

# Golden Bolt Ratio

by Jozef Dominik and Dominik Makuka

Golden ratio, phi, divine proportion,  $\varphi$ , ... etc. , these are different names for one irrational mathematical constant. This number is derived from the following geometrical question: cut the segment line in two segment lines, such that the ratio of the longer line "a" to the shorter line "b" is equal to the ratio of entire line segment "a+b" to the longer line "a". And this implicates  $\varphi$ , or approximately 1.6180339. Mathematically:

$$a/b=(a+b)/a$$

If we multiply both sides by "ab":

$$a^2=ab+b^2$$

And if we substitute in quadratic formula, we get:

$$b=(\sqrt{5} a+a)/2$$

If "a" is equal to 1, then "b" is equal to  $(\sqrt{5}+1)/2$ , which is the golden ratio.

It is important to know, that the golden ratio wasn't invented, but vice versa, it was discovered, and, not only by this geometrical problem. The golden ratio is everywhere around us, whether in the form of ratio, as ratio of the length of the arm from the elbow to the wrist and from the wrist to the end of the middle finger for example (see **Fig. 1**).

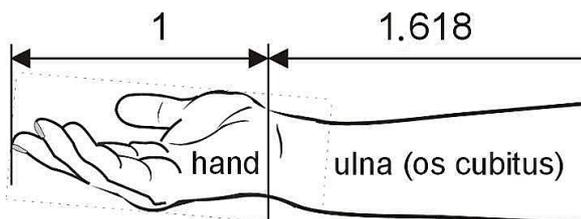


Fig. 1

Or in the form of golden logarithmic spiral (spiral with growth rate  $\varphi$ ), (when falcon flies to its prey or in the case of snail shell for example).

We have decided to take this geometrical problem and use it for bolts (see **Fig. 2**). We even came up with the name for this type of ratio-golden bolts. The bolt is golden, when the ratio of its thread (let's call it "a") and shank "b" is approximately equal to 1.618.

We can get the golden ratio from the other source-Fibonacci sequence (named after Italian mathematician Leonardo Pisano Fibonacci): 1,1,2,3,5,8,13,21,34,55...

Each number in this sequence is the sum of the two preceding ones. What it means for us is, that when we take a bolt with the thread with the length of 8cm and the shank with the length of 5 cm, the ratio a/b, which is 8/5, is 1.6, and therefore this screw could be called golden.



Fig. 2

Someone may ask, what are the benefits of this idea for bolts. In common level of knowledge, there is no practical use for bolts as such. In each case, there will be significant meaning for normalization and measurement of bolts in the world's fasteners production.

When you unleash your imagination, we can imagine a complete screw, including the height of the head, as a golden ratio (**Fig. 3**).

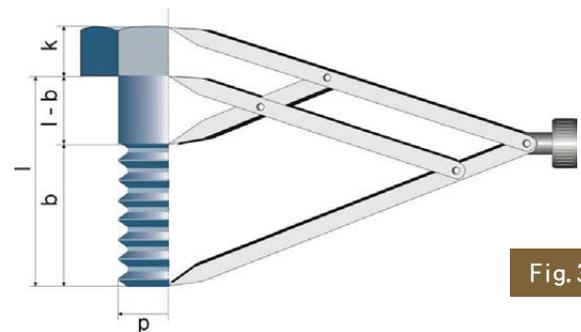


Fig. 3

And we could continue with a wrench (**Fig. 4**), etc. In light of current knowledge of the Golden Ratio principle, its wider application seems limited, but it doesn't have to take long and everything can be changed.

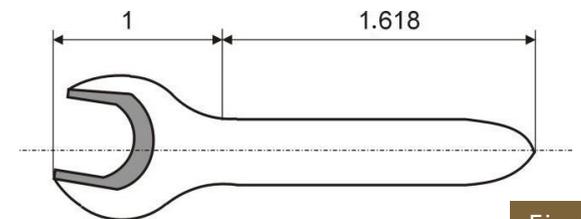


Fig. 4

## Conclusion

The nature is not wrong, it is a familiar rule. What is good for nature is also good for man. This is not some whim, but it certainly has its rational sense. This applies to the construction of screw bolts in general. The wheel was also not developed, but discovered and yet it is now used on a mass scale. It can be assumed that the golden ratio principle will also be widely applied in technical practice.



Side Note: A Message from Jozef Dominik

Why Threaded Screws Should be Included in UNESCO’s World Cultural Heritage



United Nations Educational, Scientific and Cultural Organization

Looking at the list of cultural and scientific monuments, it is surprising that there are no threaded joints. The task of this side note is not to examine why this is the case, but to try to make sure that screw connections clearly belong there. There are several reasons for this:

Helix structure is an archetypal geometric paradigm (DNA and some plants), which we humans are able to use perfectly to our advantage. No one has yet been able to replace the threaded screws equally.

It is one of the oldest construction elements. Expressed metaphorically - screws hold our civilization together.

Screws are currently being mass-produced and there is no indication that this should change in the foreseeable future.

The threaded screws as a creation of our brains have a unique history (Table 1). It all started yet before Christ, when Archimedes built the so-called transport helix, which transported water from a lower level to a higher one (Fig. 5). The biggest boom occurred during the Industrial Revolution (Gutenberg, Watt, Ford etc.), when screws were used extensively in fastening of parts (Fig. 6).

Table 1

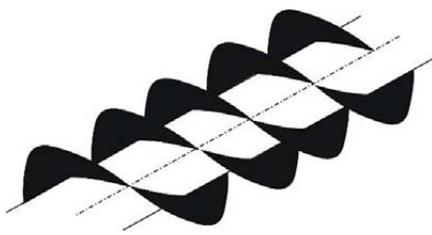
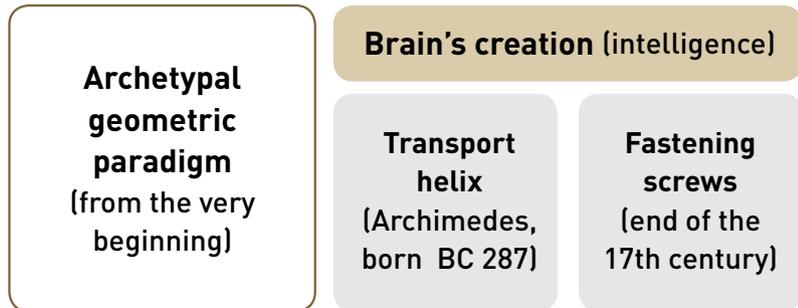


Fig. 5 Archimedes transport helix

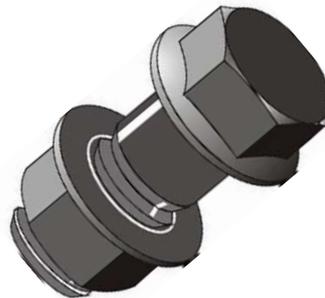


Fig. 6 Fastening threaded screw

~ Ending My Message ~

**Ode on Threaded Screws**

As it in calendar stands,  
already many years  
in the sky shines  
the star like no others.  
Yes, before many summers,  
"I repeat over again here:  
Watch day to days,  
the supernova up there".  
Saturn, Andromeda, Pluto?  
Your efforts are in vain.  
"I'm sorry, but I can't hold out,  
that other resides in Milky Way".  
Even the proud Venus doesn't know  
what Jupiter suspects already.  
Other look better now,  
another has beauty queen credit.  
Well, dear Venus, before long  
you will be out of the game  
and the jingle song will belong to,  
which THREADED SCREWS is the  
name.

Despite the fact that individual authors differ in the dating of historical milestones of screw joints, the conspicuous pause between the transport variant and the connecting screw is indisputable. It can be said that it took a disproportionately long time for a person to understand the enormous potential of screw connections. A radical turn occurred during the Industrial Revolution (end of the 17th century).

However, this may not be the historical truth, either. Therefore, the author turns to top experts as well as a wide readership of Fastener World Magazine to help us answer the question: "Threaded screws have a very long history. How far can we trace back the birth of them?"

In order to unify opinions, a support committee of top European and American experts was set up. Nevertheless, differences persist, and hence this article. We also welcome the views of experts from the Middle and Far East. Historical traces also point to these areas and are less known in Europe. □

