Owls engineered for stealth and silence

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The wings and feathers of the great gray and other large owls, says Justin Jaworski, are designed to enable the birds to fly—and to swoop down upon their prey—noiselessly.

Harry Potter's snowy owl Hedwig delivers mail and provides companionship for the famous wizard. A.A. Milne's wise old Owl provides Christopher Robin, Winnie-the-Pooh and friends with wisdom, albeit questionably so on occasion. And Owlman becomes a nighttime vigilante when his younger brother, Batman, dies in a parallel universe created by DC Comics in the 1990s.

Perhaps the most intriguing owls, however, are the nonfictional ones. These majestic birds, whose wingspans can be as long as a middle-schooler is tall, are a force to be reckoned with in the animal kingdom. Large owls, like the snowy owl, the great horned owl and the great gray owl, are silent hunters, giving them a predatory advantage over hawks and eagles, which depend on speed to catch prey.

Understanding how these large birds swoop noiselessly, says Justin Jaworski, an assistant professor of mechanical engineering and mechanics, may help engineers create quieter airplanes, wind turbines and underwater vehicles.

Jaworski began studying owl wings in 2011 with Nigel Peake, a professor of applied mathematics at the University of Cambridge, where Jaworski was a National Science Foundation international research fellow.

In November, he presented his group's findings to the 2013 meeting of the American Physical Society's Division of Fluid Dynamics.

Fibers, a buffer and a compliant trailing edge

Three features, says Jaworski, seem to account for the owl's stealthy flight.

He holds up a long, brown and elegant owl wing and offers an explanation. The wing's leading edge, the part closest to the owl's head, he points out, is made of stiff, evenly spaced, mostly aerodynamic fibers that reduce noise.

The fluffy upper surface of the wing is made of a down feather material that is similar in texture to commercial velvet. When examined under a microscope, said Jaworski, this structure looks like vertical strings with interlocking barbs at their tops. This mesh creates a buffer layer that also stifles sound.

Arguably the most important feature of the wing is its porous and compliant trailing edge. This edge is usually where the most noise is generated. In contrast to the feathers on the trailing edge of a duck or eagle wing, which are very stiff, the trailing edge feathers on a large owl's wing are flexible and provide significant noise reduction.

"The trailing back edge is the predominant noise source for any blade that passes through the air—not only the owl, but also aircraft and wind turbines," says Jaworski. "If you can eliminate the noise there you can have a lot of benefits.

"To be sure, you want to look at all three of these features in concert. We're trying to understand, or at least to model in a useful way, each of these features in turn, and then see how they interact with each other."

Jaworski is now working with a team from Virginia Tech, made of William Devenport, professor of aerospace and ocean engineering, and Ian Clark, a graduate research assistant, to develop what they've learned about noise suppression in owl wings into technologies that suppress noise from turbine blades on windmill farms.

One possibility, said Jaworski, is to add a porous and compliant extension to the back edge of a wind turbine blade. Another is to create a fuzzy upper surface while designing it in a way that is still useful.

Commercial aircraft could also benefit from owl wing research. A quieter plane might deploy owl wing technology upon takeoff or landing and retract it when it is cruising and requires maximum efficiency. This, he says, will require a tradeoff between stealth and efficiency.

Jaworski, who also collaborates with Stewart Glegg, professor of ocean and mechanical engineering at Florida Atlantic University, is enthusiastic about the progress he and his team are making.

"The final say in the owl problem will be how to understand each of these wing elements, how to integrate them together, and how to apply what we know to engineering design.

"The more closely you look at owl feathers, the more amazing they reveal themselves to be."

Provided by Lehigh University

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