Transkription eines Briefes von O. Chanute an James Means Id: **18678**

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My dear M˜ Means

I have been laid up for a week by the grippe, and in no condition to acknowledge receipt of your welcome letter of Dec. 28˜ or to satisfy your curiosity about my solution of the soaring of the bird in very light winds. This I will endeavor to do now.

I got it, not by the usual avenues of human knowledge, of observation and experiment, for these had failed me, but by an eclectic process of surmise and computation. When I got the results, they gave me the reasons for the circling of the birds, for his attitude as occasion ally noted when the sun shines behind him, and for the necessity for an independent initial speed superior to that of the light wind. In other words I got an answer to the conundrums which occurred to me when writing the article on soaring in your Annual of 1897.

I have made a great many computations, but as he most striking is that which demonstrates the possibility of soaring <u>in a dead horizontal calm</u>, a performance which I always denied and denied, although many observers claimed to have seen it, I will give you the figures for that performance when there is an ascending current of air.

If a buzzard, such as hangs in my library, is loaded to 0.92 pounds to the square foot (actual figures) and has no initial speed of his own, it is clear that he would need an ascending vertical current of about 14 miles an hour, furnishing a pressure of 0.93 lbs. per sq. foot, in order to sustain his weight. Observation indicates that there are no such currents, and critics usually dismiss the whole question at this point. But a rising of the air, when heated by the sun, at the rate of 5 miles an hour, is, I believe, quite common, and takes place on shimmering days when no horizontal movement can be detected. The pressure due to this speed of air is 0.125 lbs. per sq. foot, or quite insufficient to support the bird.

But if the buzzard has already acquired an initial speed of his own, by flapping or falling, he need only receive from the ascending air sufficient energy to make up the losses due to the resistance consequent upon forward movement. Let us assume the bird to have acquired an initial speed of 15 miles an hour, and to be in air rising vertically 5 miles an hour (7.33 ft. per second). My buzzard No. 1 measures - Area 4.51 sq. ft., Wt. 4.25 lbs. The area of the body (0.375 ft. Diam.) measures – 0.110 sq. ft. The wing edges (see chart of 0 E.) measure 0.244 sq. ft.

Assume same co-efficients as for the gull:

Co-efficient for body 1/10 of cross section.
" " wings ¼ " " "

There are two speeds to consider, that of the bird and that of the air, which are at right angles. Hence the relative wind 5/15=0.333=Tang. 3° 15'. The speed of relative wind V= $\sqrt{15^2+5^2}$ = 15.81 miles per hour. The resulting air pressure for this is 1.25 lbs. per sq. ft.

Now, if the bird assumed a negative angle of 3°, with the horizon, its own angle of incidence with the relative wind will be 18° 15-3° = 15° 15' for which the Lilienthal coefficient is 0.903. But the Normal=Surface x Pressure x Co-efficient. Hence N – 4.57 x 1.25 x 0.900=5.158 lbs. under bird. This Normal being applied at an angle of 3° we have Lift 5.158 x cos. 3° or 0.998=5.147 lbs. or more than the weight of 4.25 lbs, so that bird can rise. The tangential pressure is for 15° 15':

T=4.0754 x 4.25 x -0.076 = -0.434 lbs. which is a propelling force.

But as the normal is 5.158 and tangential -0.434 we have for the resultant action of both forces:

R= $\sqrt{5.158^2+0.434^2}=5.176\,lbs.$ applied at an angle of 0.434/5.158=0.08415=tang. Of 4° 49' (see Lilienthal fig. 29). This resultant is now to be resolved horizontally and vertically to obtain the propulsion and the net lift. It makes an angle with the horizon of Comp. 4° 49' where
Propulsion 5.176 x sin 4° 49' (or 0.084) = 0.434 pounds.
Net lift 511.76 x Cos Do (or 0.996) = 5.155 "

Whence it appears that a force of 0.434 lbs, is pulling forward and one of 5.155 is lifting up the 4.25 lbs. weight, the slight difference from the lift first calculated being due to the correction in the angle of application.

The pressure due to the speed being 1.25 lbs. per sq. ft. we have for the resistance to horizontal motion:
Resistance body 0.110 x 1.25 / 10 = 0.01375 lbs.
" wings 0.344 x 1.25 / 4 = 0.07625 "
Total = 0.09 "
so that there is a surplus both of propelling force and of lift to allow for mechanical losses

of application. The relative speed of the bird being 15.31 miles per hour or 23.18 feet per second we have for the work done:

Power 0.09 x 23.18 = 2.08 ft. pounds per second

And as the air is supposed to be rising 7.33 ft. per second, producing a pressure from this of 0.125 lbs. per sq. ft. or 1 10 of pressure on bird.

Energy 4.57 x 0.125 x 7.33 – 4.18 ft pounds per second so that, with the data assumed, the rising air furnishes nearly twice the energy required to maintain the speed.

It may be that the air does not ascend quite so fast as 7.33 ft. per second, or that the co-efficients of resistance are a little too low, but the main facts conform.

Note particularly the necessity for an initial speed of the bird, and his negative angle of incidence. These are the secrets of soaring flight in light winds.

Yours Truly

O. Chanute

P.S. I expect to sail from New York about the end of this month. Glad to hear from you before I go.