THE MORPHING WING

By Henry Holden

THE WRIGHT brothers had the warping wing concept right. They began their work by watching birds angle their wings for balance and control.

In 1903, their 'Flyer,' which used wires and pulleys that bent and twisted the wooden-and-canvas wings launched humans into controlled flight.

Studies of aerodynamics over the years showed that the shape of a wing has enormous effects on flight – but there is not a one-size fits all wing, and there is not one "ideal" wing shape. That definition changes for different aircraft wings; fixed, rotor, swept, and delta, for example. It also varies for different flight profiles of the same aircraft.

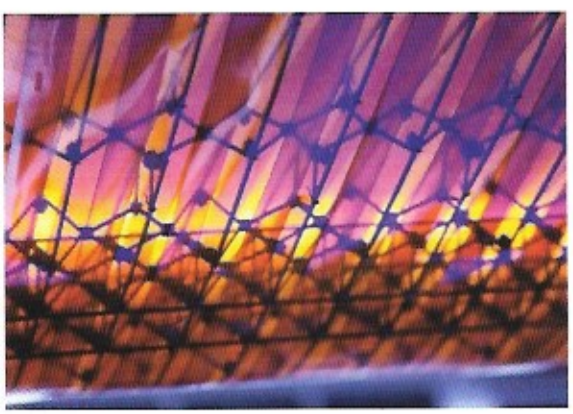
The best shape at any moment depends on many factors: such as how much the aircraft weighs, its speed, and whether the pilot wants to climb or descend.

This means that a rigid wing with a limited number of moveable surfaces, which are also rigid, is a compromise and is not the most efficient shape for the whole of any given flight.

Increased efficiency means less fuel is needed, which means less weight on the aircraft, which also increases efficiency.

In recent years, there have been advances in making and using composite materials in airframes. Scientists are studying advances in future aircraft designs that can adapt to changing flight conditions by changing the shape of the wings. The question is, could those technologies be combined into super strong, lightweight composite structures and be flexible and change their shapes as the flight profile changes?

The Wright brothers' twisted wood-and-canvas wings inspire researchers to make today's flying more efficient.



Bottom of page: *The wing is constructed from building-block units made of advanced carbon fibre composite materials.* (Photo: NASA/Kenneth Cheung)
Above: *A newly developed wing architecture could simplify the manufacturing process and reduce fuel consumption by improving the wing's aerodynamics. It is based on a system of tiny, lightweight subunits that could be assembled by a team of small specialized robots, and could be used to build the entire airframe.* (Photo: Kenneth Cheung/NASA)

BUILDING AN ULTRA-LIGHT WING

Efficient flight is always in the minds of the Mission Adaptive Digital Composite Aerostructure Technologies, or MADCAT. A team at NASA's Ames (Armstrong) Research Centre think they may have developed the "holy grail" of efficient flight. In collaboration with students from the Massachusetts Institute of Technology, they are using emerging composite material manufacturing methods to build an ultra light wing that actively changes shape to help reduce fuel costs and improved flight efficiency.

"An ultra light wing that actively changes shape could be an important part of the future of green aviation," said Kenneth Cheung co-lead on the MADCAT project.

"This type of change could improve aerodynamic efficiency and future flight by reducing the amount of drag caused by rigid control surfaces like flaps rudder, and ailerons."

The team recently tested the new morphing wing concept at a remote test airfield near Modesto, California, and plans to further evolve the wing and assess the boundaries of its feasibility.

For years, many experts have tried to create a reliable way of deforming wings as a substitute for the conventional, separate, moving surfaces. "But all those efforts have had little practical impact," said Neil Gershenfeld, director of MIT's Centre for Bits and Atoms. "It was the use of mechanical control structures within the wing that caused researchers to fail. These structures are very heavy and cancel out any efficiency advantages produced by the smoother aerodynamic surfaces."

HOW IT'S MADE

The wing is constructed from building-block units made of advanced carbon fibre composite materials. These building blocks are assembled into a lattice, or arrangement of repeating structures; the way that they are arranged determines how they flex. The wing also features actuators and computers that make it morph and twist to achieve the desired wing shape during flight.

The team created a new bendable, 'morphing wing' system of carbon fibre reinforced plastic that is assembled by a team of small robots. The miniature robots crawl along or inside the wing structure as it takes shape. An inspection robot will find where a broken part is and replace it, and keep the aircraft structure safe at all times.

Made from 0,127 mm-thick Kapton (polyimide film), the skin is cut into strips with hole patterns on a CO2 laser cutter.

The new wings are cloaked in a "skin" made over overlapping pieces that look like scales or feathers which makes the structure flexible with a smoother aerodynamic surface.

The flexible skin lets the pieces free to move across each other as the wing flexes.

The entire wing can be modified and twisted uniformly along its length, by activating two small motors that apply a twisting pressure to each wingtip.

Although the team is focused on the wing, they say the system could one day be used for the entire airframe. ✈