

How the Horse Leg and the Marine Sponge Can Help Us to Increase Innovation. Learning from Nature

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Models from nature, like a horse bone and a marine sponge, help to find new engineering solutions.

Biological examples are also useful in the study of innovative methodology. Genrih Altshuller wrote already in 1950s: "In many cases, technical contradictions encountered during the creative work have direct analogs in nature and technology." [1] About current research, see, for example, Darrell Mann's papers in the TRIZ Journal [4,5].

For me nature is one source of good stories. If the biological solution fits to the criteria of good solution, it is obvious to get a readable and saleable story. Readers are also interested in beautiful innovations. About criteria, see "Simplified TRIZ", pp. 91-101 [9]

Last year I wrote a small article of the horse bone and a bigger one displaying a marine sponge as one of main players.

Horse uses local quality and porous structures

There are holes in automobiles, buildings, ships, planes, everywhere. Everywhere they also are sources of failures. To avoid fractures engineers "... typically compensate for the weaknesses caused by these holes by increasing the thickness of the material around them. In a classic example, ship builders add extra material around portholes in hulls..", says professor Stephen Cowin from the New York Center of Biomedical Engineering. See Hoover's paper [3] and also DeGaspari's paper [2] in the Internet.

Here we have a perfect example of the tradeoff and compromise, described in Rantanen, K., Domb, E. Simplified TRIZ ..., pp. 25-52 [8].

Conventional thinking says that this like compromises are inevitable. The horse, however, manages to make strong structures with holes without additional mass. A cucumber-sized bone in the horse's leg has a pea-sized hole for blood vessels. Even if the bone fractures, it doesn't break near the hole.

Researchers from the University of Florida studied why and found that the bone has a sophisticated composite microstructure. Material is denser and stronger wherever the stresses are higher and less dense where the higher flexibility is needed.

Here we see that three innovative principles, local quality (principle 3, see "Simplified TRIZ..." p. 138), porous materials (principle 31, see "Simplified TRIZ..." p. 170), and composite materials (principle 31, see "Simplified TRIZ..." p. 180) are used together to resolve the contradiction.

Researchers imitated the horse bone and made the model there a hole was surrounded by polyurethane foam. In the stretching test the biologically inspired plate was twice stronger than a conventional one.

Marine sponge uses self-service principle

Researchers in Medical University of South Carolina and some other universities combined rapid prototyping technology, smart polymers, and cell adhesion. They got the cell printer producing living tissues. See the paper of Mironov et al. [6]

The printer uses cell aggregates as "ink" and the smart polymer as "paper". After printing the aggregates should fuse to make tissue. To make this possible researchers borrowed the technology from nature. "Fusing cell aggregates imitates the fusion of sponge fragments", writes one of researchers, Vladimir Mironov [7]. Biologist Henry Wilson demonstrated already 1907, that if a marine sponge is dissociated, fragments assemble themselves again into an organism.

The nature uses here the self-service principle (25), see "Simplified TRIZ" p. 163.

Smart, thermally sensitive polymer imitates ocean, where sponges are made without any assembly lines. Researchers have printed simple pieces of living matter and plan to make vascular structures and whole organs in future.

Useful and fascinating examples

Both cases are examples of biomimetics.

Not all problems are solved directly copying nature, but biological examples are still helpful. They help to understand concepts and principles of TRIZ and apply then to new problems.

In the paper in the TRIZ Journal, October 2003, I told how I have actually imitated daisies and dandelions to make stories more saleable [9].

An important benefit of biological examples, too, is that they are often very elegant and easy to understand.

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