

Crunching numbers: Math equations help build optimal bird wing

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If you had to design a bird or dolphin drone from scratch, how would you build the wings?

That's the question that Florida State University Assistant Professor of Mathematics Nick Moore posed in a new paper published by the academic journal *Physics of Fluids*.

Specifically, he wanted to know how flexible the wings or fins should be, so that if an engineer designed a flying or swimming drone, they could create the most effective one possible.

"We want to understand how wings and fins perform differently when they are made of [flexible material](#)," Moore said. "Sometimes, flexibility can really boost performance, but too much flexibility can be a bad thing. We want to find the happy medium."

Furthermore, Moore wanted to see if allowing the [wing](#) to be more flexible in certain places could help even more. He found that concentrating flexibility near the front of the wing, while keeping the back rigid, maximizes its capability to thrust forward when it is flapped.

In fact, a wing designed in this way generates 36 percent more thrust than one for which the [flexibility](#) is constant throughout.

Moore said the mathematical model aids in the fundamental understanding of how birds, insects and some amphibians are designed

from a biological perspective. But the practical advantages for engineers designing robots are even greater.

"Maybe engineers will look at this as a way to improve designs," he said. "If you can control exactly how to build a flapping wing, this is how you should do it."

Drones are being used in all sorts of ways, from construction design to military endeavors to search and rescue operations.

To perform the calculations, Moore used [partial differential equations](#) that were solved on an ordinary computer.

In the beginning, Moore manually chose the wing designs that were put through the computer to be tested.

Ultimately, though, he developed an algorithm that allowed the computer to suggest its own guesses, and this was used to pin down the optimal design.

Much of the advanced mathematics conducted in the world right now requires super computers, but Moore takes a different approach. He used relatively simple equations so that designers with a math or engineering background could replicate the work.

"I like to spend more energy simplifying the mathematics as much as possible, so that the calculations can be run on a desktop, or even a laptop, in a reasonable amount of time," he said.

More information: *Physics of Fluids*, [scitation.aip.org/content/aip/ ... /9/10.1063/1.4930235](https://scitation.aip.org/content/aip/journal/pof2/9/10/1063/1.4930235)

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