Harmonic Proportion
A Classical Basis for Metalwork Design

The golden proportions, recognized by the Greeks 2500 years ago, provide guidelines for designs that are visually pleasing and intellectually exciting.

By Rhoda Weber Mack, Fine Architectural Metal smiths

To the designer poised with pencil over a yet undrawn door grille or balcony guard, or to the landscape architect contemplating the void between gate pillars that awaits the sketch of a driveway gate, the empty white space may look deceptively ready to accept any freehand lines drawn.

But it is not enough to know that the client is a Tudor or Georgian or Italian Baroque enthusiast, or that the original façade was constructed in 1910. It is not enough to pull out a series of motifs of the period in question from a design book and paste them together in a way that fills the space. That can be a formula for bad design precisely where the design should be the most elegant and controlled.

Proportion: The Greek Gift to Architecture

What makes the classic styles work is a sense of proportion that brings the parts into harmony with the whole. A classical design can translate well onto a contemporary site because of the universally pleasing nature of proper proportion. Hidden in the roll of scrollwork or the meander of the frieze, the stiff linearity of English grillework or the fanciful fretwork of an Italian Renaissance piece, is a 2500-year-old key to the definition of good design: the golden section, the golden mean (or ratio), and the golden rectangle.

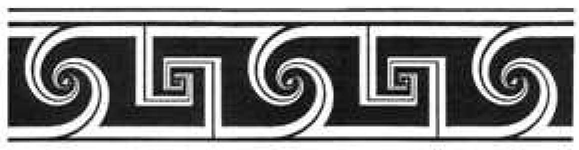
In ornamental metalwork, the geometry of proportions offers a way to develop complex scrollwork that is intrinsically harmonious to the whole. It offers a logical schematic for the grillework of a door panel, or the massive interlaced patterns of an entrance gate, or the flow of French scrollwork down the staircase of a grand foyer. Harmonic proportion is a tool for bringing the many parts of a complex project into a unified whole.

How does the theory of harmonic proportion translate onto that blank drafting paper awaiting the design for a door grille or driveway gate? Whether the designer is visually oriented, with a good instinctive feel for what "looks right", or logic-driven, with a keen appreciation for the mathematical nuances of design, the golden proportions are applicable to the design process. For the visually oriented thinker, the proportions of the golden mean and its derivatives are innately appealing; the intuitive designer will recognize their existence in nature, and will sketch them in without necessarily knowing why. For the mathematically oriented, the clear rules of proportion give a logic to design that is intellectually exciting.

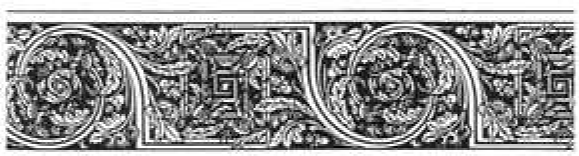
Where to Start

Stepping back from the immediate problems of the project design, look at the overall shapes of site. Does the run of the land indicate an arc? Does the scale of the property suggest a scale? Does the façade of the building demand a related proportion? The application of Hambridge's design theory provides a solid working approach to answer these elementary-but often nebulous-design questions.

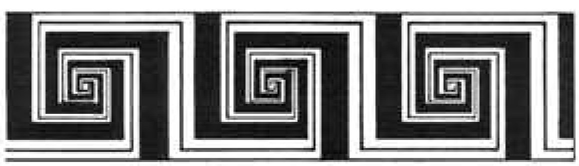
Harmonic Proportions Applied To Finished Designs



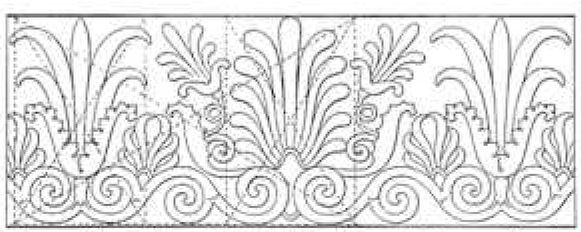
Working with nothing more than the spare geometrics of the golden proportions, Hambridge's diagonal, and related spiral developments (as explained in the accompanying sidebar) readily produces handsome designwork with an Art Deco signature.



Overlaying the schematic with decorative floral and leaf motifs of a Renaissance character produces a completely different, and accurate, period look.



The Greek geometric fret or meander is readily duplicated in the angular spiral, and the ornamentation of Egyptian and Greek temples shows the underlying proportions of the Hambridge design theory.



It is possible to "diagram" the designs of antiquity in terms of their relationship to one of the proportional rectangles.

Illustrations from "Dynamarhythmic Design", by Edward B. Edwards

Coming back to that blank paper awaiting a design, let's start with the most common design challenge in ornamental metal: proper proportions in a panel. Wrought ironwork has historically been broken up into panels;

structural considerations often demand it. The theory of harmonic proportions offers tools to develop panels that work in context. Take a common design scheme: A railing or grille broken up into alternately large and small panels. Analyzing the panel proportions that "look right" shows that in good design the smaller panel is the reciprocal of the larger panel, or the same shape and proportions of side to end as the larger panel, only rotated at 90 degrees to the large panel (Figure 1).

A second design challenge is the narrow panel that often runs along the top of a railing or fence. The narrow frieze can look lost unless it relates to the proportions of the whole. For example, if the railing or fence itself is broken into narrow upright panels, they may recreate the proportions of the frieze on a larger scale. Here, the frieze is the reciprocal of the larger upright panel, and the design works (Figure 2).

Figure 1

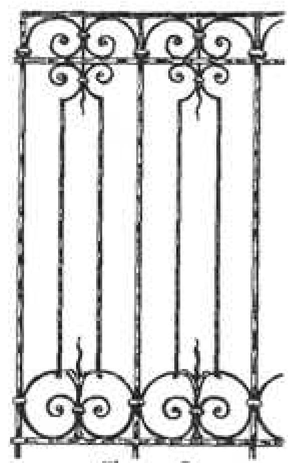


Figure 2

Proportional design is less obvious in free-form design or scrollwork. In a freely drawn arrangement, the hidden diagrammatics of proportional design form an invisible structure on which to float the design. In a traditional period style, proportional design theory is a valuable tool for scaling ornamentation appropriately to the whole. Harmonic proportion creates scrollwork that is fluid without being either too dwarfed or too overbearing for the piece. It is much easier to arrive at a satisfactory entrance gate blueprint or security door grille schematic with these design tools in hand.

Structural considerations, ergonomic criteria, owner preferences, and local codes may define the parameters of design, but it is the dynamics of proportional design theory that lend grace and beauty to ornamental ironwork. For a crafted piece meant to last for generations, working with classical design principles is an essential element of the work.

In Design, Everything is Numbers

"Everything is numbers," Pythagoras said. To his followers, the properties of numbers themselves were keys to the mysteries of the universe, and they developed a theory of the relationships of numbers to the patterns of life that have influenced architecture from the Greek times through the Renaissance to the present.

The discovery by Pythagoras that the notes of the musical scale were related to numerical ratios led to a sense that the world is profoundly based on numbers and their properties. Working with ratios. The Pythagoreans developed some powerful design tools for the artist and architect: the golden section, the golden mean (or ratio), and the golden rectangle. These ideas form a non-material superstructure upon which design is built.

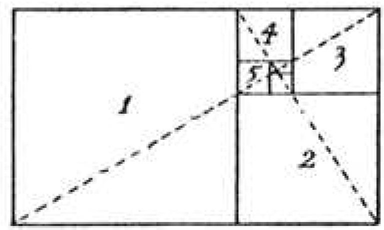


Figure 3

The golden section is a line segment which has been divided in such a way that the ratio of the longer part (a) to the shorter part (b) is the same as the ratio of the entire line segment to the longer part. Statedmathematically,a/b=(a+b)/a=phi, or the golden ratio. The Pythagoreans identified this ratio as existing throughout the natural world as an aesthetically pleasing harmony in the patterns of nature.

Developing the idea further for the arts and architecture was the related concept of the golden rectangle, or a rectangle whose adjacent sides have lengths in the golden ratio. The Greeks saw the resulting rectangles as having the most aesthetically pleasing proportions of all rectangles, and it is a proportion that can be identified repeatedly in the classical works of art, including drawings of the human figure. A golden rectangle has the interesting property that if a square with sides equal to the short side of the rectangle is marked off, the remaining form will be another golden rectangle. This process can be repeated in either direction, by addition or subtraction, ad infinitum. (Figure 3).

The Diagonal Becomes a Design Tool

The golden section, golden mean or ratio, and the golden rectangle yield a wealth of productive ideas for the architect and designer. While the Greeks led the way to unlock much of the mathematical treasure for us, further analysis has opened new ways to use these design tools.

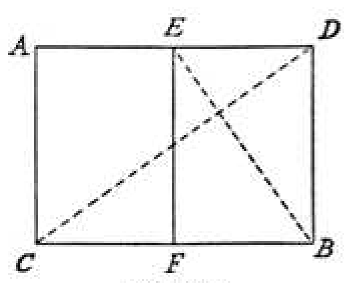


Figure 4

In 1971, an illustrator by the name of Jay Hambridge began a series of living room lectures on what he termed "Dynamic Symmetry" to interested New York City art students. The design theories he had developed were based on geometrical principles of order and proportion. The class soon outgrew the living room, spilling over into an artist's studio, and moved again to a room at the Architectural League to accommodate the crowds. Hambridge went on to lecture at Yale and Harvard, and published two books on the subject, Dynamic Symmetry, the Greek Vase and The Diagonal, both by Yale University Press. Hambridge's contribution to the theory of design was the rediscovery that placing two diagonals in a rectangle at right angles was a method of developing inherent properties of proportion. From his analysis of Egyptian and Greek architecture, sculpture, vases, and surface design, he credited these Mediterranean cultures with the original use of this design theory.

To lay out the ideas of proportion in design that excited so many students of the arts in 1917, consider a hypothetical rectangle AB (Figure 4). To introduce into this rectangle the design principle of dynamic symmetry, first draw a diagonal CD, and then from B a perpendicular BE to the diagonal CD. This creates the boundaries of a rectangle FD, which has the interesting property of being the same shape as AB, but is positioned at right angles to it. It is the reciprocal of AB. To find the reciprocal of any rectangle, divide the length of the long side into the shorter side. In the rectangle below, BD divided by the length FB is the same ratio as BC divided by BD. This ratio of the rectangle applies to rectangles of any length. As a rectangle increases in length, its reciprocal decreases in width.

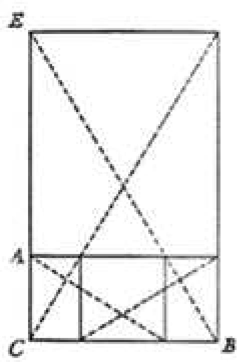


Figure 5

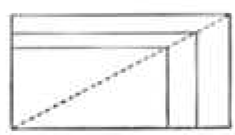


Figure 6

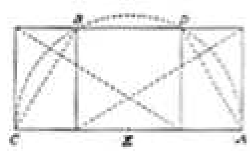


Figure 7

The area CE also has some intersecting properties. This area was called a gnomen by the Greeks, or that shape which, when added to any other shape whatsoever, leaves the resultant figure unchanged except in area. (For example, an arc added to a logarithmic spiral is a gnomen, and exists in nature as the growth of a shell.) We can add another gnomon to the rectangle AB by extending the diagonal BE to an extension of the side AC (Figure 5). This creates a new rectangle with the same proportions as the original rectangle AB, and the process of adding or dividing gnomens can be continued indefinitely. This illustrates a basic principle of continued proportional growth in natural forms and provides a basic schematic for proportional design development, whether applied to a building façade or to fabric design. The process of dividing a rectangle into gnomens and reciprocals can be developed into smaller and smaller units of the rectangle as well Figure 3) with the gnomens revolving around the point of the intersections of the two diagonals. This creates a design which Hambridge called the whirling gnomens. The golden rectangle, with a side-to-end ratio of 1:1.618, creates a special figure of whirling squares.

The gnomen can also be in the shape of a carpenter's square (Figure 6), in which case the rectangle can be increased or decreased without rotation.

We can develop more complex design schematics from these basic principles. Add another reciprocal to the short side of the golden rectangle, for example (Figure 7), which creates a compound figure of two whirling square rectangles AB and CD with a shared, overlapping gnomen. If we bisect the gnomen at E, and describe a semicircle with a radius of EA, the semicircle will intersect the side of the rectangle at B and D, defining the points where the lines of the reciprocal of the rectangle are drawn.

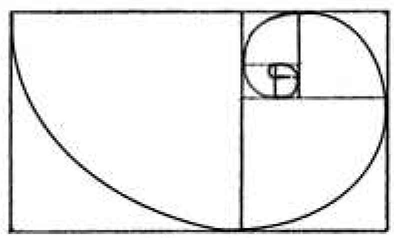


Figure 8

This creates the potential for developing a proportional nonlinear design. Adding another design tool to the rectangular constructions, out of each of these rectangles a logarithmic spiral can be constructed in harmonious proportion to the overall form. In architecture, this might help to define the curve of a staircase in a mezzanine; in the decorative arts the possibilities of design development are stunning. Spirals can be smooth or angular, reversed or set at perpendiculars, overlapped or limited to a section of the arc. Spiral forms can be thickened, tapered, multi-lined, or echoed with free ornamentation. One of the most elegant spirals is the one developed out of the golden rectangle. The spiral is developed along the intersections of the "whirling squares" (Figure 8).

One of Hambridge's students, Edward B. Edwards, was so excited by his first night's lecture that he went home and developed a complex tile design by placing two rectangles at right angles, drawing their principle structural lines, and shading in alternate areas of the resultant pattern in black and white. Edwards went on to publish his own treatise on the theory in 1932, Dynamaryhythmic Design (republished in 1967 by Dover as Pattern and Design with Dynamic Symmetry). Edwards, who was less of a design purist than Hambridge, experimented with many variations of design development. His enthusiasm led him away from Hambridge's scholarly analysis of ancient vase handles and friezes to a fertile exploration of design.