Scientist uses dragonflies to better understand flight

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Z. Jane Wang talks about her dragonfly research, which found that the slender, elegant insect uses a lot of aerodynamic drag to carry its weight. Kevin Stearns/University Photography

If mastering flight is your goal, you can't do better than to emulate a dragonfly. With four wings instead of the standard two and an unusual pitching stroke that allows the bug to hover and even shift into reverse, the slender, elegant insect is a marvel of engineering.

Z. Jane Wang, professor of theoretical and applied mechanics at Cornell University, presented her research on flying systems and fluid dynamics yesterday at the annual meeting of the American Association for the Advancement of Science. In a seminar "Falling Paper, Dragonfly Flight and Making a Virtual Insect," she said the best way to learn about flight is by first looking at what happens naturally.

Look at how such thin structures as falling paper move through a fluid environment like air, she said, and then examine how insects use their wings to manipulate that environment and stay aloft.

"The major question I focus on is the question of efficiency," Wang said in an interview. "It's the long-standing question: Of birds and planes, which is better? And if we think planes are better -- why?"

Conventional wisdom holds that airplanes (airfoils) are more efficient because they travel from point to point with no wasted up-and-down motion. "But there are infinitely many ways you can go up and down," said Wang. "Of all these paths, are any better than a straight line? Some are -- that's what I found."

The insight came from dragonflies.

"Dragonflies have a very odd stroke. It's an up-and-down stroke instead of a back-and-forth stroke," she said. "Dragonflies are one of the most maneuverable insects, so if they're doing that they're probably doing it for a reason. But what's strange about this is the fact that they're actually pushing down first in the lift.

"An airfoil uses aerodynamic lift to carry its weight. But the dragonfly uses a lot of aerodynamic drag to carry its weight. That is weird, because with airplanes you always think about minimizing drag. You never think about using drag."

The next question, she said, is whether engineers can use these ideas to build a flapping machine as efficient as a fixed-wing aircraft.

Questions of size and feasibility remain. "To hover well or to fly for a long time is hard, especially at slow speeds," she said. "Power is limited. So finding these efficient motions is very important."

Still, Wang's work moves researchers a step closer to building such a machine.

"I want to build insects on a computer as a way of learning why almost all things that move in fluid use a flapping motion," said Wang. "Whether it's a fish which flips its fins or a bird, they're actually using the same principle.

"The way paper or leaves fall, and how insects fly, may give us some ideas about why animals use these methods at all," she said.

Source: Cornell University