Should Planes Look Like Birds?
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We explore the ideas proposed by RJ Huyssen, and tested for the first time in the USC wind tunnel in May 2010.

We ask the following question: Is the current Dominant Configuration for an aircraft an optimum? We consider only drag. All other things being equal (an aircraft must lift a fixed weight, travel a certain distance), we wish to minimise energy consumption, which depends on drag. For any mission requirement (cargo plane, glider, passenger transport), there ought to exist one variation that performs this task with minimum drag. We search for such configurations and show that the current DC cannot be optimal. So what might be?

F1

The shape of things to come? Points that are different from the standard tube-and-wing include, fore-aft sweep of wings (for stability), absence of separate tail plane (at least as we normally see it), shorter, stubbier fuselage, and a small tail at the rear of the body. The purpose of the tail is to modify the airflow over the body such that the overall flow over the wings remains close to optimal, despite the presence of the body. The tail fixes up the disturbances that the body creates.
An experimental simplification of the basic problem. This model can be tested as: (i) wings alone; (ii) wings + body; (iii) wings + body + tail. The tail can be set at different angles.

The hypothesis is that the tail can be set at an angle such that the airflow behind the wing+body+tail combination is very similar to that created by the wings alone. In that case, we can say that the disturbance due to the body has been removed.

Wind tunnel tests of bird-like bodies and wings use digital imaging methods of the smoke-filled flow in a closed-circuit tunnel to measure the flow field.
Given the equipment to hand, we settled on reconstructing the 3D volume behind the body through a large number of planes that lie parallel to the mean flow. Although this gets only two of the three velocity components, they are the two most important. The component $w$ that is parallel to the *lift* force direction and opposes the weight, and the component $u$ that shows the horizontal force, which is the *drag*. 
This is the measured flow behind the wings alone, in one selected horizontal sheet. This view is as if we are behind and beneath the wing, looking up. The vertical flow induced by the wing is directly proportional to the lift. It is an almost perfectly uniform carpet of vectors of the same length, raining down upon the observer with equal magnitude, everywhere.

This is the ideal distribution, but only professors at universities can explore the aerodynamics of isolated wings in any great depth, because in practice, we have to carry something, and it is rare that the thing fits conveniently inside a wing.
This is what happens when a body is added to the wings. It is all bad. The vertical velocity which used to be a uniform carpet is now a ragged mix of vectors. All non-green colors are vectors that are smaller in length than our original ideal green. The lift has been reduced.
Adding a tail fixes the vertical downwash distribution so that it once again is almost uniform. At a very slightly smaller tail angle, it would be indistinguishable from the wings-alone case of F5.

Therefore, yes, it works.

We conclude:
-- A small tail surface can lead to a better (more efficient) airflow around the wings + body.

-- Therefore optimal aircraft configurations perhaps should look more like F1. Even for passenger planes. At the very least, it is an idea worth exploring.