A Guide to Good Design

Pleasing proportions borrowed from nature

BY GRAHAM BLACKBURN

Even if you should be blessed with a good eye, it's not easy to design a piece of furniture without using some underlying paradigm for determining its dimensions and the inner proportions of its parts. Whether it's a design method passed on from craftsman to apprentice or the inherent sense of balance that humans possess, without such a paradigm to follow it is perfectly possible to build something that is structurally sound and functionally adequate but not pleasing to the senses. A piece of furniture that disregards proven design may look clumsy, unbalanced, or awkward.

The geometry of furniture design

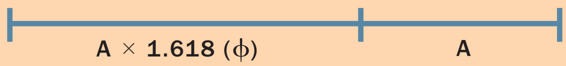
Chief among the many paradigms that designers have used—and continue to use—to ensure balance and good proportions in furniture design is the golden ratio (also referred to as the golden mean). Represented by the Greek letter phi (ϕ), the golden ratio can be expressed as the equation $[1 + \sqrt{5}]/2 = \phi$. For practical purposes, we can think of phi as equal to 1.618, and visualize it by dividing any given line so that the longer part is 1.618 times greater than the shorter part. One of many intriguing principles of the golden ratio is that the shorter portion of the line is in the same proportion to the longer part as the longer part is to the whole line.

A naturally occurring proportion—The golden ratio underlies much of nature and the way our universe is constructed. Examples abound on every level from astrophysics to quantum mechanics. Planetary orbits and even the very structure of the human figure abide by it. Being so fundamental and pervasive in nature, the ratio appeals to us at a subconscious level as being essentially right. As such, it has been used for centuries by designers of everything from the pyramids to furniture masterpieces.

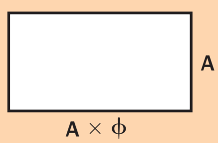
The golden rectangle—The golden ratio relates to furniture design most commonly by way of a rectangle that is constructed

THE GOLDEN RATIO

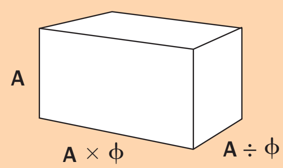
The golden ratio, represented with the Greek letter phi (ϕ), is based on an equation ($[1 + \sqrt{5}]/2 = \phi$) that produces a decimal that proceeds infinitely without repetition. For practical purposes, it is rounded off to 1.618.



THE GOLDEN RATIO IN ITS SIMPLEST FORM
If you bisect any given line using phi, the longer portion is 1.618 times greater than the shorter portion. Interestingly, the whole line is also 1.618 times greater than its longest bisection.

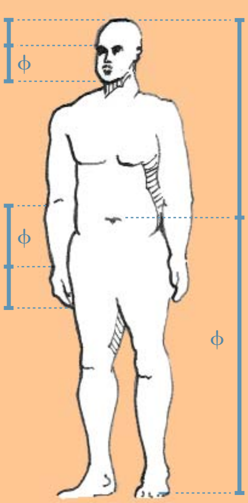


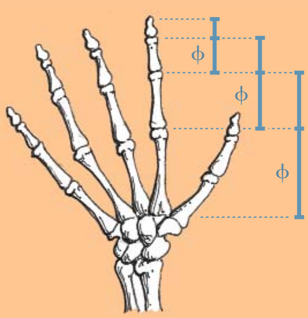
THE GOLDEN RECTANGLE
The long dimension of a golden rectangle is 1.618 times greater than the shorter dimension.



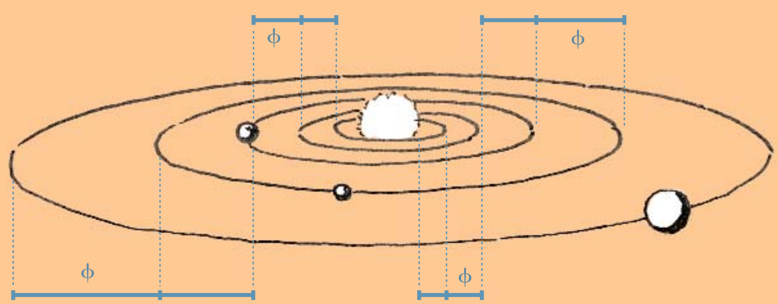
THE GOLDEN SOLID
A golden solid incorporates multiple golden rectangles that are proportionate to one another.

The golden ratio in nature and in art

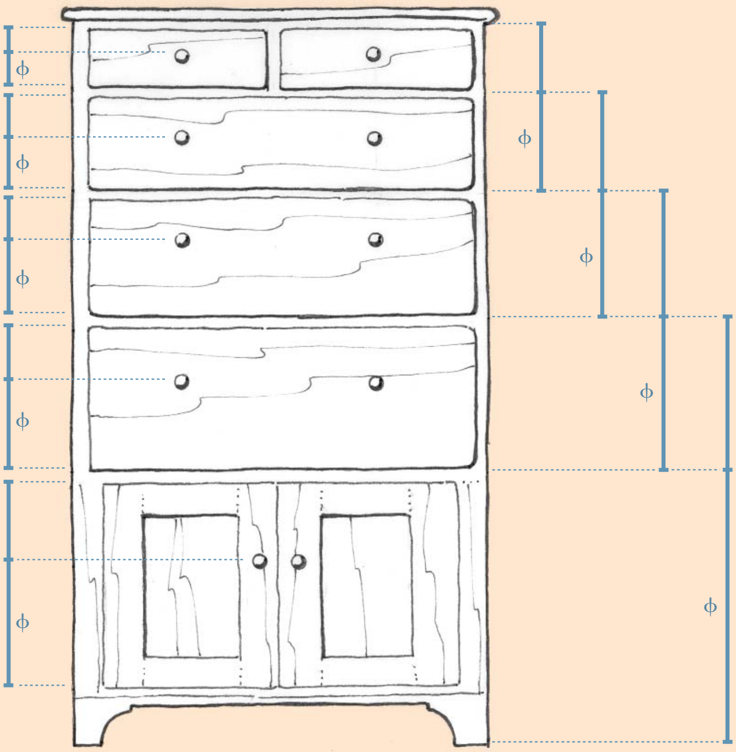




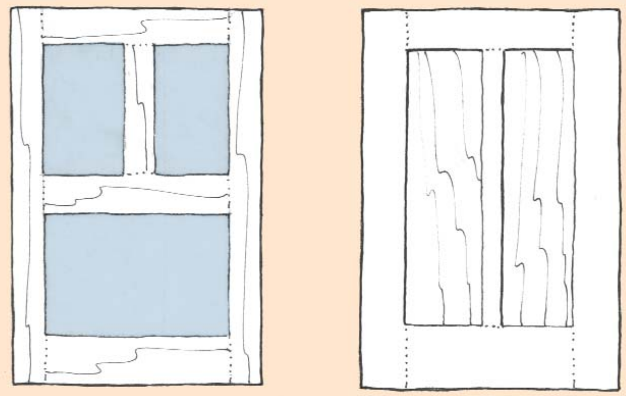
PHI IN THE HUMAN BODY
The eyes divide the head at the golden ratio. The navel divides the body's height at the golden ratio. The wrist divides the arm, from elbow to fingertip, at the golden ratio. The bones on an average human hand are related to each other in phi proportions from wrist to fingertip.



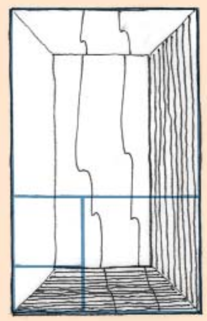
PHI IN THE SOLAR SYSTEM
The distances between the sun and the first five planets in the solar system are close to the golden ratio in their relationship to one another, taking into account that they measure different distances throughout their orbits and are not on the same linear plane. Astronomers have used the golden ratio to locate planets in their orbits.



GRADUATED DRAWERS
This Shaker-style chest of drawers uses phi increments, which can be determined with a Fibonacci series (see p. 50), to establish the height of the graduated drawers as well as the positions of the drawer pulls.



DOOR ELEMENTS
In a door, the golden ratio can be used to size the panels (left) as well as the widths of the muntin, stiles, and rails (right), which increase in size by multiples of phi.



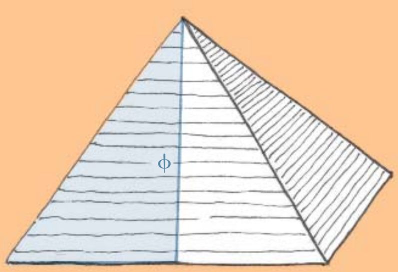
PANEL PROPORTIONS
The overall dimensions of this panel form a golden rectangle. Squaring the rectangle to produce smaller, proportionate golden rectangles helps determine how much of the panel should be raised.

using phi for its two dimensions. Known as the golden rectangle, it is sized so that the length is 1.618 times larger than the width (or vice versa). These proportions can be used to determine the overall dimensions of furniture as well as interior parts, such as doors and drawers.

The golden solid—Furniture is three dimensional, and the golden ratio can be applied to all three dimensions by turning a golden rectangle into a golden solid. Take, for instance, a simple case. When viewing its profile, the height may be the long dimension of a golden rectangle. However, when viewed from the front, the height may be the short dimension of a proportionate golden rectangle.

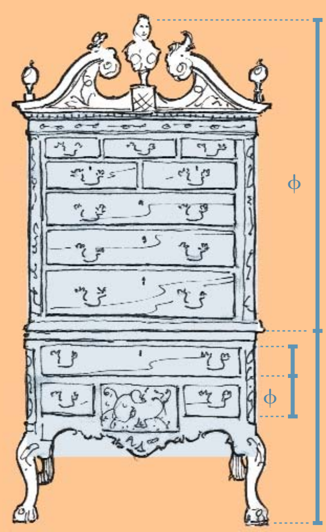
Applying the golden ratio to furniture proportions

A word of caution before applying the golden ratio as a design paradigm: Remember that form must follow function. Even the most sublimely proportioned piece of furniture can be a failure if it does not function because it is too small or too large or other-



PHI IN THE PYRAMIDS
The Great Pyramid of Giza is constructed with the golden ratio at its core. The height of its side is equal to 1.618 times the length of half its base.

PHI IN THE PARTHENON
The Parthenon uses the golden ratio for its overall dimensions. When squared, it leaves a second, smaller golden rectangle, which when squared determines the height of the columns. Many other elements and details were determined with this method.



PHI IN THE HIGHBOY
The high chest of drawers, known as the Pompadour, made in Philadelphia between 1762 and 1790, uses the golden ratio to determine many of its measurements. The carcase is a golden rectangle. The position of the waist is determined by dividing the overall height by phi. And the two lower drawers also are golden rectangles.

Drawings: Graham Blackburn

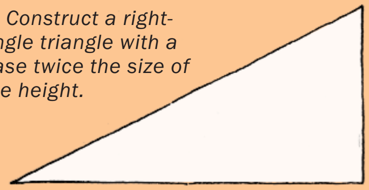
Four ways to construct a golden rectangle

Before you can conveniently use the golden ratio to design a piece of furniture, you must know how to produce it. You could simply multiply or divide any given measurement by 1.618, but this typically results in very clumsy numbers. It is much easier to construct an arbitrarily sized golden rectangle and then adjust the size to match your requirements. There are several simple methods to do this.

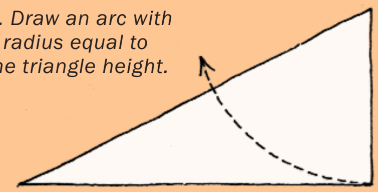
Use the triangle method

Construct a right-angle triangle with a base that is twice the length of the height. Then use a compass to draw an arc with a radius equal to the height of the triangle. The center point of this arc is located on the triangle where the vertical line and the hypotenuse meet. Next, using the location on the triangle where the base and the hypotenuse meet as a center point, draw an arc with a radius equal to the first bisection of the hypotenuse. The point at which this second arc bisects the base of the triangle divides the line into two portions that are related by the golden ratio. The two sections can be used to form the width and height of a golden rectangle.

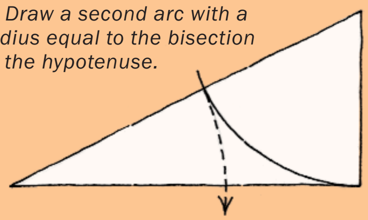
1. Construct a right-angle triangle with a base twice the size of the height.



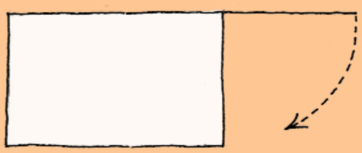
2. Draw an arc with a radius equal to the triangle height.



3. Draw a second arc with a radius equal to the bisection of the hypotenuse.



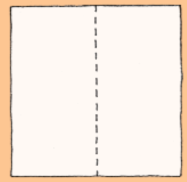
Second arc bisects the base at the golden ratio.



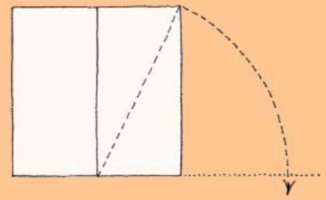
4. Rotate the shorter section 90° to complete the golden rectangle.

Divide and extend a square

Divide a square in half with a vertical line, then draw a line continuing the baseline beyond the square. Draw an arc with a compass using the diagonal of one half of the square as a radius, with the center point on the baseline at the point of bisection. The point where the arc meets the continued baseline determines the extended line. The original baseline is now 1.618 times the length of the extension. These two lengths can be used to form the width and height of a golden rectangle.



1. Construct a square and divide it in half vertically.



2. Draw an arc with a radius equal to the diagonal of one half of the square.

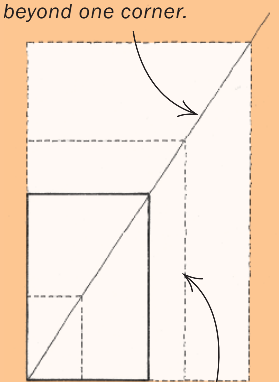
Original base is 1.618 times the size of the new extended section.

3. Rotate the shorter section 90° to complete the golden rectangle.

Scale a golden rectangle

Using a golden rectangle of any size, you can create another golden rectangle with different dimensions. Simply draw a golden rectangle and bisect it with a diagonal line that stretches from one corner to another. Then extend the diagonal line. Any rectangle that shares this diagonal, whether it is smaller or larger, will be golden.

Draw a diagonal line through the golden rectangle extending beyond one corner.



Any rectangle that shares this diagonal is golden.

Apply the Fibonacci series

Yet another way to derive measurements that reflect the golden ratio is to use a method known as the Fibonacci series, which is a sequence of numbers, with each number equal to the sum of the two preceding numbers. A simple series starting with 1 produces the following: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, and so on.

A Fibonacci series is useful because any number divided by the previous number—with the exception of the first few values—is roughly equal to phi. This explains why dimensions such as 3 by 5 and 5 by 8 are so common. They are based on phi.

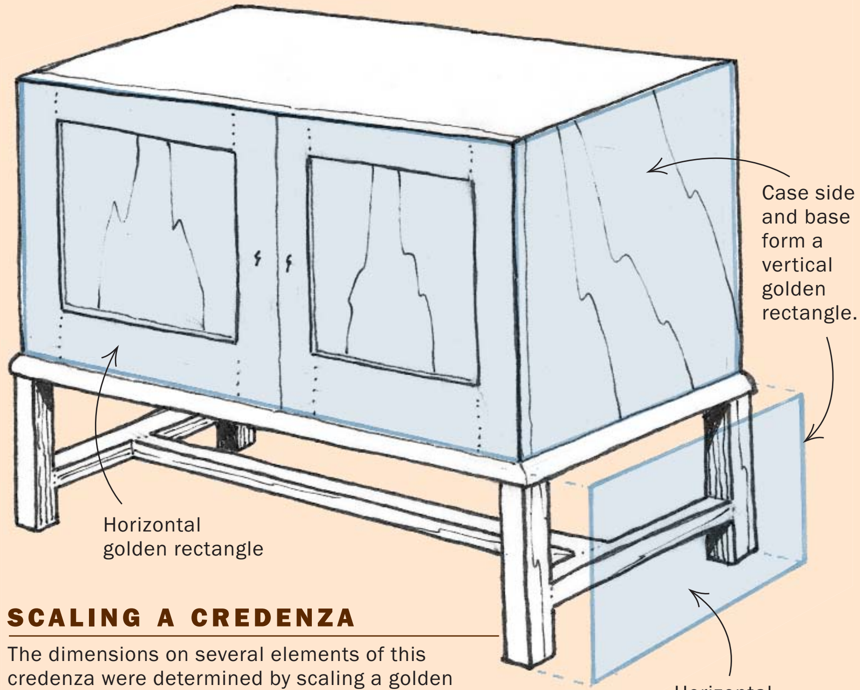
Perhaps more useful to the furniture designer is that a Fibonacci series can be generated using any two numbers. Starting with two given dimensions for a furniture piece, add them together to produce the third value, and continue this pattern to create a series of other potential dimensions related by phi. For example, a case piece with a 15-in.-deep by 22-in.-wide top would produce the following Fibonacci series: 15, 22, 37, 59, 96, 155, 251, 406, and so on. Once again, discarding the first few values, you now have a series of pairs of numbers with a phi ratio, which might be used as a basis for other dimensions.

One thing to note is that while the first two values are expressed in inches, the successive numbers in a Fibonacci series could be expressed in any unit of measure, such as fractions of an inch. Therefore, a door panel on the case piece used as an example here could measure 251⁄64 in. by 406⁄64 in. and still be proportionate to the 15-in. by 22-in. case top.

wise unable to be used comfortably. Practical considerations, therefore, must come first.

In fact, most furniture designs require that you start with some given dimensions: A table must be a certain height, a cabinet may have to fit a particular space, or a bookcase may require a fixed number of shelves. But almost certainly you will be left with many other decisions regarding dimensions to which you can apply this proportion. It will be worth the effort to see whether the golden ratio might work for these other elements. Deciding on dimensions by eye alone—or worse, on the basis of the lumber that is conveniently at hand—is a less certain way of achieving a well-balanced, nicely proportioned piece.

Individual elements—Whether or not the overall dimensions of a piece are proportioned using the golden ratio, individual parts, such as table legs or even the relative sizes of framing members such as stiles, rails, and muntins, can be determined with the golden ratio. The golden ratio also offers one way to solve the problem of designing graduated drawers. Each consecutive drawer can increase in size by multiplying the depth of one drawer by phi to get the depth of the next-largest drawer. The method can be applied just as effectively to other elements such as shelving or partitions.



SCALING A CREDENZA

The dimensions on several elements of this credenza were determined by scaling a golden rectangle. The horizontal golden rectangle of the credenza's legs is formed by squaring the larger vertical golden rectangle of the credenza's overall profile.

Any measurement on a piece of furniture originally may have been determined by functional and structural requirements, but many adjustments can be made that add inner harmony. Using the golden ratio when designing furniture will enable you not only to produce a pleasing whole but also to ensure that all of the constituent parts, such as door panels and drawers, are fundamentally related.

Practical adjustments

Designing something with perfect proportions is rarely possible in the real world. Almost every piece of furniture or woodwork will need to accommodate constraints imposed by details of function, joinery, or economics. But even the attempt to approach perfection (which may be defined as measurements that correspond precisely to a system like the golden ratio) is virtually guaranteed to produce a better result than designing with no regard for any such paradigm. Even if you are close to perfect proportions, the eye is inclined to accommodate slight imperfections and fill in the gaps. Don't think that everything has to fit the formula exactly.

Last, remember that we often adjust things by eye to make a piece look lighter or better balanced, and we do so by using techniques that are part of the everyday woodworking vocabulary. They include the calculated use of grain direction to imply movement; highly figured grain to help the eye see curves where none exist; finished edges and corners that give the impression of thickness or thinness; the use of molding to adjust an apparent golden rectangle or solid; the use of tapered legs to give the appearance of more closely approximating an ideal proportion; and the mixing and matching of many other design paradigms. □

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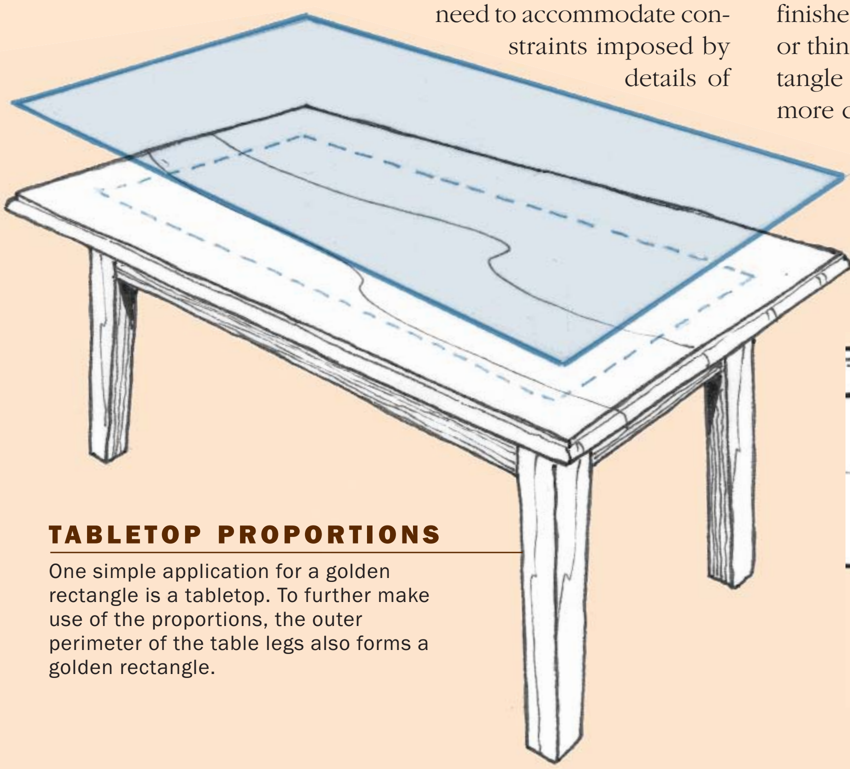

TABLETOP PROPORTIONS

One simple application for a golden rectangle is a tabletop. To further make use of the proportions, the outer perimeter of the table legs also forms a golden rectangle.

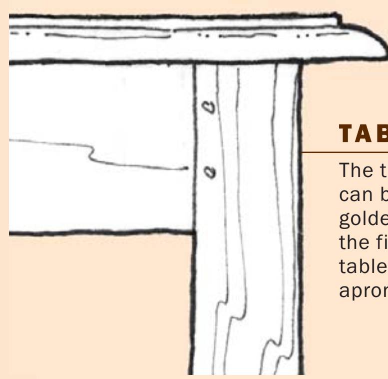

TABLE DIMENSIONS

The tabletop, legs, and apron can be determined using the golden ratio. In this example, the fillet to roundover, the tabletop to leg, and the leg to apron are related by phi.