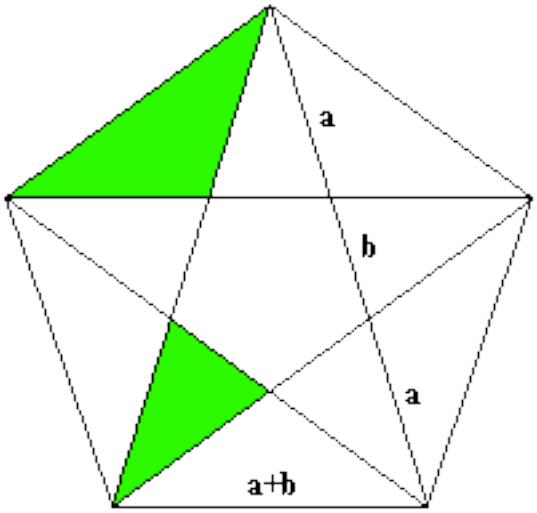
High Sierra Rod Company
Phi Φ (Golden Ratio/Resonant) Pentagonal Rods Series
Background information

Our newest rod series named Phi (for *Phidias*, described herein), and inscribed simply as Φ, is the latest in our comprehensive pentagonal rod offering.

Each of these hollowed rods is individually hand tuned to obtain the rod's best **resonant frequency**, thereby increasing the rod's efficiency. This **resonance tuning** and the inherent **golden ratio** of the **pentagonal** construction combine in these rods to provide a very unique casting experience. These rods are ammonium treated for a uniform medium brown color.

The following information is provided for those with interest in the **golden ratio** and **resonance**.

1.0 Golden Ratio a.k.a Phi Φ



The golden ratio shows up (as an exact fit) in mathematics in many unexpected places. The ratio shows up everywhere in the pentagram (five pointed star) and its circumscribed **pentagon** (shown on the left). a/b=(a+b)/a=(a+b+a)/(a+b)=phi (the **golden ratio**). Here we also see the two kinds (acute and obtuse) of golden triangles (I've painted two of them green). They are any of the isosceles triangles in this diagram. These are triangles, which exhibit the golden ratio.

In mathematics and the arts, two quantities are in the **golden ratio** if the ratio of the sum of the quantities to the larger quantity is equal to the ratio of the larger quantity to the smaller one. The golden ratio is an irrational mathematical constant, approximately 1.6180339887.

Other names frequently used for the **golden ratio** are the **golden section** (Latin: *sectio aurea*) and **golden mean**. Other terms encountered include **extreme and mean ratio**, **medial section**, **divine proportion**, **divine section** (Latin: *sectio divina*), **golden proportion**, **golden cut**, **golden number**, and **mean of Phidias**. In this document the **golden ratio** is denoted by the Greek lowercase letter phi (φ), while its reciprocal (and most common reference), 1/φ, is denoted by the uppercase variant Phi (Φ).

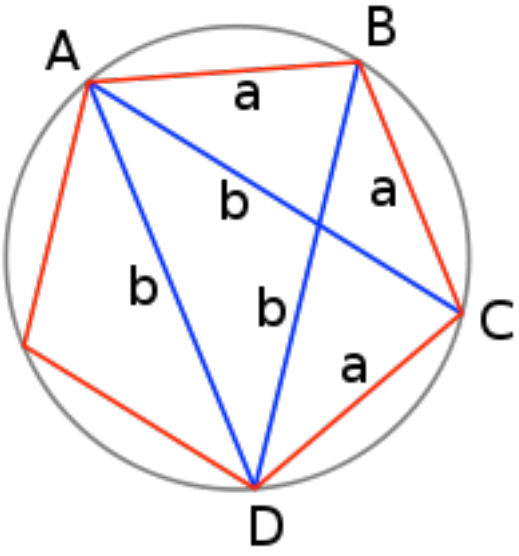
Who discovered The Golden Ratio first?

No one really knows for sure as to who **originally** discovered the **Golden Ratio – 1.618 -** (a.k.a. the **Phi ratio** or simply **Φ**) in Human history, but some suggestions point to the **ancient Egyptians** and even as far back as the ancient **Sumerian civilization**. However, many artists, mathematicians, scientists and philosophers throughout history also used the ratio. The most renowned include the **Greeks**.

Ancient Greek mathematicians first studied what we now call the **golden ratio** because of its frequent appearance in geometry. The division of a line into "extreme and mean ratio" (the golden section) is important in the geometry of regular pentagrams and **pentagons**. The Greeks usually attributed discovery of this concept to Pythagoras or his followers. The regular pentagram, which has a regular **pentagon** inscribed within it, was the Pythagoreans' symbol.

The ratio is usually given the Greek symbol Φ (Phi) in honor of the great Greek sculptor Phidias who made extensive use of the ratio when designing buildings such as the Parthenon and the Propylaea on the Acropolos in ancient Athens. Phidias also carved the statue of Zeus at Olympia. This statue was one of the Seven Wonders of the World.

The number φ turns up frequently in geometry, particularly in figures with **pentagonal symmetry**. The length of a regular pentagon's diagonal is φ times its side.



The **golden ratio** in a regular **pentagon** can be computed using Ptolemy's theorem. The **golden ratio** can also be confirmed by applying Ptolemy's theorem to the quadrilateral formed by removing one vertex from a regular **pentagon**. If the quadrilateral's long edge and diagonals are b, and short edges are a, then Ptolemy's theorem gives $b^2 = a^2 + ab$ which yields the **golden ratio**.

Golden Ratio & the Renaissance ("Rinascimento")

The Renaissance artists used the **Golden Ratio** extensively in their paintings and sculptures to achieve balance and beauty. Leonardo Da Vinci, for instance, used it to define all the fundamental proportions of his painting of "The Last Supper," from the dimensions of the table at which Christ and the disciples sat to the proportions of the walls and windows in the background and sculptures to achieve balance and beauty.

Was the **pentagon** as important during the Middle Ages through Renaissance as it was during the time of Pythagoras? Definitely. In fact, until the Middle Ages, no one realized exactly how important it was. Only then was the particular proportion of its elements was considered divine and attributed a unique mysticism.

After the Middle Ages, the **pentagon** continued to be used in some parts of the world as a sign that represented the craftsmen. Most of the time this sign was placed next to where craftsman's name was carved on his work

2.0 Resonance

In physics, **resonance** is the tendency of a system to oscillate with larger

amplitude at some frequencies than at others. These are known as the system's **resonant frequencies**. At these frequencies, even small periodic driving forces can produce large amplitude oscillations, because the system stores vibrational energy.

Resonances occur when a system is able to store and easily transfer energy between two or more different storage modes (such as kinetic energy and potential energy in the case of a pendulum). However, there are some losses from cycle to cycle, called damping. When damping is small, the resonant frequency is approximately equal to a natural frequency of the system, which is a frequency of unforced vibrations. Some systems have multiple, distinct, resonant frequencies.

Resonance phenomena occur with all types of vibrations or waves: there is mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) and resonance of quantum wave functions. Resonant systems can be used to generate vibrations of a specific frequency (e.g. musical instruments), or pick out specific frequencies from a complex vibration containing many frequencies.

Resonance was recognized by Galileo Galilei with his investigations of pendulums and musical strings beginning in 1602

Examples

Resonance occurs widely in nature, and is exploited in many man-made devices. It is the mechanism by which virtually all sinusoidal waves and vibrations are generated. Many sounds we hear, such as when hard objects of metal, glass, or wood are struck, are caused by brief resonant vibrations in the object. Light and other short wavelength electromagnetic radiation is produced by resonance on an atomic scale, such as electrons in atoms. Other examples are:

Mechanical and acoustic resonance

- the timekeeping mechanisms of all modern clocks and watches: the balance wheel in a mechanical watch and the quartz crystal in a quartz watch

- the tidal resonance of the Bay of Fundy
- acoustic resonances of musical instruments and human vocal cords
- the shattering of a crystal wineglass when exposed to a musical tone of the right pitch (its resonant frequency)

Electrical resonance

Electrical resonance of tuned circuits in radios and TVs that allow individual stations to be picked up

Golden Ratio and Resonance

Whenever one has to minimize or optimize harmonic resonances the **golden ratio** proves a sound basis from which to do so.

Background

I have been involved in Amateur Radio for many years, and have learned how to tune circuits and antennas to their resonant frequencies, and have experienced the incredible increase in efficiency when doing so.

This got me thinking about bamboo rod tuning. After much trial and effort, I have developed proprietary methods of tuning a bamboo rod section to its closest optimum resonance frequency resulting in increased efficiency and more accurately casting rods.

Of course, starting with a pentagonal geometry with its inherent **Golden Ratio** naturally helps with the resonance tuning as has been described herein.

Sources

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