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Biomimetic flow control

In spite of a common fascination, even obsession, with feathers, we too often forget to appreciate them in their natural setting, gracing the wild creatures around us. Whether our amazement springs from the plumes in a hat, the warmth of a down jacket, or the uncanny physics of a feathered wing in flight, we owe the debt of our wonder to birds.

– Thor Hanson
Feathers: the evolution of a natural miracle (2011)

Fig. 1. Common Kestrel (*Falco tinnunculus*).

Foreword

What is more surprising than seeing a Common Kestrel (Fig. 1) motionless in the wind? As if suspended by a wire in the sky, it controls its position and its stability by imperceptible changes of its wings. This flight, defined as the "Holy Spirit" in French and Italian (*Vol en Saint Esprit, Volo a Spirito Santo*), stops suddenly when the falcon swoops on its prey, identified by UV radiations of the urine marks. The bird can thus determine the distance that separates them and dive under gravity reaching high speeds, while folding its wings along its body to reduce drag.

To paraphrase Thor Hanson, the "debt of wonder" we owe also to fish, butterflies and plants, constant sources of inspiration for scientists, engineers and poets. In the articles collected in this volume, natural features, such as those responsible for a lotus leaf's hydrophobic properties, such as the tubercles of whale flippers, able to delay stall, or the collective arrangement of the remiges of a bird-wing, capable of reducing lift-induced drag, are scrutinized and mimicked, for performance breakthroughs to occur in selected scientific and technological applications. Could the ultimate goal in aviation be possibly represented by the cartoon in Fig. 2?

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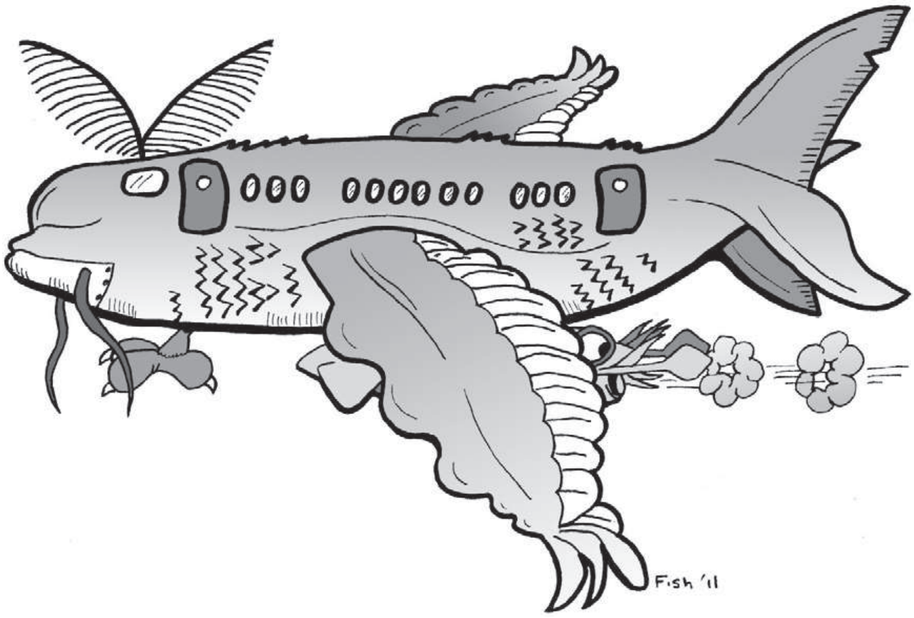

Fig. 2. The ultimate biomimetic jet airplane. The plane incorporates advanced sensing and navigation systems with moth antennae for chemical detection, a lateral line system to detect pressure and flow velocity, dolphin echolocation for ranging, and catfish barbules for tactile reception. Efficient propulsion is promoted by squid jet propulsion and drag reduction with an outer skin of shark scales. Stabilization control and lift generation is provided by wings equipped with humpback whale tubercles to control vorticity and prevent stall, flight feathers to increase lift while reducing weight, and posterior positioned stabilizer and rudder using dolphin flukes and shark caudal fin. Landing gear for short take-offs and landings is facilitated by eagle talons for perching. Cartoon drawn for this special issue by Frank Fish, Liquid Life Laboratory, West Chester University.

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