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My dear Mr. Marvin.

Absence from the city has prevented an earlier acknowledgment and answer of your most valued letter of 4th inst.

I cannot convey to you how grateful I feel for the pains you have taken to solve the intricate mechanical problem of gliding flight, and to propose a nomenclature applicable thereto. I feel that this is a good time to thrash he subject out and to lay down certain rules and terms, which when published may form a guide for others.

I have been hitherto confining my attention to evolving automatic stability and have neglected the computation of the forces on action, largely because of my imperfect knowledge of the subject, and I recognize that my data are not full enough. In future experiments I will endeavor to have them conducted on the lines indicated on pages 1 & 2 of your letter. I cannot give you diagrams of the various velocities, in different parts of the glides, as requested on page 3, but I will send your letter to Mr. Wright who may have such data for one or two glides. You will understand that when the start la obtained by running against the wind the initial relative speed <u>may</u> be more (or less) then is required for support. In my 1896 glides the operator often went off horizontally, lost speed and then descended steeply. Moreover, the glide is so brief, [?] (10 to 14 seconds) that it is difficult to separate the velocities. We will see what can be done by staking off a middle portion as you suggest.

I quite agree to your definitions [?] of the planes of reference and axes, as stated on your page 4, and also to your illustration of the “elementary pressures” as stated on page 5. I quite realize that the resultants are but the summation of many diverse pressures, and <u>to their moments</u> which may, and do, frequently vary the “center of pressure”. Now that we have come to your page 8, I am going to ask you to consider some proposed changes on your terms and definitions.

I agree of course to the “Normal” but I differ from you as to the “tangential <u>or</u> edge pressure.” Here I believe [?] we have two different forces which may or may not be opposed to each other. You are familiar with the classic diagram of the effect of the wind on sail, in which the wind force is represented by a line in its own [?] the wind's direction; this

is decomposed into two forces, one, the “Normal,” at right angles to the sail, which is further resolved into a boat propelling component (here is where Newton's followers got the square of the angle incidence.) and into a lee-way component resisted by the keel. The second component of the original wind force is shown as parallel with the sail, and, (as this is assumed to be a plane,) is dismissed as inoperative except for possible friction. But Lilienthal's experiments seem to show that for an arched surface this component may be operative and act either as a propelling or as a retarding force in variation with the angle of incidence. This I should propose to you to call the “Tangential” force and to take it into separate account.

The parallel component of the resultant, which you tern “edge resistance” if adhered to, should preferably, in my judgment, be considered as two separate forces, one due to the component of the “Normal” and the other to the resistance of the framing and of the operator. This latter I have heretofore called “Head resistance” and the other the “drift.”

I believe that I was the first to use the terms “lift” and “drift” in connection with aviation, and they seem to have been generally accepted, without any exact definitions. I have gone on using them and have been resolving the forces vertically and horizontally because I considered that when we came to dynamic flight the horizontal and vertical forces would be the ones to calculate, and I am not even now satisfied whether this is best, or whether it is best to resolve the forces along the path, as you have done to arrive at static equilibrium. I ask you therefore whether the following terms and definitions would be appropriate?

“Tangential” Parallel component of original wind force, may propel or retard according to angle.

“Normal” Rectangular component of original wind force. Note, Experiments show that this varies greatly with the form of the surface and is, even for planes very much greater than sin [?] or sin α.

“Lift” Vertical component of the Normal (sustaining)

“Drift” Retarding effect on surface alone. How to apply?

“Head resistance” Retarding effect framing &c.

“Path-rectangular” Resultant when projected on path.

“Path-parallel” Resultant projected parallel to path.

“Centre of pressure” Point of application of wind forces.

“Relative wind” Wind actually met by surfaces

“Angle of incidence” Angle with relative wind”

“Horizontal incidence” Angle of surfaces with horizon?

There may be others. When we get them to our liking I will send them to

Major Moedebeck for his German, English, French, Aeronautical lexicon, and they go thence to the "Techno lexicon of the Society of German Engineers".

I enclose herewith two articles of mine. The one: "condition of success &c." was written about 3 years ago for Moedebeck's paper; and the other: "Aeronautics" was contributed about two years ago to the Supplement to the Encyclopaedia Brittanica to be printed by the London Times. I do not know whether it is issued yet, but I got a few paged proofs struck off. You will note that I approached the subject from the opposite and from your own: beginning with the design of the machine and endeavoring to calculate what it would perform. You will add to my obligations to you if you will point out any blunders which I may have made.

To return your letter – On page 8 you discuss the path of the centre of gravity during a glide. I have already stated that at the start the relative speed may be more then required, but this is of no importance. At the end of the glide, however, the operator glides upward, (by shifting either weight or rudder) in order to check the speed, and then alights, so that the path of C. G. may be as follows:

[Skizze]

In timing the glides we snapped the stop match (you will find a curious one in the Richards Anemometer box) the moment the apparatus went free, and again when it alighted. Your question as to the safety of the latter operation is answered by the above diagram.

At Kitty Hawk we tested the trend of the wind a number of times, and found that it flowed very nearly parallel with the slope of the hill, which was 10°. At Dune Park we could not tell what it trend was at the machine which was often 40 to 50 feet above the ground. It would be difficult to stake off the portion of uniform speed.

I suggest that on page 8, and also on p. 11 you will change the term "Head resistance" = W Sin a 1 to the term "Total resistance" or rather to "Propulsion." (If you were resolving it horizontally it would be = W tang a = 42.3 lbs. as I have it. The same numerical result which you have termed "drift" on page 11 should preferably be called the "total resistance" and consist of the "drift" (which I am not clear about) + the head resistance. Your term of "edge pressure" I suggest to be discarded. The "total resistance" I believe [?] consist of the "drift" + the "head resistance," ±❑ the "Tangential." If that be so your various formulae will need to be changed.

Now as to the "lift." I have heretofore considered it as equal to the weight, because I was thinking of horizontal flight. Should it (and therefore the "Normal,") be less, as you have it, for gliding flight. Mr. Wright says that his recent experiments with models agree much more closely with Lilienthal's co-efficients than he believed at first, more

particularly for angles of 10° and upwards. He differs at lower angles, but not much. I will write you again when I hear from him. His paper is being printed, and I will send you a copy in a few days.

Yours truly

O. Chanute