

THE GOLDEN RATIO

Knowledge of the Golden Section, ratio, or proportion has been known for a very long time. The Egyptians knew about it and the Greeks learned about it from them. It is called *phi*, Φ , in honor of Phideas, the architect of the Parthenon, and it is approximated by the irrational fraction 0.618034... Shamans, priests, and artists throughout the world and across history have understood and applied Φ to ritual, architecture, art, and the crafting of musical instruments and everyday objects.

Φ appears throughout the natural world at all size scales. Recall the famous drawing by Da Vinci showing man within the circle and the Golden Ratios in the human body, and more recently, Le Corbusier's *The Modular*. For example, the finger bones are in Φ ratio to each other, and the position of features on the human face follow Φ . The major 6th harmony interval in music is in Φ ratio to the octave.

The Golden Rectangle (GR), the organizing form in ***Sacred Geometry 2003*** and in my current work, is a rectangle with a short to long side ratio of 1: 1.618, or 1: $(1 + \Phi)$. An interesting property of GR's is that if you cut out a square starting from one of the short sides of the GR, you will be left with another GR. You can continue to cut out short side squares for each successively smaller GR and another smaller GR will remain. And the dimensions of each successively smaller rectangle will be in Φ ratio to the previous larger size. ***Sacred Geometry 2003*** paintings are based upon this Φ -ratio "coiling" property of GR's, as seen in Figure 1:

Figure 1

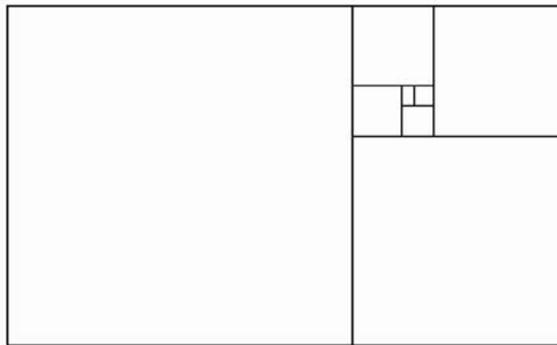
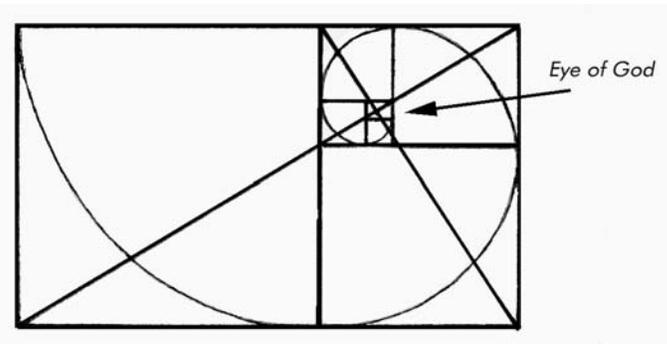


Figure 2 shows a logarithmic spiral superimposed on a coiled GR. This study shows the Φ -ratio sectioning of the GR with short side squares and the diagonals of the original seed GR (GR_0) - outside boundary lines) and the diagonal of the first Φ -sectioned GR (GR_1). Note that the two diagonals intersect at a point called the "Eye of God," the origin of the logarithmic spiral.

Figure 2



Logarithmic spirals are natural forms (remember the chambered nautilus?) and many natural forms will fit neatly with a GR. Examples include bird eggs, human heads, and spruce trees. So, it would seem that the distinction between a simple "geometric" form like a GR and an organic form like a logarithmic spiral is superficial. Both forms imply and can be derived from the other!

A final note about the GR involves *fractals*. Fractals are geometric forms that look the same no matter what the size scale. They are composed of repeating units that combine to make larger and similar units at larger scales. This property is called *self-similarity*, and it is an important property of nature and natural forms. Fractals also have a property called *fractional symmetry*, which means that the self-similar units are in non-integer fractional proportion to each other. The square is the self-similar shape that is repeated in the GR, and Φ is a non-integer proportionality ratio, so GR's qualify as basic fractals.

THE PROCESS FOR THE *SACRED GEOMETRY 2003* COLLABORATION

I have been studying the Golden Ratio for the past 5 years, and in August of 2001 had an exhibit of small collages featuring coiled Golden Rectangles using proportional squares. See figures 3 and 4 for examples:

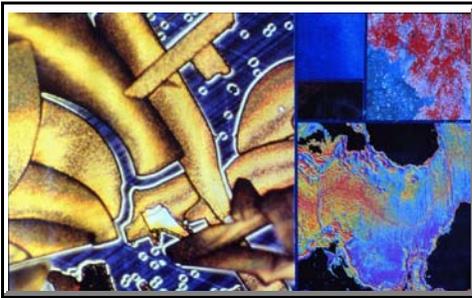


Figure 3



Figure 4

These collages combined abstract images of the natural world in unexpected ways and I soon realized that the same idea could be applied to painting. Further, collages of paintings could be assembled from other people's work - and that was the genesis of the *Sacred Geometry 2003* collaboration. But how could this idea be executed on a practical level? The answer is found in the Fibonacci number series.

FIBONACCI NUMBERS AND THE *SACRED GEOMETRY 2003* COLLABORATION

Fibonacci was the pen name of Leonardo of Pisa, a 13th century mathematician whose book, *Liber Abaci*, introduced western civilization to Arabic numerals (replacing Roman numerals), and a special sequence of numbers named after him. Fibonacci raised rabbits and observed their population numbers over successive generations. They increased in a peculiar "additive" way, and from this he surmised the more abstract number sequence. Starting with 0 and 1 as the first two numbers in the sequence, each successive number is determined by adding the previous two numbers. Starting with 0 and 1, the series goes like this:

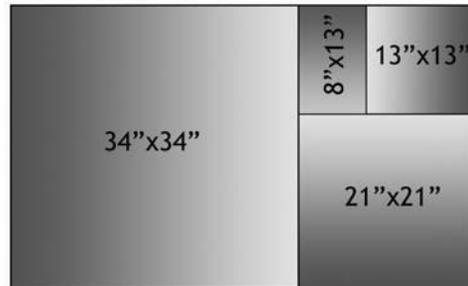
0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, ...

It turns out that this sequence of integers is much more than an arithmetic game. These numbers turn up *all the time* in nature, and are observed in the dimensions and branching of all plants and animals, as

well as crystals and the solar system. This happens because when things grow, they often grow on top of a previous structure, so that the new growth is "added to" the existing structure (like new offspring are added to the existing population). Many plants exhibit Fibonacci numbers in branching, or in spiral structures like the rows of bracts on pine cones, petals on an artichoke, and scales on a pineapple.

This would just be a curiosity about nature until we start calculating the *ratio* between adjacent Fibonacci numbers. It turns out that these ratios approximate Φ . Furthermore, since canvas stretchers usually come in 1-inch increments, selecting stretchers with Fibonacci number sizes makes creating a Golden Rectangle a simple matter. I calculated that a 34"x55" Golden Rectangle could be prepared from squares measuring 34"x34", 21"x21", and 13"x13", plus a small 8"x13" Golden Rectangle:

Figure 5



In November 2002, Dave Griffin, Kent Rucker, Roger Rapp, and Rolf Helland came over to my house for a Fibonacci stretching party. Each of us prepared a set of canvases that formed a 34"x55" Golden Rectangle. Then, over the winter, each of us separately completed a painting inspired only by the theme of this show: sacred geometry. In March 2003, we all met at Roger Rapp's house and mixed each other's Golden Rectangle fragments to create the collaged arrangements seen in the ***Sacred Geometry 2003*** paintings. The consensus decisions about the composition of the collages - what fragments worked best with others - were made over a very short time in a freely improvised manner - much like a musical jam session. Thus, the arrangements seen in this exhibit are not unique, but just one possibility out of many.

BIBLIOGRAPHY

These books have been helpful in my study of the Golden Proportion and form in nature and art. I recommend Garland's *Fascinating Fibonacci*s to anyone who would like a general overview. It's easy to understand and gives a lot of good visual examples. Teachers may want to consider Garland as an introduction and Runion's *The Golden Section* or Walser's *The Golden Ratio* for a more math-oriented approach with problems in each chapter. Garland is suitable for middle school kids while Runion and Walser are high school algebra level. Let me know if you have recommendations for other books on the subject of sacred geometry, the Golden Proportion, or form-based aesthetics.

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