BIOINSPIRTIONS IN SURFACE LAYER PROPERTIES CREATION

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Plan of presentation

1. Introduction
2. Methodology of bionic design
3. Bionic surface layer structure design
4. Conclusions

1. INTRODUCTION

„**Bionic** is the branch of science which aim is to investigate occuring in animals and plants:

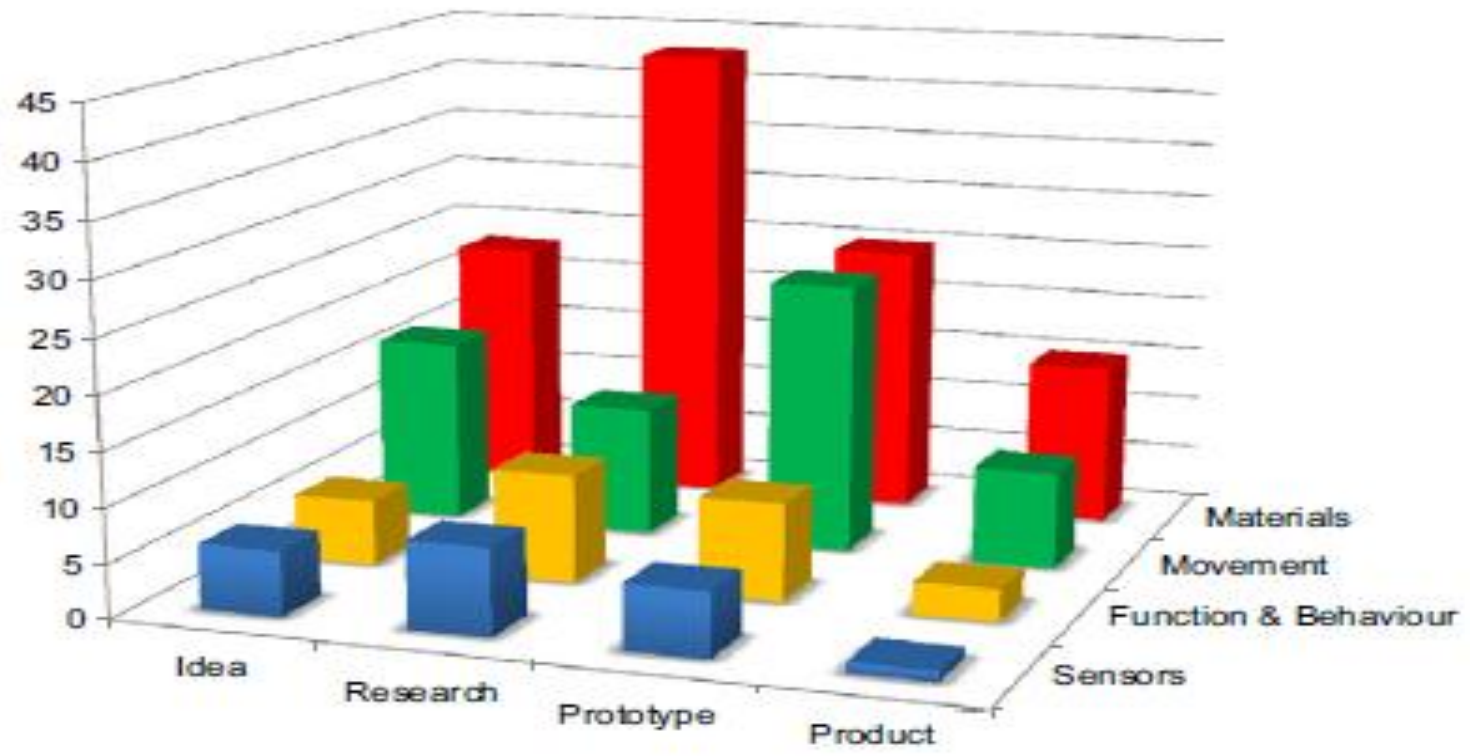
structures, materials and processes,

in order to apply results in solving problems occuring in any kind of engineering including aircraft and space industry, informatics, management a.s.o. [1,2,3,4,5,6]

From literature results that in natural surroundings there are [6]:

- 55 000 mammals,
- 31 000 fishes,
- 10 000 birds,
- 8 800 reptiles,
- 1 000 000 insects,
- 300 000 plants.

Each of above mentioned animals or plants developped in evolution proces optimal structures, shapes, surfaces which could be applied in each kind of engineering or technology



Distribution of problems (Material, Movement, Function & Behavior, Sensor) and stages of development (Idea, Research, Prototype, Product); [6]

2. METHODOLOGY OF BIONIC DESIGN

SCIENTISTS evaluate that now people are able to take advantage from about ~10% bio - solutions. It results from the facts that:

- for advanced bionic investigations it is necessary to have **interdisciplinary team** and very advanced research equipment.

- sometime it is very difficult to manufacture structures designed as a results of bioinspirations. **The Nature „produce organisms" using additive methods much more precise than manufacturing methods invented by engineers.**

- sometime engineers **forgot** about solution offered by the Nature

The bionic design is **usually carried out by interdsiciplinary team (engineers, biologists, chemists, phisicians)** in the following stages**:**

1. Technical problem formulation.

2. Analysis of biological systems in order to find out bio-inspirations for technical problem solution.

3. Mathematical modeling of bionic systems (structures or processes).

4. Bionic prototype design and manufacturing.

5. Experimental investigations of bionic prototype (stiffness, stresses and distortions, mass, fatigue resistance, wear resistance, forces, friction, vibrations).

6. Evaluation of bionic design and decision about its further development.

It is worth to underline that here the very important research tool is ***intuition.***

In the area of PRODUCTION ENGINEERING the main bio - inspirations are connected with:

A - improvement of mechanical properties - lightweight designe ,

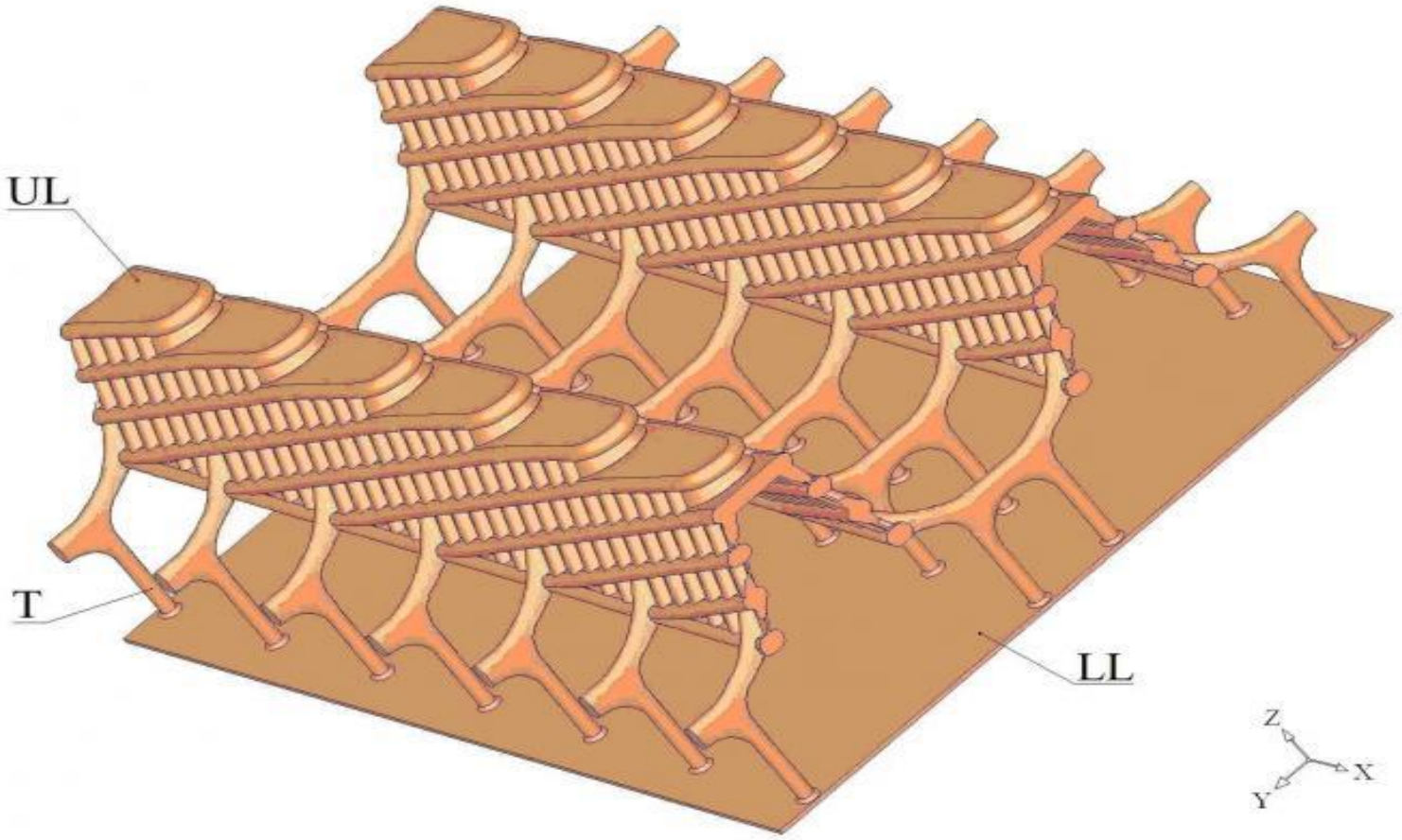
B. optimal shape design

C - creation of surface layer properties,

3. BIOINIC SURFACE LAYER STRUCTURE DESIGN

From analysis of surface structures occurring in the nature rsults that in alive organisms the **smooth surfaces don’t occur.** Surface structures of alive organisms are adopted for its living conditions.

Skin of butterfly wings gives high lifting force, high speed, good control and low loudness of flight. As an inspiration for bionic turbine blades design was structure of Butterfly Monarch (*Danaus plexippus L)* wings presented here [2,3].



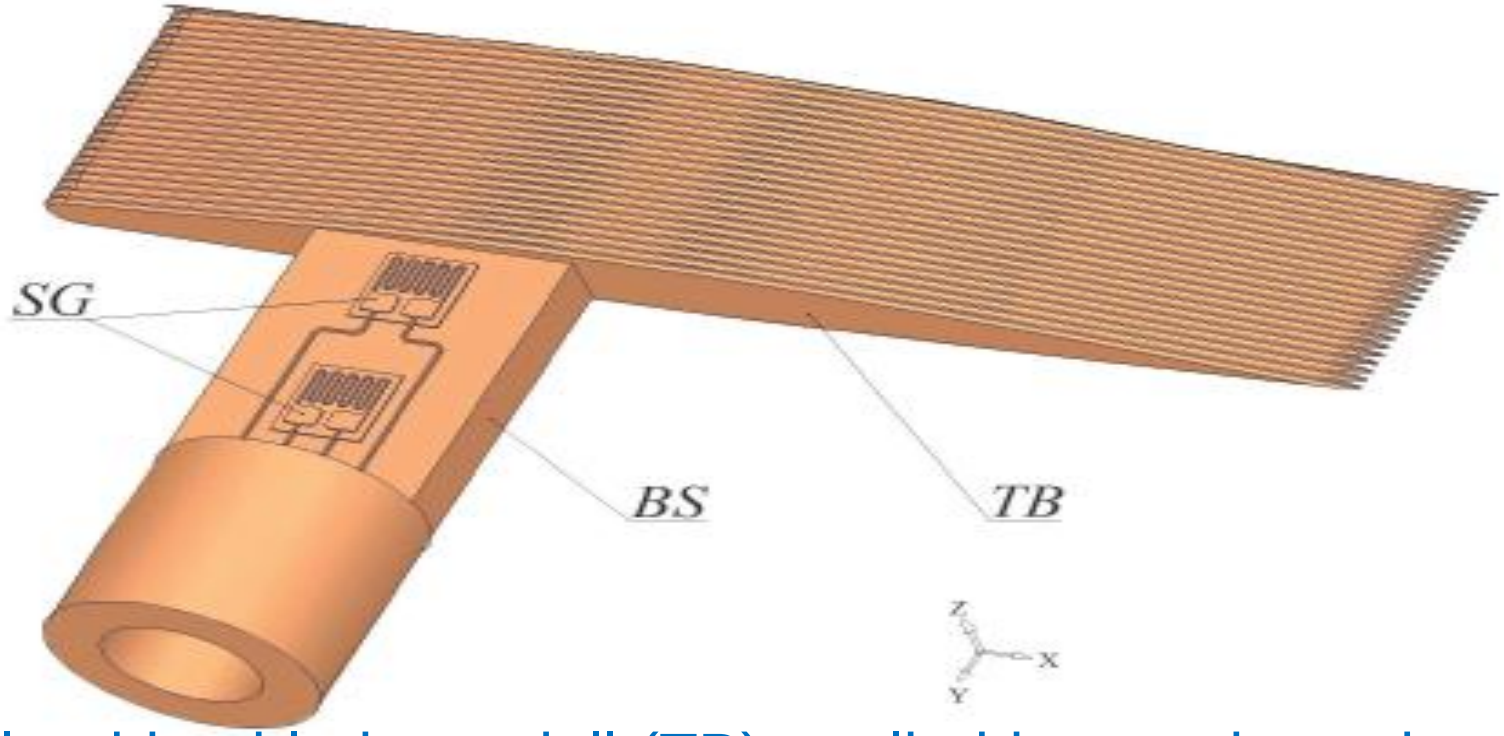
Crossection of butterfly wing Danaus plexippus; UL – higher layer LL – bottom layer, T – supported structure [2,3]

Bionic structure consists of two layers [2,3].

Upper metallic layer in shape of converted „V” and **lower plane layer** create channel of thickness ~0.4 – 0.7.mm.

In upper layer there are the rows of 0.5 mm depth **Distance between** edges in shape of converted „V” was 1 mm.

In rows the holes were make: 0.4mmx04 mm = 0.16 mm^2, through which the air fow inside space between upper and lower surfaces..



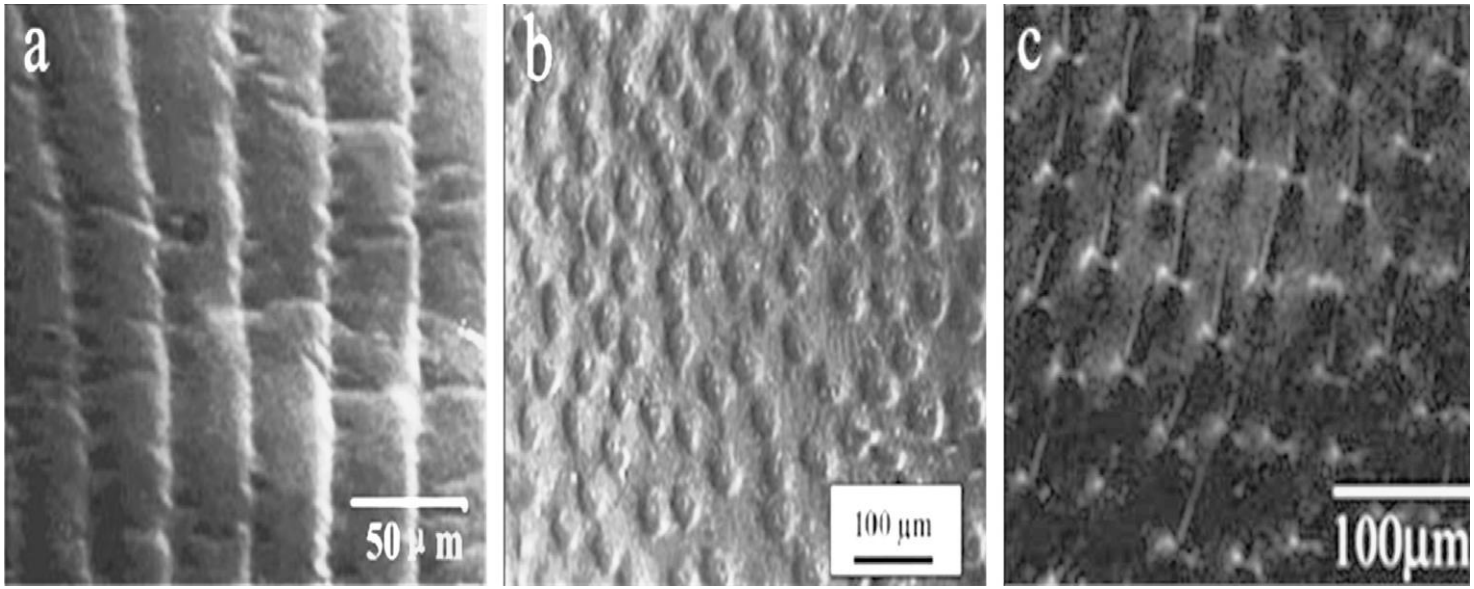
Real turbine blade modell (TB) applied in aerodynamic tunnel. BS – spring element, SG – tensometric sensor of distortion BS. Experiments in aerodynamic tunnel proved that bionic blade take from wind :

ABOUT 15% ENERGY MORE IN COMPARISON TO CONVENTIONAL BLADE (SMOOTH SURFACE) [2,3].

WE WASTE FOR FRICTION AND WEAR ABOUT 40 – 50 % OF TOTAL ENERGY PRODUCTION

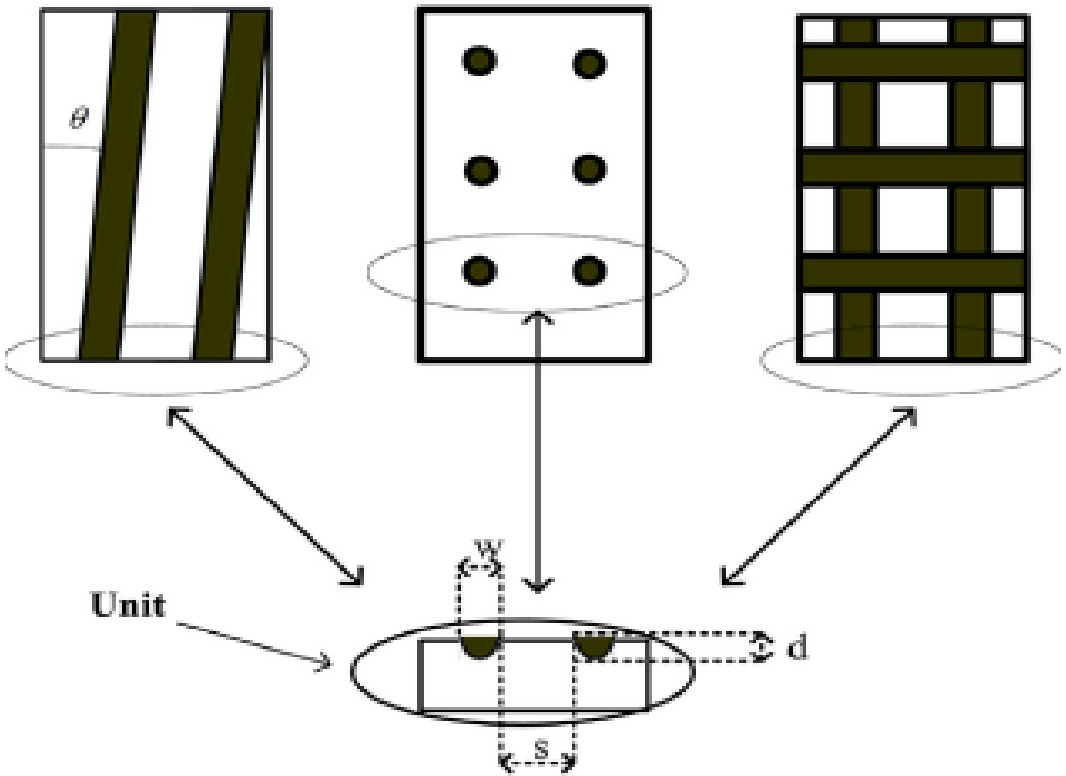
- In the alive organisms there are not smooth surfaces
- In alive organisms surface layer structures were craeted as the accomodation for living conditions in evolution process.

Dung beetle has the **different structures** of the head, body and wings [4,5].



Different structures on wings (a) and head (b,c) of dung beetle (stripes, cavities and protrusions) identify by using Scanning Electron Microscope [4,5]

a.



Taking into account as bio-inspirations wings and body skin of dung beetle the different structures (stripes, cavities and protrusions) on samples made of **grey cast iron** have been done using laser beam and **tests of fatigue wear have been carried out [4,5].**

All samples made of grey cast iron - GCI with bionic structure have significantly **higher (of ~20 to 53%) fatigue wear resistance** in comparison to samples with conventional smooth surface structure. Similar conclusion results from experiments for samples made of steel [4,5].

4. CONCLUSIONS:

1. **The bionic** builds a bridge between world of plants, animals and processes developed by the Nature in evolution process and technical applications.

2. **Using "bionic" solutions** it is possible to solve satisfactory technical problems occurred in each area of engineering.

3. In the presentation only a VERY small part of bionic applications cnnnected with surface layer properties creation was presented.

a-wind turbine inspired by butterfly wings make it possible to **take over of 15% more wind energy** in comparison to wings with smooth surface,

b - surface structure inspired by dungle beatle increase this surface fatigue **wear resistance even of 53%.**

4. The rational way for signifant improvement of our technique development shoud be: **higher range of bionic research and wider application of bionic research results.**

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Thank you

for your attention