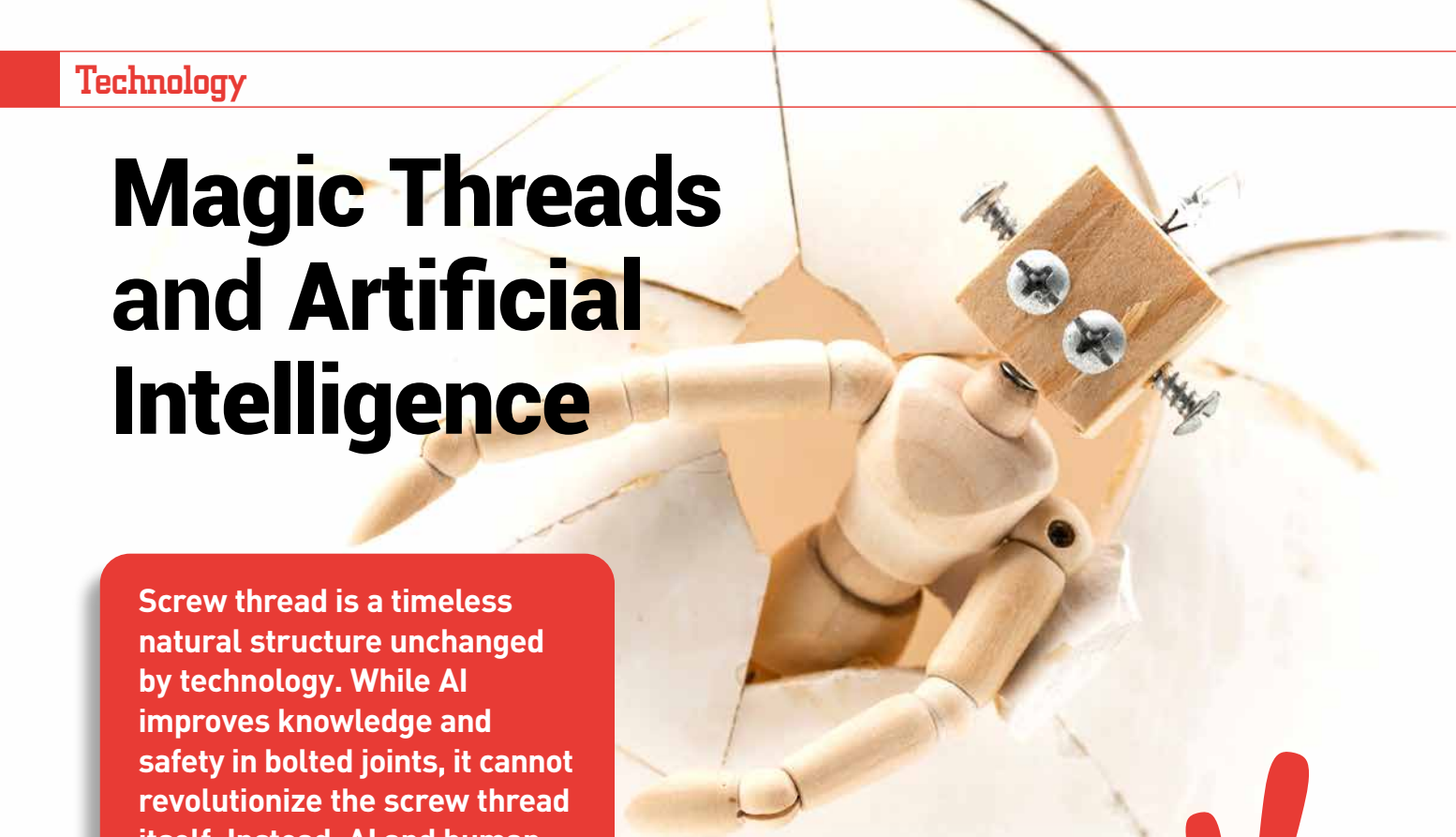
Magic Threads and Artificial Intelligence

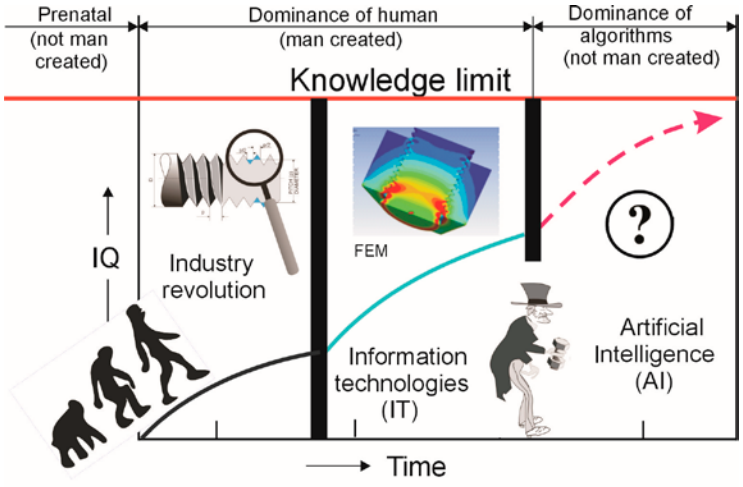


Screw thread is a timeless natural structure unchanged by technology. While AI improves knowledge and safety in bolted joints, it cannot revolutionize the screw thread itself. Instead, AI and human intelligence together steadily advance understanding, but the thread remains constant.

"We have already discovered the tunnel of knowledge. The light at the end of it is still out of sight."

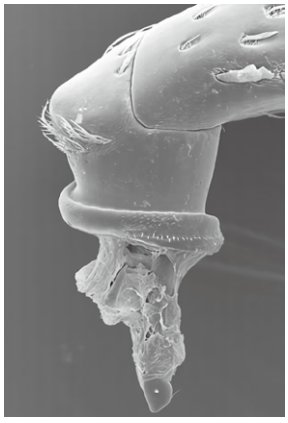
Overview of the AI Development

Could popular Artificial Intelligence (AI) platforms help discover the light at the end of the tunnel of knowledge? This is the fundamental question plaguing the current society. Fig. 1 is an attempt to show the individual stages of the development. Each of the stages contributed in its own way to the level of knowledge, while sharing experiences with each other. When homo sapiens entered the scene, big things started to happen. Three of the stages in particular left a significant mark on the development of bolted joints.



▲ Fig. 1. Stages of Development

▲ Fig. 2. Nature itself has noticed the magical powers of threads



▲ Fig. 3. Even a trigonopterus beetle can extend its leg using a biological thread (wiki image)

1. Prenatal stage (not created by mankind)
2. Human dominance stage
3. Algorithms (AI) dominance stage

The task of this article is not to analyze the individual stages in detail. It is only necessary to emphasize that the characteristic element of fasteners, namely the threads, is an autochthonous geometric element (like the structure of DNA, or architecture of galaxies). It was not invented, but exists ab origine; that is, from a time immemorial. Not only did men (such as Archimedes, Leonardo da Vinci, Whitworth, Sellers) knowing its

advantages began to use it exclusively for their own benefits, there is evidence that Nature itself has noticed the magical powers of threads (Fig. 2). Even a trigonopterus beetle can extend its leg using a biological thread (Fig. 3).

The industrial revolution provoked an enormous consumption of fasteners which were already being mass-produced (Fig. 4).

It took quite a long time to understand that a screw‘s thread connection is not an ordinary soulless monster, but a living organism with its own life. Understanding this "life" has been made possible by scientific and technological progress, especially with the advent of information technology. Finite Element Method (FEM) has made it possible to analyze the stress state of structural elements as threaded joints (Fig. 5). This was a huge contribution of information technology to the knowledge of the behavior of bolted joints during assembly and operation.

Fundamental, Intelligence-independent Laws of Matter

To understand the continuity of development, some important facts need to be clarified. Laws of matter are independent of intelligence, exist from time immemorial. Men have no influence on this. Their genius lies only in the fact that they observed and formulated into logical mathematical relationships (Newton's law of gravity for example). Let us therefore take note that all the laws of matter mentioned here existed long before intelligence. Below are some of the important ones concerning bolted joints:

Property 1:

Friction is the force that slows down movement over a surface. It plays an important role in bolted joints because without friction the bolted joints would immediately fall apart. It is calculated using the formula:

$F_t = \mu.F_N$, where

F_t - shear friction force in [N]

F_N - perpendicular pressure force between the bodies in [N]

μ - coefficient of friction (dimensionless number)

Property 2:

The ability to create a thermodynamic equilibrium state, i.e. to transfer or absorb heat by conduction, convection or radiation. Heat or thermal energy is the internal energy that a body receives or transfers during heat exchange with another body. Only bodies with different temperatures are able to exchange heat. The formula for calculating the heat required to increase the temperature of a body is:

$Q = m.c.(t-t_0)$, where

c - specific heat capacity [$J.kg^{-1}.K^{-1}$]

m - mass [kg]

$t-t_0$ - final and initial temperature [°C]

Property 3:

Under external load, it transitions from an equilibrium state to an unbalanced state and changes its external dimensions (Fig. 3).

All of the above properties and many more of matter have existed since time immemorial, long before man formulated them into laws. They are independent of intelligence and after all played an important role not only in bolted joinings.

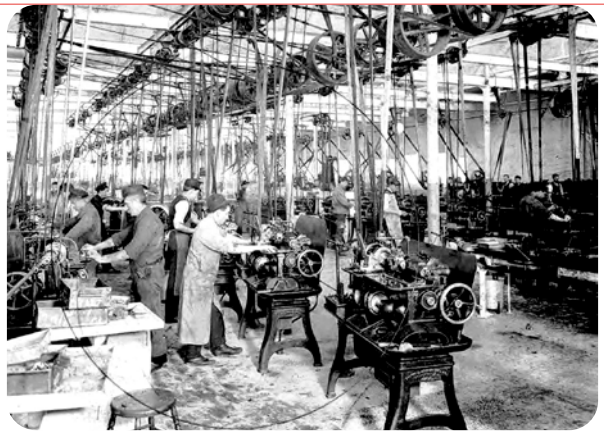


Fig. 4. Screw Production (Image from Wiki)

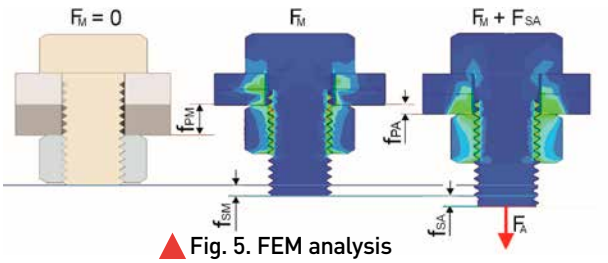


Fig. 5. FEM analysis

Artificial Intelligence and Context

In confrontation with Fig. 1, we now enter the current development stage of Artificial Intelligence, which is able to take over, process and evaluate all previous experiences.

It is known that technical universities do not provide students with sufficient knowledge in the field of mechanical joining technology. In general, this topic is underestimated. Therefore, specialized institutions organize professional seminars for relevant clients (Bolt Science, EN, Ferodom, SK, etc.). Also thanks to these seminars and professional publications, AI will be able to provide anyone with easily accessible information at the appropriate level. This will increase the overall "culture" of connecting with practical use. This means, above all, higher safety of structural units and higher economic utilization. However, one cannot expect any revolutionary progress in the field of screw joint design from AI as a separate category. **The screw as such is a very conservative structural element. No one has been able to replace threads. Neither technical revolution nor information technology has done it, and neither can AI.** Artificial and human intelligence are in a synergistically relationship. One supports the other. Therefore, it can be reasonably expected that the development curve in Fig. 1 will go up sharply and will asymptotically approach the limit value. The big surprise is therefore not included.

Conclusion

Deus et machina or machina et deus (God and machine or machine and God)? Even the greatest thinkers of the time, such as Albert Einstein or Steven Hawking, were unable to reliably answer this to near Hamlet question. However, if we look at the evolutionary series of human intelligence, we cannot help but notice a gradual escape from technocratism in human life. This also applies to screw connections. Let's be surprised by what happens next, what artificial intelligence will bring. One thing is certain, however:

The world changes, but threads (spiral) remain because they are an ideal trajectory that leads from simplicity to complexity in the shortest possible way! ■