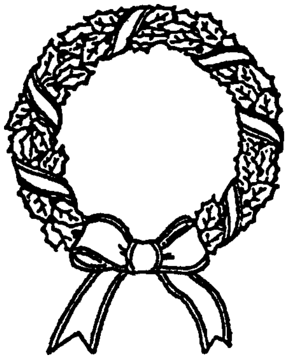
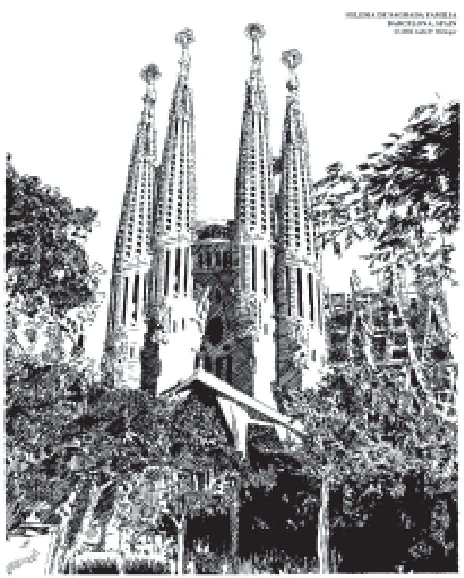
# ARCHITECTURE





Ehlinger & Associates extends Seasons Greetings to all of our friends who receive the newsletter. Merry Christmas, Happy Hanukkah, and Happy New Year.



## Iglesia de Sagrada Família

**Barcelona, Spain**

This issue's limited edition signed print by Ladd P. Ehlinger is of the south transept of Iglesia de Sagrada Família (Church of the Holy Family) in Barcelona, Spain. This church is locally called a "Temple" so as to differentiate it both from the Cathedral and an ordinary church. Iglesia de Sagrada Família was primarily designed by Antoni Gaudí i Cornet, a Catalan Architect.

Antoni Gaudí was born 25 June 1852 in Reus, a fair sized provincial town west of Tarragona. He was born into a family of metalworkers, that for generations had intermarried with daughters of other smiths. Growing up in this dry Mediterranean environment, Gaudí was enamored of nature and the structure and form of the plants in the region in particular. This life-long interest and love of natural form found its way into the buildings that he designed, especially in Sagrada Família. Gaudí worked in the Art Nouveau style of the times initially, but grew as an artist / architect and devolved his own style that became more and more radical as time went on. The author Robert Hughes said that Gaudí used the most modern techniques of structure and construction to become more ancient. For instance, Gaudí modeled the structures of many buildings, including Sagrada Familia, in upside down string and weight fabrications at a 1:100 scale. He photographed the deformed shape of the model, turned the photo $180^{\circ}$, and then used it as the basis for the shapes of the un-reinforced daring arches that he built. The results were often bizarre as well — which confirmed the opinions of many about the bizarre nature of Barcelona and its inhabitants.

Sagrada Família is located in the Eixample (Extension in Catalan) section of Barcelona, which was developed in the 19th century in response to enormous industrialization and growth that Barcelona was undergoing. The old Gothic section couldn't manage all of the expansion needed, so a whole new area was developed to the west with wide streets and boulevards where the buildings at intersections are all on a $45^{\circ}$ angle, rendering the streets visually larger than they really are.

Sagrada Família started in 1866 with the formation of a right-wing conservative group of Catholic men that were devoted to the Holy Family in response to calls from the Pope. The Spiritual Association for Devotion to St. Joseph — the Josephines — was thus formed. A prominent local leader persuaded the group that Barcelona needed a permanent church devoted to Joseph, his virgin spouse, and their Son. There, the people could go and do penance for the sins of modernism — hence the official name: the Expiatory Temple of the Holy Family.

The Josephines raised considerable sums of money, bought the property in the Eixample, and hired an architect named Villar, who quit after a year and produced a mediocre Gothic revival design (part of which, the Chevet, was built). It should be pointed out that Villar oriented the church $180^{\circ}$ opposite from how churches normally are oriented: the west front is the rear instead of the front. Somehow this fits the character of Catalunya with its penchant for bizarre and eccentric behavior and form. The group then hired Gaudí, who was given totally free rein.

Gaudí completely changed the design to reflect his evolving aesthetic. The north transept was the first to be built. It has the look of having been constructed out of snow that had partially begun to melt — various details are droopy and dissolving in appearance. It is no accident that Salvador Dalí, who is also a Catalan and was very familiar with Gaudí, championed Gaudí and fathered the surrealist movement in art, with the painting of the dissolving watch.

The south transept in the sketch was first constructed in 1903-1926. Gaudí did not live to see this portion completed as he was hit by a tram in 1924, and died three days later. The transepts and the nave are structured by strange inclined columns that branch at the top like trees, and then support domes — all based upon the string and weight models, trees and human bones somehow fused together into a coherent form.

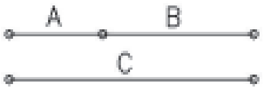
The work remained uncompleted and worked on only in fits and starts as money became available to the private Josephines. In 1936, during the civil war, a mob broke into the church and destroyed all of Gaudí's records, drawings and models. What is being built today is a reconstruction based upon photographs of these records as interpreted by others today. Modern structures and materials are being incorporated over many people's objections. But there is no choice but to finish it.

**2200 Houma Blvd., Metairie, LA 70001-1399 (504) 455-8911 3109 Ivy Ave. SW, Huntsville, AL 35805-4698 (256) 534-1900**

# Phantastic Phi!

In Architecture, a fundamental principle of design is to find the balance of form and function. One tool used to help satisfy this balance is Phi (pronounce "fee" or "fie", and represent as F). Phi is a unique mathematical constant that, at its most basic level, describes the proportion where a number is equally proportional to a number smaller than itself as to the next number.

$C/\Phi = B = A\Phi$




Only one number solves this equation, and that number is: **1.618033988749895.......** (it's an irrational number, but 16 digits is all most calculators and computers bother with.)

What's unique about Phi is not just its mathematical implications, but that this proportion is also a building block of physics, nature, and life. It is found in the workings from the subatomic to the cosmic, from inorganic order to the most complex of living organisms. When examined from this basis, it is not surprising that this number has been named the "Golden Ratio" and the "Divine Proportion", and that its symbol, Φ, even has theological implications. Φ has played a crucial role in many religions, from Ancient Egypt to Christianity.

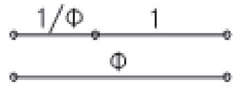
From an architectural design viewpoint, it is the perfect proportion for both form and function. On the function level, it works because all life is designed on the basis of Φ. On the form level, it works because the human mind is tuned to Φ... literally. Studies show that the brain waves in people who are in a pleasant state are tuned to Φ. The human heart beats in a Φ rhythm. What, then, could be more pleasing to the eye, then, than Φ?

In a series of articles, I will be expanding upon the different aspects of Phi, and how it relates to architecture and design. So, to help really get a grasp on Phi, let's start with the math and geometry.

**The Math of Phi**

I've already explained the fundamental of Phi: $C/\Phi = B = \Phi A$, but this is only the tip of the iceburg. If we rewrite this formula we can see how Φ is derived.

$\Phi - 1 = 1/\Phi$




This formula can also be expressed as:
$\Phi^2 = \Phi + 1$

Reducing even further, we can solve Φ:

$$\Phi = \frac{\sqrt{5}+1}{2} = \Phi = 1.618033988749895.......$$

(try it out on your calculator).

What's very interesting is that this solution can be written in different ways, all of them focused around the number 5:

$$\Phi = 5^{.5} * .5 + .5 \qquad \Phi = \sqrt{\frac{5+\sqrt{5}}{5-\sqrt{5}}}$$

The one on the right is my favorite, because of the numerical oddity the same numbers create as expressed below:

$$(5+\sqrt{5})*(5-\sqrt{5}) = 5+5+5+5$$

The number 5, for some reason, appears over and over again as related to Φ, particularly in nature and life. 5 is also of note in how Φ relates to the other irrational mathematical constants, π (pi), and ***e*** (natural log).

$$\Phi = 2\cos\left(\frac{\pi}{5}\right) \quad \text{and} \quad 2\sin\left(\frac{\pi}{5}\right) = \sqrt{3-\Phi}$$

$$\Phi = e^{\text{asinh}(.5)}$$

(That's an inverse hyperbolic sine function, if you remember your math.)

Phi has a harmonic relationship to both π and e, and, in my humble opinion, p and e are merely different manifestations of Φ.

"Okay, great," you might be thinking to yourself. "What does this have to do with architecture?"

Well, besides mathematically providing a consistent method to proportion, it provides one that works on any scale, and can be curvilinear or logarithmic as well as spatial. And that's just to start.

To even better understand Φ and architecture (as well as nature, the living form, genetics, and subatomic particles), it will help to delve into even more math: The Fibonacci Series.

**The Fibonacci Series**

In 1202, Leonardo Pisani (nicknamed "Fibonacci") published a book of mathematics , of which one word problem led to the following sequence of numbers:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233....

Where the mathematical formula is $F(n) = F(n-1) + F(n-2)$, such that any number is derived by adding the two previous numbers, starting with 0 and 1. 0+1=1. 1+1=2. 2+1=3. 3+2=5. etc. etc.

While Fibonacci's book had little impact at the time, this series of numbers took on a life of their own as amazing mathematical discoveries and science relationships were made regarding them.

To begin with, this series of numbers is a progression towards Φ. If you take the proportion of one number to the next: $F(n)/F(n-1)$, the number approaches Φ.

| | |
|---|---|
| $1/0 = \infty$ | $5/3 = 1.666...$ |
| $1/1 = 1$ | $8/5 = 1.6$ |
| $2/1 = 2$ | $13/8 = 1.625$ |
| $3/2 = 1.5$ | $21/13 = 1.615..$ |

$f(\infty)/f(\infty - 1) = 1.6180339.... \Phi$

The Fibonacci sequence is important to Architecture (and the sciences) because it provides a whole number method to approaching Φ. There is no 1.6180339 sized brick, or tile, but one can create a rectangle of 13x8 tiles to define a proportion. One can dimension 34x21 easier than 33.9787119...x21.

It's also important in the sciences, because nature is also defined by discrete units: 1 atom, 1 molecule, 1 gene, 1 cell. Nature builds things using the Fibonacci sequence: one DNA molecule is 34 angstroms long by 21 angstroms wide (two sequential Fibonacci numbers). The double helix spiral of DNA is spaced 13 angstroms to 21 angstroms (two more sequential Fibonacci numbers), and a cross section of DNA reveals a dodecahedron shape, which is two pentagons overlapped, one rotated half the distance of the face of the other. A pentagon is proportioned by Φ.

Fibonacci described the simplest of numerical sequences, with the farthest reaching implications.

***Next:*** More Fibonacci, and Φ Geometry.