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Author: H. Barber

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THE AEROPLANE SPEAKS

By H. Barber

(Captain, Royal Flying Corps)

DEDICATED TO THE SUBALTERN FLYING OFFICER



MOTIVE

The reasons impelling me to write this book, the maiden effort of my pen, are, firstly, a strong desire to help the ordinary man to understand the Aeroplane and the joys and troubles of its Pilot; and, secondly, to produce something of PRACTICAL assistance to the Pilot and his invaluable assistant the Rigger. Having had some eight years' experience in designing, building, and flying aeroplanes, I have hopes that the practical knowledge I have gained may offset the disadvantage of a hand more used to managing the "joy-stick" than the dreadful haltings, the many side-slips, the irregular speed, and, in short, the altogether disconcerting ways of a pen.

The matter contained in the Prologue appeared in the Field of May 6th, 13th, 20th, and 27th, 1916, and is now reprinted by the kind permission of the editor, Sir Theodore Cook.

I have much pleasure in also acknowledging the kindness of Mr. C. G. Grey, editor of the Aeroplane, to whom I am indebted for the valuable illustrations reproduced at the end of this book.



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THE AEROPLANE SPEAKS

PROLOGUE

PART I. THE ELEMENTARY PRINCIPLES AIR THEIR GRIEVANCES

The Lecture Hall at the Royal Flying Corps School for Officers was deserted. The pupils had dispersed, and the Officer Instructor, more fagged than any pupil, was out on the aerodrome watching the test of a new machine.

Deserted, did I say? But not so. The lecture that day had been upon the Elementary Principles of Flight, and they lingered yet. Upon the Blackboard was the illustration you see in the frontispiece.

“I am the side view of a Surface,” it said, mimicking the tones of the lecturer. “Flight is secured by driving me through the air at an angle inclined to the direction of motion.”

“Quite right,” said the Angle. “That’s me, and I’m the famous Angle of Incidence.”

“And,” continued the Surface, “my action is to deflect the air downwards, and also, by fleeing from the air behind, to create a semi-vacuum or rarefied area over most of the top of my surface.”

“This is where I come in,” a thick, gruff voice was heard, and went on: “I’m the Reaction. You can’t have action without me. I’m a very considerable force, and my direction is at right-angles to you,” and he looked heavily at the Surface. “Like this,” said he, picking up the chalk with his Lift, and drifting to the Blackboard.

“I act in the direction of the arrow R, that is, more or less, for the direction varies somewhat with the Angle of Incidence and the curvature of the Surface; and, strange but true, I’m stronger on the top of the Surface than at the bottom of it. The Wind Tunnel has proved that by exhaustive research—and don’t forget how quickly I can grow! As the speed through the air increases my strength increases more rapidly than you might think—approximately, as the Square of the Speed; so you see that if the Speed of the Surface through the air is, for instance, doubled, then I am a good deal more than doubled. That’s because I am the result of not only the mass of air displaced, but also the result of the Speed with which the Surface engages the Air. I am a product of those two factors, and at the speeds at which Aeroplanes fly to-day, and at the altitudes and consequent density of air they at present experience, I increase at about the Square of the Speed.

“Oh, I’m a most complex and interesting personality, I assure you—in fact,

a dual personality, a sort of aeronautical Dr. Jekyll and Mr. Hyde. There's Lift, my vertical part or COMPONENT, as those who prefer long words would say; he always acts vertically upwards, and hates Gravity like poison. He's the useful and admirable part of me. Then there's Drift, my horizontal component, sometimes, though rather erroneously, called Head Resistance; he's a villain of the deepest dye, and must be overcome before flight can be secured."

"And I," said the Propeller, "I screw through the air and produce the Thrust. I thrust the Aeroplane through the air and overcome the Drift; and the Lift increases with the Speed and when it equals the Gravity of Weight, then—there you are—Flight! And nothing mysterious about it at all."

"I hope you'll excuse me interrupting," said a very beautiful young lady, "my name is Efficiency, and, while no doubt, all you have said is quite true, and that, as my young man the Designer says, 'You can make a tea-tray fly if you slap on Power enough,' I can assure you that I'm not to be won quite so easily."

"Well," eagerly replied the Lift and the Thrust, "let's be friends. Do tell us what we can do to help you to overcome Gravity and Drift with the least possible Power. That obviously seems the game to play, for more Power means heavier engines, and that in a way plays into the hands of our enemy, Gravity, besides necessitating a larger Surface or Angle to lift the Weight, and that increases the Drift."

"Very well," from Efficiency, "I'll do my best, though I'm so shy, and I've just had such a bad time at the Factory, and I'm terribly afraid you'll find it awfully dry."

"Buck up, old dear!" This from several new-comers, who had just appeared. "We'll help you," and one of them, so lean and long that he took up the whole height of the lecture room, introduced himself.

"I'm the High Aspect Ratio," he said, "and what we have got to do to help this young lady is to improve the proportion of Lift to Drift. The more Lift we can get for a certain area of Surface, the greater the Weight the latter can carry; and the less the Drift, then the less Thrust and Power required to overcome it. Now it is a fact that, if the Surface is shaped to have the greatest possible span, i.e., distance from wing-tip to wing-tip, it then engages more air and produces both a maximum Reaction and a better proportion of Lift to Drift.

"That being so, we can then well afford to lose a little Reaction by reducing the Angle of Incidence to a degree giving a still better proportion of Lift to Drift than would otherwise be the case; for you must understand that the Lift-

Drift Ratio depends very much upon the size of the Angle of Incidence, which should be as small as possible within certain limits. So what I say is, make the surface of Infinite Span with no width or chord, as they call it. That's all I require, I assure you, to make me quite perfect and of infinite service to Miss Efficiency."

"That's not practical politics," said the Surface. "The way you talk one would think you were drawing L400 a year at Westminster, and working up a reputation as an Aeronautical Expert. I must have some depth and chord to take my Spars and Ribs, and again, I must have a certain chord to make it possible for my Camber (that's curvature) to be just right for the Angle of Incidence. If that's not right the air won't get a nice uniform compression and downward acceleration from my underside, and the rarefied 'suction' area over the top of me will not be as even and clean in effect as it might be. That would spoil the Lift-Drift Ratio more than you can help it. Just thrust that chalk along, will you? and the Blackboard will show you what I mean."

"Well," said the Aspect Ratio, "have it your own way, though I'm sorry to see a pretty young lady like Efficiency compromised so early in the game."

"Look here," exclaimed a number of Struts, "we have got a brilliant idea for improving the Aspect Ratio," and with that they hopped up on to the Spars. "Now," excitedly, "place another Surface on top of us. Now do you see? There is double the Surface, and that being so, the proportion of Weight to Surface area is halved. That's less burden of work for the Surface, and so the Spars need not be so strong and so deep, which results in not so thick a Surface. That means the Chord can be proportionately decreased without adversely affecting the Camber. With the Chord decreased, the Span becomes relatively greater, and so produces a splendid Aspect Ratio, and an excellent proportion of Lift to Drift."

"I don't deny that they have rather got me there," said the Drift, "but all the same, don't forget my increase due to the drift of the Struts and their bracing wires."

"Yes, I dare say," replied the Surface, "but remember that my Spars are less deep than before, and consequently I am not so thick now, and shall for that reason also be able to go through the air with a less proportion of Drift to Lift."

"Remember me also, please," croaked the Angle of Incidence. "Since the Surface has now less weight to carry for its area, I may be set at a still lesser and finer Angle. That means less Drift again. We are certainly getting on splendidly! Show us how it looks now, Blackboard." And the Blackboard obligingly showed them as follows:

“Well, what do you think of that?” they all cried to the Drift.

“You think you are very clever,” sneered the Drift. “But you are not helping Efficiency as much as you think. The suction effect on the top of the lower Surface will give a downward motion to the air above it and the result will be that the bottom of the top Surface will not secure as good a Reaction from the air as would otherwise be the case, and that means loss of Lift; and you can’t help matters by increasing the gap between the surfaces because that means longer Struts and Wires, and that in itself would help me, not to speak of increasing the Weight. You see it’s not quite so easy as you thought.”

At this moment a hiccough was heard, and a rather fast and rakish-looking chap, named Stagger, spoke up. “How d’ye do, miss,” he said politely to Efficiency, with a side glance out of his wicked old eye. “I’m a bit of a knut, and without the slightest trouble I can easily minimize the disadvantage that old reprobate Drift has been frightening you with. I just stagger the top Surface a bit forward, and no longer is that suction effect dead under it. At the same time I’m sure the top Surface will kindly extend its Span for such distance as its Spars will support it without the aid of Struts. Such extension will be quite useful, as there will be no Surface at all underneath it to interfere with the Reaction above.” And the Stagger leaned forward and picked up the Chalk, and this is the picture he drew:

Said the Blackboard, “That’s not half bad! It really begins to look something like the real thing, eh?”

“The real thing, is it?” grumbled Drift. “Just consider that contraption in the light of any one Principle, and I warrant you will not find one of them applied to perfection. The whole thing is nothing but a Compromise.” And he glared fixedly at poor Efficiency.

“Oh, dear! Oh, dear!” she cried. “I’m always getting into trouble. What WILL the Designer say?”

“Never mind, my dear,” said the Lift-Drift Ratio, consolingly. “You are improving rapidly, and quite useful enough now to think of doing a job of work.”

“Well, that’s good news,” and Efficiency wiped her eyes with her Fabric and became almost cheerful. “Suppose we think about finishing it now? There will have to be an Engine and Propeller, won’t there? And a body to fix them in, and tanks for oil and petrol, and a tail, and,” archly, “one of those dashing young Pilots, what?”

“Well, we are getting within sight of those interesting Factors,” said the Lift-Drift Ratio, “but first of all we had better decide upon the Area of the

Surfaces, their Angle of Incidence and Camber. If we are to ascend as quickly as possible the Aeroplane must be SLOW in order to secure the best possible Lift-Drift Ratio, for the drift of the struts wires, body, etc., increases approximately as the square of the speed, but it carries with it no lift as it does in the case of the Surface. The less speed then, the less such drift, and the better the Aeroplane's proportion of lift to drift; and, being slow, we shall require a LARGE SURFACE in order to secure a large lift relative to the weight to be carried. We shall also require a LARGE ANGLE OF INCIDENCE relative to the horizontal, in order to secure a proper inclination of the Surface to the direction of motion, for you must remember that, while we shall fly upon an even keel and with the propeller thrust horizontal (which is its most efficient attitude), our flight path, which is our direction of motion, will be sloping upwards, and it will therefore be necessary to fix the Surface to the Aeroplane at a very considerable angle relative to the horizontal Propeller Thrust in order to secure a proper angle to the upwards direction of motion. Apart from that, we shall require a larger Angle of Incidence than in the case of a machine designed purely for speed, and that means a correspondingly LARGE CAMBER.

"On the other hand, if we are thinking merely of Speed, then a SMALL SURFACE, just enough to lift the weight off the ground, will be best, also a SMALL ANGLE to cut the Drift down and that, of course, means a relatively SMALL CAMBER.

"So you see the essentials for CLIMB or quick ascent and for SPEED are diametrically opposed. Now which is it to be?"

"Nothing but perfection for me," said Efficiency. "What I want is Maximum Climb and Maximum Speed for the Power the Engine produces."

And each Principle fully agreed with her beautiful sentiments, but work together they would not.

The Aspect Ratio wanted infinite Span, and hang the Chord.

The Angle of Incidence would have two Angles and two Cambers in one, which was manifestly absurd; the Surface insisted upon no thickness whatever, and would not hear of such things as Spars and Ribs; and the Thrust objected to anything at all likely to produce Drift, and very nearly wiped the whole thing off the Blackboard.

There was, indeed, the makings of a very pretty quarrel when the Letter arrived. It was about a mile long, and began to talk at once.

"I'm from the Inventor," he said, and hope rose in the heart of each heated Principle. "It's really absurdly simple. All the Pilot has to do is to touch a

button, and at his will, VARY the area of the Surface, the Angle of Incidence, and the Camber! And there you are—Maximum Climb or Maximum Speed as required! How does that suit you?”

“That suits us very well,” said the Surface, “but, excuse me asking, how is it done without apparatus increasing the Drift and the Weight out of all reason? You won’t mind showing us your Calculations, Working Drawings, Stress Diagrams, etc., will you?”

Said the Letter with dignity, “I come from an Inventor so brilliantly clever as to be far above the unimportant matters you mention. He is no common working man, sir! He leaves such things to Mechanics. The point is, you press a button and——”

“Look here,” said a Strut, rather pointedly, “where do you think you are going, anyway?”

“Well,” from the Letter, “as a matter of fact, I’m not addressed yet, but, of course, there’s no doubt I shall reach the very highest quarters and absolutely revolutionize Flight when I get there.”

Said the Chalk, “I’ll address you, if that’s all you want; now drift along quickly!” And off went the Letter to The Technical Editor, “Daily Mauler,” London.

And a League was formed, and there were Directors with Fees, and several out-of-service Tin Hats, and the Man-who-takes-the-credit, and a fine fat Guinea-pig, and all the rest of them. And the Inventor paid his Tailor and had a Hair-Cut, and is now a recognized Press Expert—but he is still waiting for those Mechanics!

“I’m afraid,” said the Slide-rule, who had been busy making those lightning-like automatic calculations for which he is so famous, “it’s quite impossible to fully satisfy all of you, and it is perfectly plain to me that we shall have to effect a Compromise and sacrifice some of the Lift for Speed.”

Thud! What was that?

Efficiency had fainted dead away! The last blow had been too much for her. And the Principles gathered mournfully round, but with the aid of the Propeller Slip¹ and a friendly lift from the Surface she was at length revived and regained a more normal aspect.

Said the Stagger with a raffish air, “My dear young lady, I assure you that from the experiences of a varied career, I have learned that perfection is impossible, and I am sure the Designer will be quite satisfied if you become the Most Efficient Compromise.”