Owls' ability to fly in acoustic stealth provides clues to mitigating conventional aircraft noise

Owls have the uncanny ability to fly silently, relying on specialized plumage to reduce noise so they can hunt in acoustic stealth. Researchers from the University of Cambridge, England, are studying the owl's wing structure to better understand how it mitigates noise so they can apply that information to the design of conventional aircraft. They present their findings at the American Physical Society's (APS) Division of Fluid Dynamics meeting, held Nov. 18 – 20, in San Diego, Calif.

"Many owl species have developed specialized plumage to effectively eliminate the aerodynamic noise from their wings, which allows them to hunt and capture their prey using their ears alone," said Justin Jaworski with the department of applied mathematics and theoretical physics at the University of Cambridge. "No one knows exactly how owls achieve this acoustic stealth, and the reasons for this feat are largely speculative based on comparisons of owl feathers and physiology to other not-so-quiet birds such as pigeons."

All wings, either natural or engineered, create turbulent eddies as they cut through the air. When these eddies hit the trailing edge of the wing, they are amplified and scattered as sound. Conventional aircraft, which have hard trailing edges, are particularly noisy in this regard.

Owls, however, possess no fewer than three distinct physical attributes that are thought to contribute to their silent flight capability: a comb of stiff feathers along the leading edge of the wing; a soft downy material on top of the wing; and a flexible fringe at the trailing edge of the wing. At present it is not known whether it is a single attribute or the combination of attributes that are the root cause of the noise reduction.

The researchers attempted to unravel this mystery by developing a theoretical basis for the owl's ability to mitigate sound from the trailing edge of its wing, which is typically an airfoil's dominant noise source. Earlier owl noise experiments suggest that their wing noise is much less dependent on air speed and that there is a large reduction of high frequency noise across a range where human ears are most sensitive.

Using mathematical models, the researchers demonstrated that elastic and porous properties of a trailing edge could be tuned so that aerodynamic noise would depend on the flight speed as if there were no edge at all. "This implied that the dominant noise source for conventional wings could be eliminated," said Nigel Peake also of the University of Cambridge. "The noise signature from the wing could then be dictated by otherwise minor noise mechanisms such as the roughness of the wing surface."

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