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Low noise with wood milling "Airface" constructions

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Abstract: ***L****ow noise with wood milling"airface" constructions*. The noise surrounds us everywhere, constituting a disruptive component of our lives. In the wood industry it is more than in other industries due to the specificity of wood processing carried out by high-speed tools. GUS data say that in 2012 as many as 53% of employees worked in noise. Hence the necessity of constant search for new methods of noise reduction. One of them is the use of a grooved surface patterned on the plumage of owls in the construction of milling heads. Their characteristic construction makes the flight of owls almost silent. this is possible due to the special construction of ailerons, which form the bearing surface of the wing. The "owl's wing" smoothes the air flow with a serrated edge and scatters the noise. This allows for almost silent flight characteristics without adversely affecting aerodynamics. Leuco has used this concept of learning from nature to make the milling tools even more aerodynamic, and to get further noise reduction effects! Leuco has submitted a patent for this aerodynamic head design called "airface".

Keywords: noise emission, milling, airFace head design, grooving, surfaces, combs

INTRODUCTION

NOISE AND METHODS OF HIS COMBATING IN THE WORKING ENVIRONMENT

Along with the development of civilization, technological progress and the demand for work that generate machine tool noise, its projection on man has been increasing for years. With regard to harmful and onerous factors, noise in the wood industry has been one of the dominant threats that occur in the work environment, contributing to widespread environmental degradation.(Anonim 2018, Oswald et al. 1997).

Noise is a very harmful factor. The high noise level not only affects the hearing organ by damaging it; it also affects the entire human body, reducing the comfort of life and being one of the basic threats to our health in the environment.GUS data for 2012 say that as many as 53% of employees worked in noise. In the wood industry, we are particularly exposed to the impact of noise generated during high-speed tools such as circular saws, milling cutters, machining heads, etc.

Fortunately, in the face of noise in the work environment, we are not defenseless. There are many methods by which we can protect your hearing. These methods can be divided into two basic groups:

- legal-organizational-administrative methods,
- methods using technical means.

The first method includes directives as well as EU regulations, but also national laws that concern the protection of workers against noise. (Kortylewski and Wieloch 1998, Kortylewski and Wieloch 2002).

Organizational and administrative projects concern:

- designing a workplace using appropriate technology,
- employee turnover at endangered workplaces, organizing breaks, shortening working hours, limiting the number of employees working at workplaces exposed to high noise, well-thought-out placement of workplaces so as to separate the source of noise and bring its service to a minimum.
- frequent shifting of employees from noise-exposed positions to others - less troublesome,
- application of occupational medicine prophylaxis. Specialist medical examinations.

LIMITING THE NOISE THROUGH MODIFYING TOOLS

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PERFECT NATURE IN THE WING'S LEAF CONSTRUCTION

Toolmakers from Leuco have created a tool with a limited noise level. And what inspired them? Bionics, a new field of knowledge, deals with conducting natural research in order to use them in solving technical tasks. Searching for patterns in nature, analysis of the principles of their construction and operation, allows to obtain innovative solutions (Bachmann 2000, Branowski et al. 1997, Branowski et al. 2003, Cieślak 2011, Engel 2011, Samek 2010).

Drawing inspiration from the aerodynamic operation of the owl's wings, they created a new milling head design. When introducing the problem of noise reduction, one should devote a few words to the perfection of nature in adapting predators to noiseless movement. An example of this can be an owl which is a bird, which has great possibilities in this respect.

Owls (Strigiformes - a row of birds from the infrared cluster of neognathic birds (Neognathae).) Includes predatory species that have adapted to hunting at night and at dusk. They inhabit the whole world, leading a basically sedentary lifestyle.

Their sophisticated feather designs allow them to almost silently fly. Most of the noise is generated by turbulence on the back edge of the bird's wing. The concept of the "owl's wing" used in the construction of the milling cutter smooths the air flow through the serrated edge and scatters the noise, which allows for almost silent flight characteristics without adversely affecting the aerodynamics.

Figure 1. Close up of an ear owl feather (*Asio otus*).

PROTECTION - CONSTRUCTION OF THE SINGLE LEAF

Plumage owls usually have a masking pattern, in gray or brown colors. In comparison with birds that lead their daily lifestyle, their coloration is very little differentiated. The owl plumage is dense and soft. Each pen on the upper surface of the flag is covered with a velvet can in a touch resembling plush. Thanks to this, the feathers rubbing against each other during the strokes of the wings do not make a sound - the owl flies noiselessly. In addition, the front edges of the ailerons located at the front are equipped with "teeth" - a brush-shaped seam. A similar edge has the back edges of all ailerons. Such a construction of feathers is likely to prevent air turbulence during the flight and also favors its silencing. The characteristics given do not have the

Figure 2. Serrated edge of the wing edge.

plumage of fish-feeding owls that use eyes instead of hearing during hunting.Their characteristic construction makes the flight of owls almost silent (Jaworski and Clark 2013).

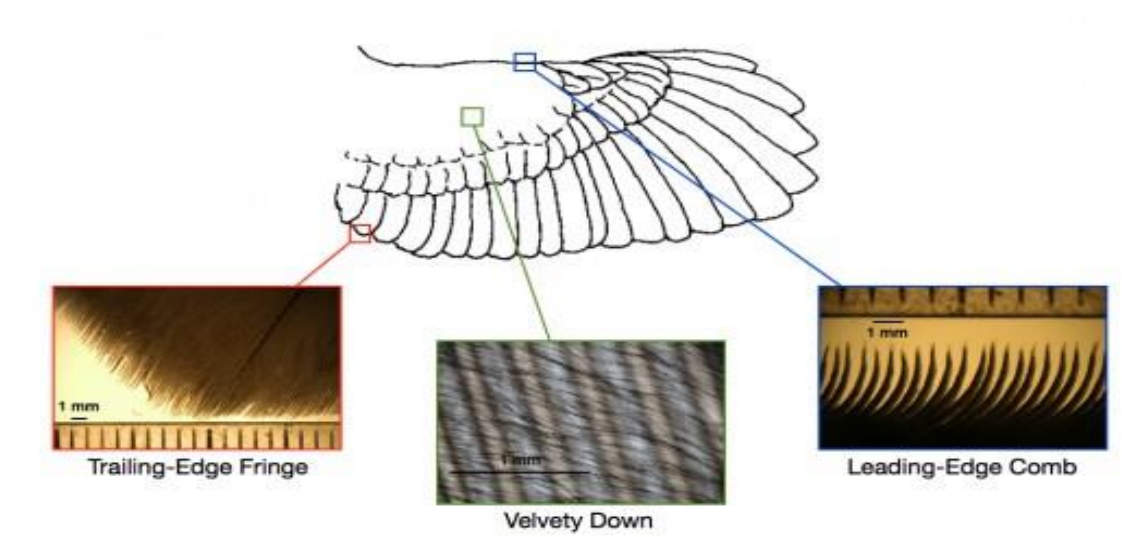

Figure3. Three key elements of the owl's quiet wing: a serrated leading edge, a downy canopy across the upper surface feathers, and a fringed trailing edge.

This is possible due to the special construction of ailerons, which form the bearing surface of the wing. (Fig.1, 2). On the front edge of the wings there is a comb that causes a gentle separation of the air masses behind the wing, preventing any turbulences.

A similar function is performed by delicate feathers resembling fringes, located on the rear edges of the wings (Jaworski and Clark 2013).

Owls are nocturnal predators, hence the need to move silently to surprise the victims. That is why their plumage is extremely fluffy. The flight of owls is characterized by extraordinary softness and lightness, which is largely contributed by the structure of the feathers. The surface of each pen covers like a delicate muffle suppressing murmurs, and the front edge of the first aileron is serrated, thanks to which the wing cuts the air completely without rustling. In order to determine these opinions, the noise generated by birds of selected species during the flight was tested. For testing in a specially prepared hangar, measuring equipment with 6 highly sensitive microphones was prepared. The owl, the city pigeon and the falcon were selected for research (www.wykop.pl, https://www.videoman.gr/pl). All the birds were arranged to capture the prey that was placed on the column. The pipe on which the microphones are located was placed under the flight of birds. The birds were each placed on a pedestal so that their flight took place over the microphones (Natural World). Noise related to over flight was recorded on the computer. The preparations of Fig.4 and the flight of pigeons and eared owls are shown in Figs. 5,6 and 7.

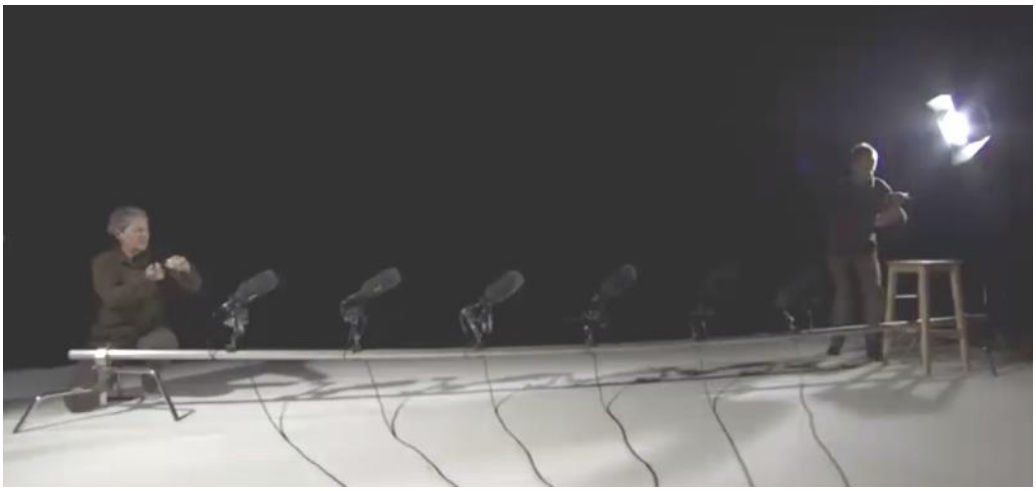

Figure.4. On the right the pedestal on which birds were placed before the flight.

Figure 5. Flight of a pigeon over microphones. You can see the registered noise of the wings.

Figure. 6. Fly owls over microphones. no registered wing noise.

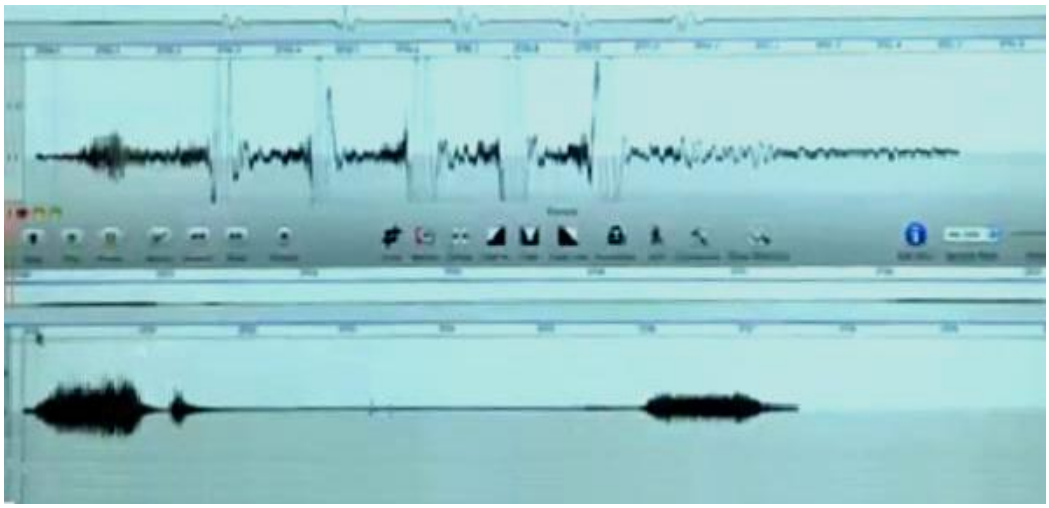

Figure.7. Recorded noises emitted during the flight, at the top - falcon, at the bottom – owls [14].

The "Owl's Wing" smoothes the air flow through the serrated edge and scatters the noise, allowing for almost noiseless flight characteristics without adversely affecting aerodynamics. LEUCO has used this learning concept from nature to make the milling tools even more aerodynamic, and to get further noise reduction effects! LEUCO has submitted a patent for this aerodynamic head design called "AirFace".

The phenomenon of silent flight of nocturnal hunters is also the merit of "micro-combs". They are located on the outer edges of the primary ailerons (these are the longest feathers located on the wing, the most "outside"). The first outer wing in the wing has a "full-length" edge, the second and third feather in the wing have only a fragment of the comb, while on subsequent flights this feature disappears. The "gutted" ailerons cause the bird to fly, cuts the airwaves without creating a turbulence, and then the flight is almost inaudible. This allows you not only to get closer to the victim without being noticed, but it does not disturb the sounds that reach the owl while hunting (https://www.videoman.gr/pl). The wing's sashing pattern is applied to the design of the milling head [Fig.8 tools].

Figure 8. The edge of the ailerons is represented on the blade mounted in the milling head – AirFace.

Figure 9. Milling head with AirFace grooved surface.

This concept has been used by LEUCO as a template design to develop more aerodynamic milling tools and further reduce noise thanks to a completely new blade clamping tool design. During operation and idling, the tool generates air streams, and their turbulence generates noise that has a negative effect on the working environment around the machine (Anonim 2018). During the rotation of the tools, the flowing air is channeled on the walls of the head.

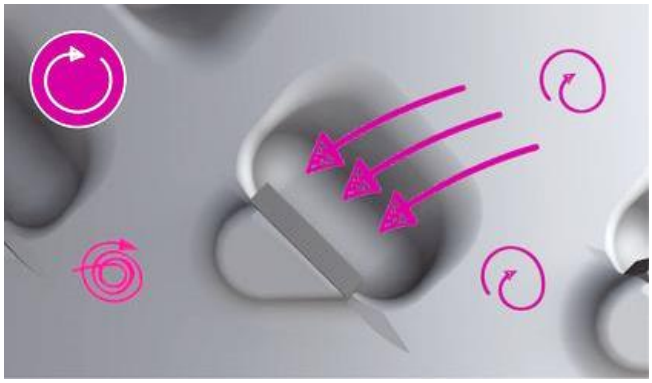

Figure 10. Generation of turbulence with air flow (curled arrows).

Aerodynamics, however, allows you to reduce noise using solutions used in nature. The Leuco tool company has introduced milling heads with a design solution for heads called "Owl's Wing".

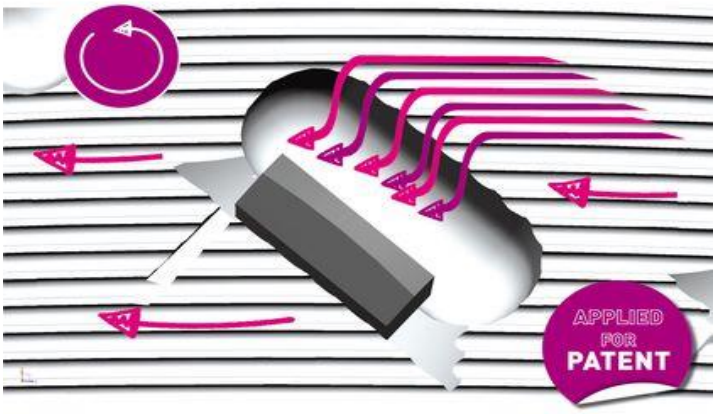

Figure 11. Orientation of the air stream thanks to the corrugated surface of the head.

"Owl's Wing" is a role model for new projects that may appear in the next years after AirFace ". The advantages of a structure based on the owl wing principle were noticed and

this concept was implemented in the design of a new generation of wood cutters. The aim of the design was to shape the head to systematically direct the air stream around the DP blades and reduce their turbulence. The formation of air turbulence at the cutting edge generates noise that affects the working environment around the machine. The so-called "LEUCO airFace" surface on the steel body of the connection cutters is the source of quiet air streams at the head.

Thanks to the completely new design of the shape of the warheads by the owl's wings, the air flow streams are smoothed, channeling them in the corrugated surface. At the same time, it scatters the noise with a serrated edge, which allows noise-free operation of the head without adversely affecting the aerodynamics of the process.

NOISE REDUCTION

Aerodynamics, however, allows you to reduce noise using solutions used in nature. The Leuco tool company has introduced milling heads with a design solution for heads called "Owl's Wing". The formation of air turbulence at the cutting edge generates noise that affects the working environment around the machine. Thanks to AirFace, the noise is reduced by up to 2 dB (A) at idle speed. These milling cutters are the quietest joint cutters made of a steel body.

SUMMARY

"Owl's Wing" is a role model for new projects that may appear in the next years after “AirFace". The advantages of a structure based on the owl wing principle were noticed and this concept was implemented in the design of a new generation of wood cutters. The aim of the design was to shape the head to systematically direct the air stream around the DP blades and reduce their turbulence. The formation of air turbulence at the cutting edge generates noise that affects the working environment around the machine.

The so-called "LEUCO AirFace" surface on the steel body of the connection cutters is the source of quiet air streams at the head.

Thanks to the completely new design of the shape of the warheads by the owl's wings, the air flow streams are smoothed, channeling them in the corrugated surface. At the same time, it scatters the noise with a serrated edge, which allows noise-free operation of the head without adversely affecting the aerodynamics of the process.

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Streszczenie: *Niski poziom hałasu podczas frezowania drewna dzięki aerodynamicznej konstrukcji głowicy "AirFace".* LEUCO wykorzystało koncepcję uczenia się od natury, aby narzędzia do frezowania były aerodynamiczne, i aby uzyskać efekty redukcji hałasu. LEUCO opatentowało tę aerodynamiczną konstrukcję głowicy o nazwie „AirFace". Dostrzeżono zalety konstrukcji opartej o zasadę skrzydła sowy i wdrożono tę koncepcję w projektowaniu nowej generacji frezów do drewna. Celem zabiegów projektowych było ukształtowanie głowicy do systematyczne kierowanie strumienia powietrza wokół ostrzy DP i zmniejszenie ich turbulencji Powstawanie turbulencji powietrza na krawędzi tnącej generuje hałas, który wpływa na środowisko pracy wokół maszyny. Dzięki AirFace zredukowany zostaje hałas nawet o 2 dB (A) na biegu jałowym. Omawiane frezy są najcichszymi frezami do fug wykonanymi ze stalowym korpusem. Aby uniknąć negatywnego wpływu otworów wyważających LEUCO zdecydowało się na wykonanie korpusu z specjalnymi gwintami do śrub równoważących. Tak zwana powierzchnia „LEUCO AirFace" na korpusie frezów do połączeń jest skutkiem rozwijanej innowacji powstawania spokojnych strumieni powietrza przy głowicy. Dzięki nowemu projektowi kształtu głowic wg skrzydła sowy następuje wygładzanie strumieni przepływu powietrza kanalizując je w ryflowanej powierzchni. Jednocześnie za pomocą ząbkowanej krawędzi rozprasza hałas, co pozwala na bez hałasową pracę głowicy bez negatywnego wpływu na aerodynamikę procesu.

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