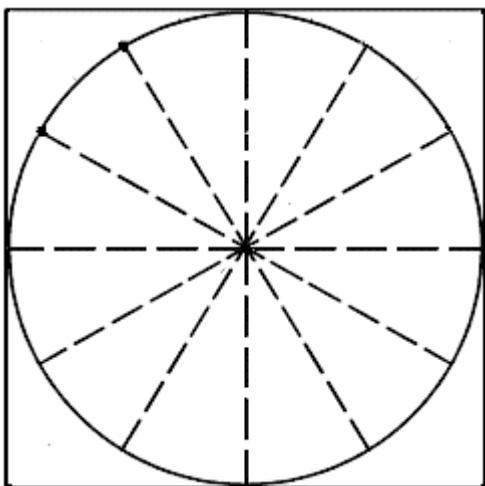
Hexafoil



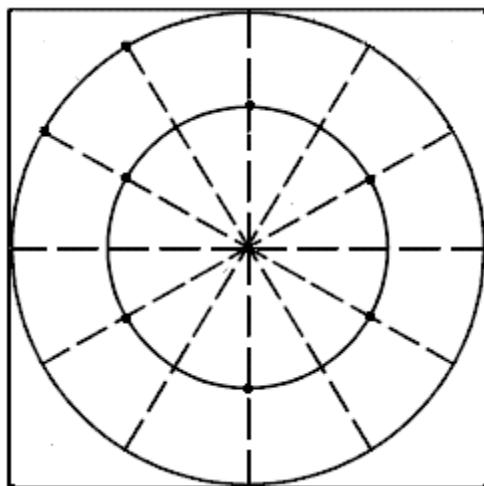
Start with a square and find your center as shown.



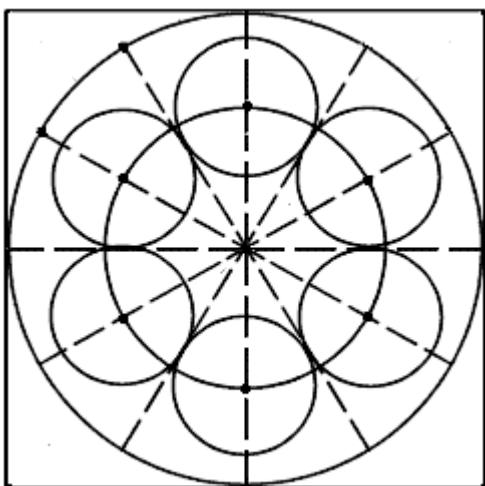
Construct a circle within the square. Divide upper left quadrant into thirds.



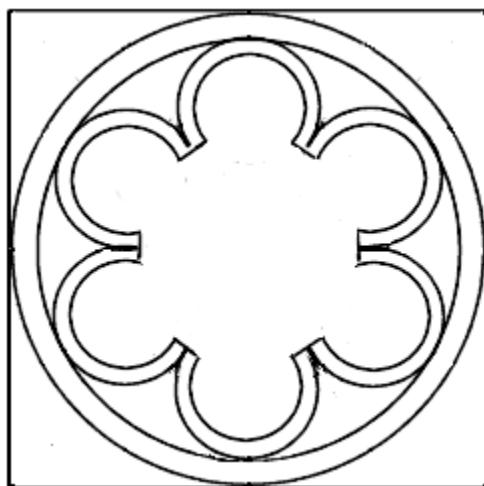
Now divide all quadrants in thirds.



Draw a half-radius circle to find 6 centers.



With tracing lines removed, a molding is further added to complete.



GOTHIC TRACERY

A lion perches atop hexafoil tracery at the Church of Orsanmichele, Florence, Italy.

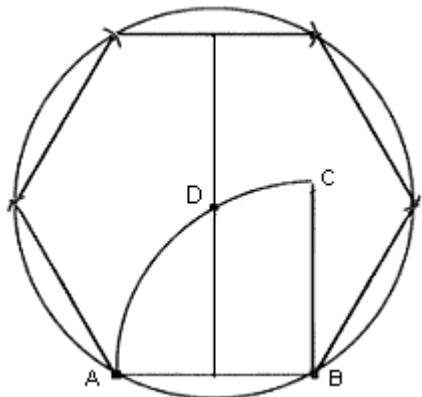


A Simple Rose Window

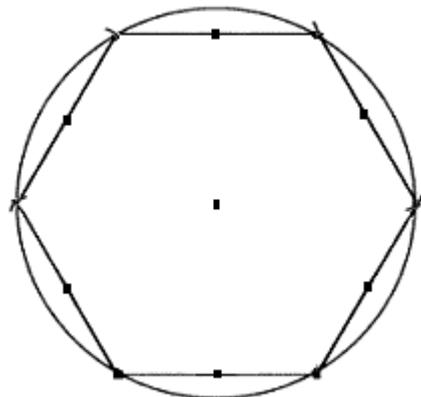
GOTHIC TRACERY

NOTE: Although this blueprint may look easy compared to period designs by Gothic masters - the geometry can be a little daunting if you aren't familiar with the developmental steps described so far in this book.

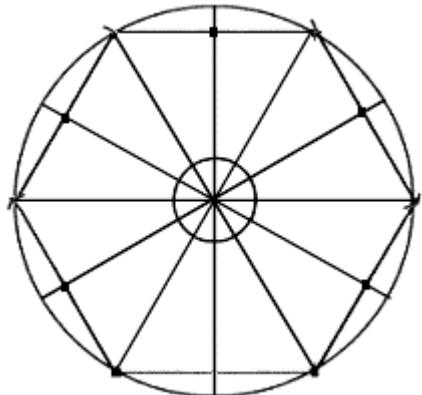
Basic construction begins with a hexagon. Within the hexagon a complete circle is inscribed and, suddenly, you're halfway home:



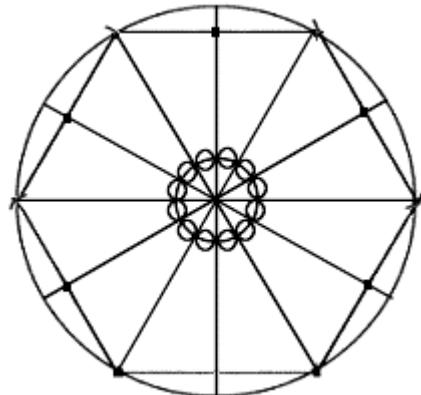
Set out baseline A-B and bisect it to find the vertical center line. Construct the rise B-C equal to A-B. Spread out your compass to the length of A-B and, with the needle on point B, construct arc A-C. Where it intersects with the vertical is the center point, D. From D, spread out compass to A and construct a complete circle. Next, with compass spread out to the length of A-B, step around the circle to find the six sides of the hexagon.



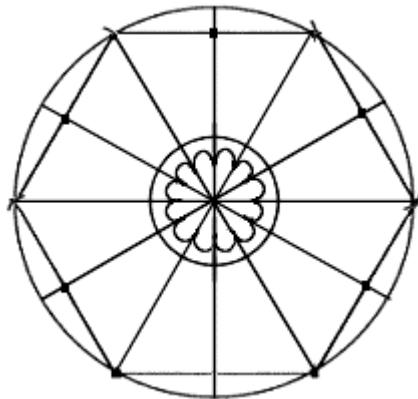
Further bisect the walls of the hexagon into 12 parts as shown.



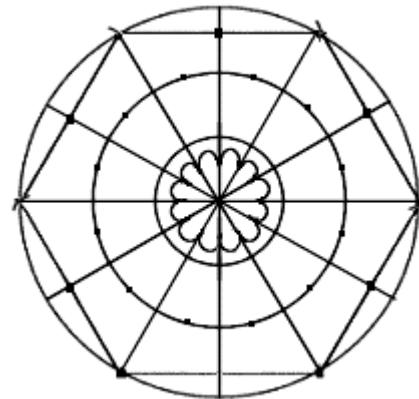
To 'slice up the pie' draw diagonals to result in 12 sections. To begin the first rosette, construct a small circle around the center.



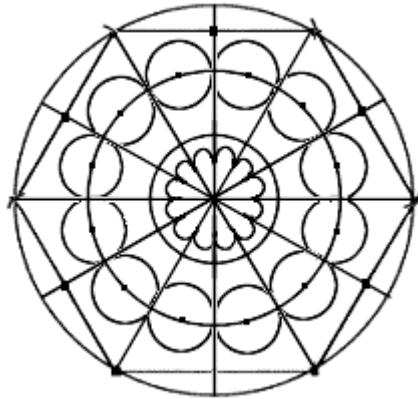
Use this circle as a center line to inscribe smaller circles within each segment, as shown.



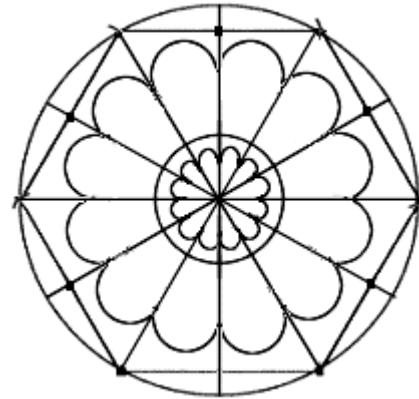
Remove the unnecessary scribe lines to reveal the first rosette. Now from the main center point, inscribe a border.



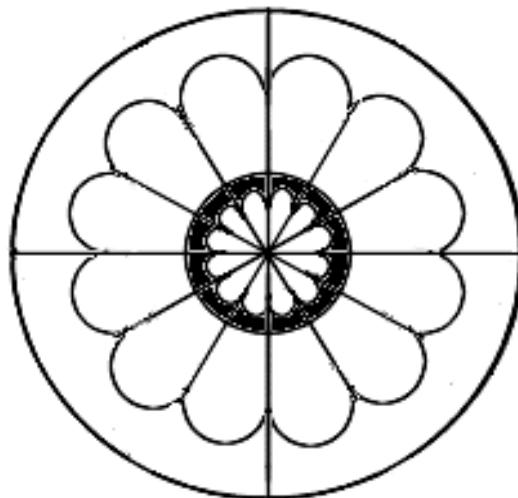
Next, the process is repeated on a larger scale - with another circle inscribed for the main rosette. Bisect the diagonals to find center points.



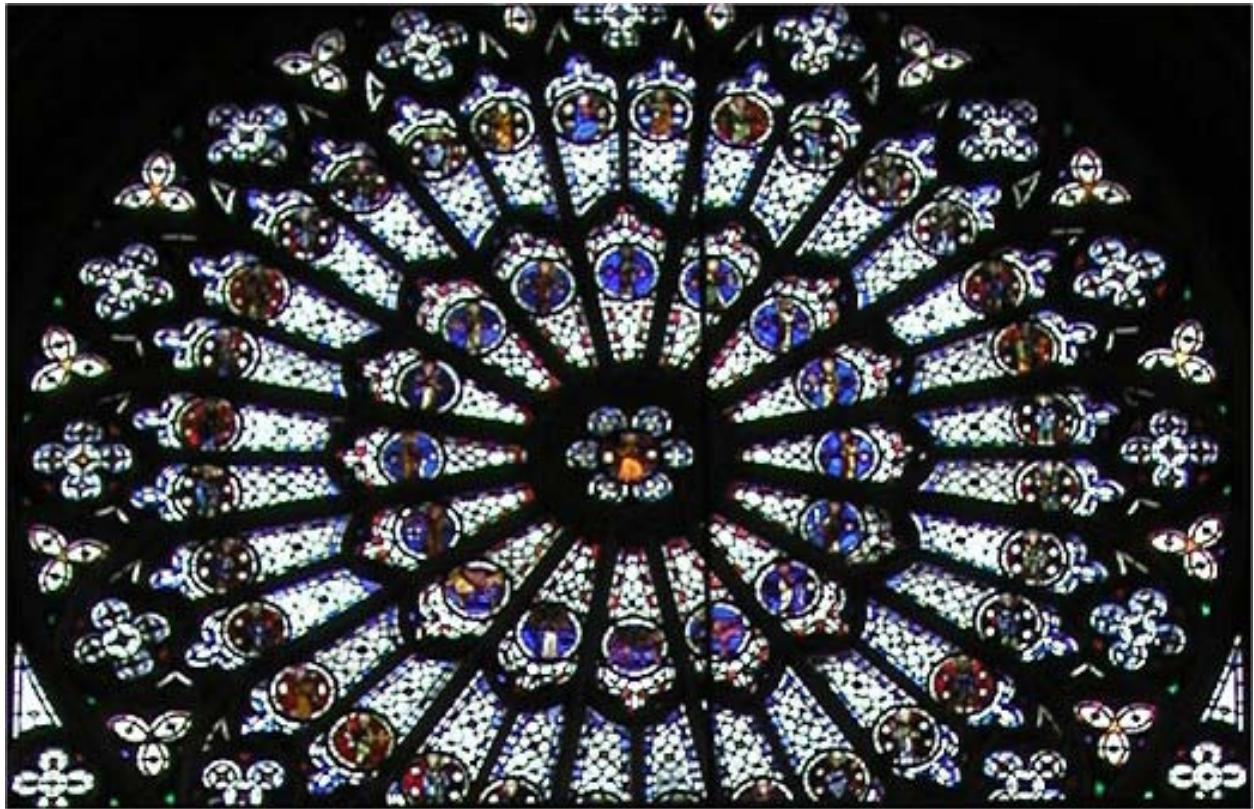
From the center points, inscribe larger circles as shown.



Remove the scribe lines to reveal the 'petals.'



The completed rose window.



Rose window, Rouen.



Rose window, Chartres.



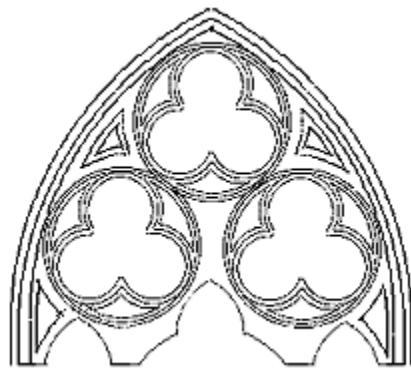
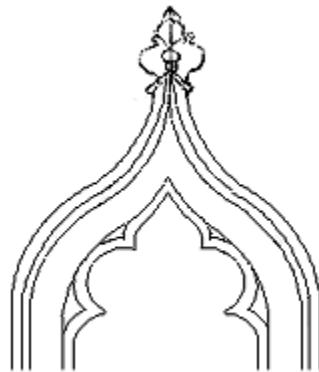
Rose window, Notre Dame, Paris.



Rose window, St. Denis, Paris.

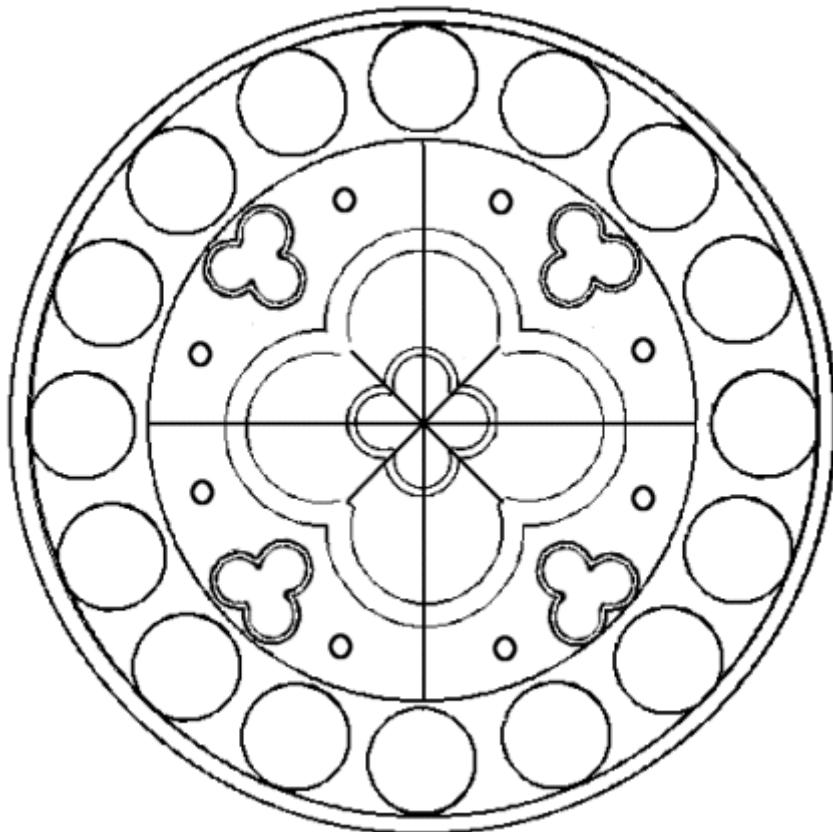
Examples of Developed Tracery from Designs Used in This Book

When you're familiar with the basic geometric constructions, try arranging them in original patterns of your own. It's best to begin with these classic examples, below, which maintain a good balance between line and curve:



Ogee arch topped by a finial.

Three trefoils in an equilateral arch.



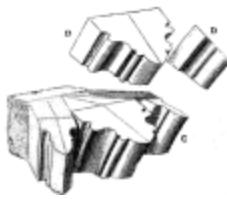
Quatrefoils, trefoils, and circles in a rose window, based on an example from Lincoln Cathedral.



Gothic arcade at Avignon.

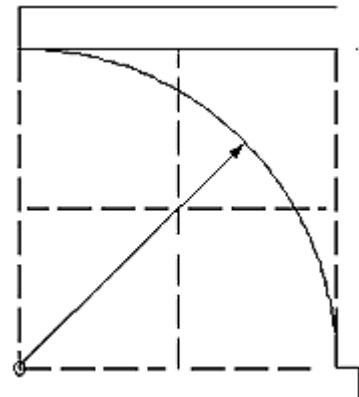


Five, four and three-sided foils embellish a pinnacle stone at St. Denis, Paris.

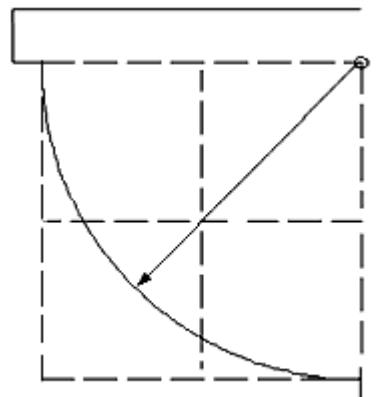


Gothic Moldings

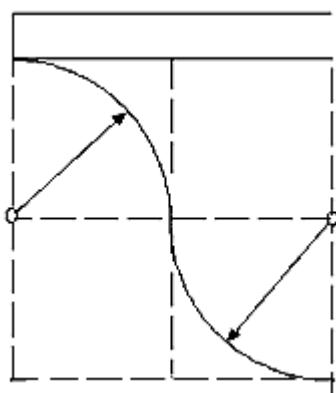
Whether on a facade or in interior columns or coursework, decorative moldings are often deeply cut to enhance the interplay of light and shadow:



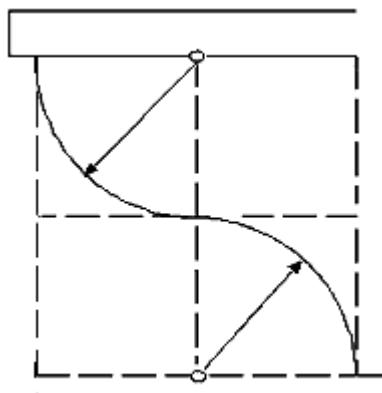
caveto



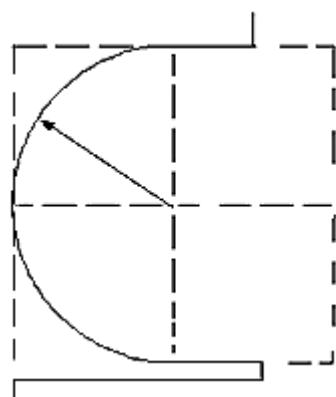
ovolo



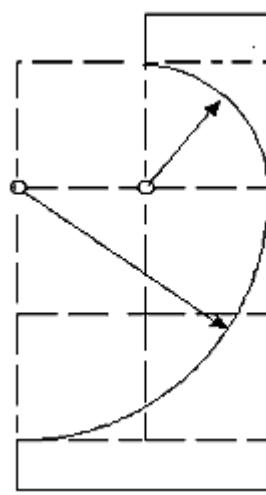
cyma recta



cyma reversa



torus



scotia



Cavetto, ovolto and torus moldings on the exterior of St. Denis, Paris.



Recommended Reading

The geometric constructions found in this book are based on diagrams and readings from *Modern Practical Masonry* by E.G. Warland, first published in 1929 (even today considered the 'mason's bible' with old copies jealousy guarded); and *Building Geometry and Drawing* by Frank Hilton, which originally appeared in print in 1973. Both publications are now sadly out-of-print and difficult to find.

Links to mainly historical works on Gothic and sacred geometry are listed below and readily available for purchase at Amazon.com. In addition, there are a good number of sites on the World Wide Web that may be of interest:

Books through Amazon.com:

- [A Beginner's Guide to Constructing the Universe: The Mathematical Archetypes of Nature, Art, and Science](#) by Michael S. Schneider
- [Sacred Geometry](#) by Miranda Lundy
- [Sacred Geometry: Philosophy & Practice](#) by Robert Lawlor
- [The Fourth Dimension: Sacred Geometry, Alchemy & Mathematics](#) by Rudolph Steiner
- [Sacred Geometry: Symbolism and Purpose in Religious Structures](#) by Nigel Pennick
- [The Geometry of Art & Life](#) by Matila Costiescu Ghika
- [Geometry of Design: Studies in Proportion and Composition](#) by Kimberly Elam
- [Pugin's Gothic Ornament: The Classic Sourcebook of Decorative Motifs](#) by Augustus Charles Pugin

Web Sites of Interest:

- [Sacred Places: Sacred Geometry](#)
- [Engines of Our Ingenuity: Gothic Math](#)
- [Number Symbolism in the Middle Ages](#)
- [Creating a Geometry Cathedral](#)
- [Geometry, Gothic Architecture, Rose Windows, and Christmas Ornaments](#)
- [Religious Beliefs Made Visual: Geometry and Islam](#)
- [Cunning Geometry: The Designing of Medieval Churches](#)
- [The Paper Folding Project](#)
- [The Geometry of War](#)
- [The Medieval Liberal Arts Curriculum: Arithmetic](#)
- [The History of Geometry](#)
- [Architecture into Art](#)
- [Rose Windows: Beyond Art to Mysticism](#)
- [The Architecture of Notre-Dame de Chartres: The Victory Over Darkness](#)
- [Medieval Cathedrals and Their Meanings](#)
- [In the Womb of the Rose](#)
- [Medieval Architecture: The Rose Window](#)
- [Martin Dace's Geometry Page](#)