FirstRand

New research shines a light on the mystery of the butterfly's flight - and the future of flight technology or Flight of the Butterfly

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The delicately beautiful butterfly finds itself at the centre of new research which reveals a secret hiding in plain sight that could influence the future of flying technology.

The flight of the humble butterfly has transfixed human beings for centuries. Its delicate beauty encapsulates the magical and mysterious qualities of the insect that goes by the scientific name rhopalocera.

The butterfly's unique life cycle symbolises rebirth and perpetual change through metamorphosis, as it transforms from an uninspiring caterpillar to a spectacular, winged creature whose beauty has moved composers like Giacomo Puccini (Madama Butterfly), Moritz Rosenthal (Papillons), and Edvard Grieg (Schmetterling) among others.

Though Chopin's Etude for piano No. 21 in G flat major had little to do with the insect, the piece was popularly called "Butterfly" or "Butterfly's Wings" because of the way the pianist's fingers are meant to dance along the keys, like the insect moving from flower to flower.

In art, butterflies symbolise transition, lightness - and the ability to float in the air effortlessly. To Native Americans the butterfly symbolises joy and change. Young Native American women would wear their hair in the shape of butterfly wings to show their availability. Early Christians believed the butterfly represented the soul, and to the Chinese they symbolised conjugal bliss. Today, butterfly tattoos are as plentiful as the flying insects themselves.

However, the butterfly has been an influential figure too in the science of weather prediction and the concept of time travel. In chaos theory, "the butterfly effect" idea represents the sensitive dependence on initial conditions - meaning that one small change could lead to major changes far away. In time travel, changing one thing in the past could fundamentally change the future.

The "butterfly effect", which originated in the 1960s from mathematician and meteorologist Edward Lorenz, is used to describe how a minute or "butterfly-scale" change can have drastic and sometimes disastrous effects on weather patterns many thousands of kilometres away. To emphasise this point, it's said that if a butterfly flaps its wings in Tokyo it could cause a tornado in Tennessee weeks later.

Now, the fragile butterfly finds itself at the centre of a new study that has revealed a secret hiding in plain sight that could influence the future of flying technology. The question: how is the butterfly able to take off so fast and evade predators with its large and ungainly wings that appear too large for its body?

The study of butterflies in flight is not new, but thanks to improved technology scientists have been able to observe free-flying butterfly far more closely than before.

In the 1970s researchers came up with a theory that the butterfly claps its big wings together on the upstroke to power its take off - but up until now that theory was just that - a theory, which no one could illustrate - until Swedish researchers, using a wind tunnel and high-speed cameras were able to capture the butterfly's unique skill in slow motion.

Early observations of butterflies flying suggest that their wings are too large to be effective. Most other flying species have evolved powerful and efficient wings to evade predators, yet butterflies seem able to do the same with their oversized wings. How?

To explore this further, researchers at Lund University in Sweden studied the aerodynamics of butterflies in a wind tunnel. What they found confirmed the 1970s theory - that the butterfly' clap technique, using its unique wings helps them take off quicker than their predators can pounce.

Researchers found that during the clap, when the wings meet, the wings have a reverse camber, resulting in a "cupped" clap.

"That the wings are cupped when butterflies clap them together, makes the wing stroke much more effective. It is an elegant mechanism that is far more advanced than we imagined, and it is fascinating. The butterflies benefit from the technique when they have to take off quickly to escape from predators," said biology researcher Per Henningsson, who studied the butterflies' aerodynamics together with his colleague Christoffer Johansson.
"We hypothesised that a cupped clap with flexible wings, essentially forming an air pocket in the late stages of the clap, results in a larger impulse because the wings will be affecting a bigger air volume at the final critical instance of the clap."

Butterflies are as fascinating as they are beautiful and unique. One fact you probably wish you didn't now know, is that butterflies don't defecate. This is due to their exclusive liquid diet of mostly nectar. They use all of it. Butterflies also taste with their feet and only live for two to four weeks, which makes eating and mating top priorities in their life.

The flight findings by Henningsson and Johansson could now influence the design of flapping drones and boost propulsive performance in the future. Drones and underwater vehicles use propulsion systems which Henningsson says could become more efficient and more powerful in the future.

Most butterflies reach a top speed of about 20km/h, though the fastest butterflies have been recorded at an impressive 60km/h. There are an estimated 20 000 to 25 000 different butterfly species in the world, and most cannot fly unless their body temperature reaches at least 30 degrees Celsius.
Henningsson and Johansson used six silver-washed fritillaries which were caught in the meadows in southern Sweden.

During the research, the duo designed two pairs of mechanical wings - one rigid pair and one flexible pair that mimicked the real ones. The result of the tests confirmed that the flexibility and shape of the butterflies' wings made it efficient and powerful.

"Our measurements show that the impulse created by the flexible wings is 22 percent higher and the efficiency 28 percent better compared to if the wings had been rigid," added Johansson.

"The shape and flexibility of butterfly wings could inspire improved performance and flight technology in small drones," Henningsson added. "We're suggesting that the people that are working on these designs, they should look into this cup-shape behaviour, since there are lots of efficiency and effectiveness to be gained from it," Henningsson concluded.