SOWING THE SEEDS OF STABILITY

by Paul R. Hare

In the years just before the First World War it appeared vitally important, both in the minds of some designers, and of those responsible for equipping Britain's embryonic air services, that aeroplanes should be inherently stable. Not only would this, it was thought, make them safer, but it would free their pilots from the need to make constant control corrections in order to maintain a steady attitude, and leave them free to undertake something else, such as observing the ground below, a consideration that was deemed especially important for military purposes.

Stability had been a desirable feature since Sir George Cayley had defined[1] the forces acting upon an aeroplane at least as far back as 1809, and had sought to include it in his glider designs. Flying models produced during the latter part of the nineteenth century, by such experimenters as Alphonse Penaud and Charles Renard, were also designed to be inherently stable, as all un-piloted aircraft must be, and stability was a prime consideration for gliding pioneers such as Otto Lilienthal, if only because their sole means of control was to shift their body weight, swinging their legs to and fro in an attempt to adjust the position of the centre of gravity.

The Wright brothers, aware of the inadequacy of this method, developed true three axis control, perfecting it by means of gliding experiments before attempting powered flight. Their forward elevator configuration was chosen specifically to avoid the possibility of the stall/spin accidents that had killed earlier experimenters and, like an arrow flying feathers first, was highly unstable and, indeed as F.W. Lanchester[2] pointed out when comparing the Wright and Voisin designs, the Wrights had *no belief in the possibility of making an aeroplane safe by its own inherent stability*. The instability of the Wright design led to the accusation[3] that they had only flown *because they were accomplished acrobats* and that they had been *specially trained to balance their machines in flight*.

Although, with practice, the necessary constant control movements soon became instinctive for any competent pilot, acrobat or not, it none-the-less remained true that the pilot of a Wright machine needed to keep his hands on the control levers at all times, leading one writer to observe[4];

There is not one movement which one has to make when handling a Wright machine that is swifter or in any sense more acrobatic than is employed in the case of a bicycle. None-the-less, if it were possible to make a bicycle automatically stable, without making it in any way more complicated, or increasing the weight and bulk, there is no gainsaying that it would be a decided improvement.

So what exactly is 'inherent stability', and why was it considered so important, especially for military reconnaissance?

Professor G.H. Bryan, ScD FRS, who began lecturing on stability even before the Wright Brothers first flew and who later wrote the definitive mathematical work *Stability in Aviation*[5] earlier explained stability as follows:[6]

We may say that the motion of a flying machine is steady when the resultant velocity is constant in direction and magnitude, and when the angle of the machine to the horizontal is constant. If this motion is slightly disturbed, the machine may either after a time return to the original motion, or it may take up a new and altogether different motion. In the first case the steady motion is said to be stable, and in the second unstable.

Thus an inherently stable aeroplane, if upset by a gust, would automatically right itself, without control input by the pilot, whereas an unstable one would not.

The advantages of ensuring that military aeroplanes were inherently stable were explained by a member of the Advisory Committee for Aeronautics, as follows;[7]

Observations of a number of full scale experiments show that longitudinal and lateral stability, in some measure independent of the pilot or wind gusts are the qualities of primary importance. In the absence of gusts no difficulty exists and, in still air, it is common knowledge that there are 20 or 30 makes of machines that can be flown with ease, but machines are wanted that can fly safely in a wind showing large speed variations of, say, 20 miles per hour to 50 miles per hour if we are to be sure of getting their full military value. The importance of this, which is usually described as stability, is so overwhelming that it is better to concentrate on experiments in this, in preference to any other, direction, though not to their exclusion.

Pilots of military aeroplanes were expected to be too busy, observing the ground below, and carrying out any other duties assigned, to keep constantly correcting the attitude of their machines.

Directional stability (i.e. stability in yaw) simply required the provision of keel area at the rear of the machine, something every arrow maker had known for centuries. Lateral stability (i.e. stability in the rolling plane) could be achieved by setting the wings at a slight dihedral angle, longitudinal stability (pitch) required a tailplane set a negative angle of incidence relative to the main planes and both were employed in Penaud's *Planophore* of 1871.

But what these angles should be remained very much open to debate, with no formulae yet devised by which they could be calculated. On 1 April 1909, for example, in a lecture to the Royal Institute, Professor Bryan spoke at length of recent experiments in aeroplane stability, without announcing any definite conclusions,[8] although he stated that the majority of machines recently exhibited were obviously unstable, without explaining why this was so. In November 1911 Mervyn O'Gorman, Superintendent of the Royal Aircraft Factory, published a paper[9] stating that there was *A strong presumption* that these areas, and angles could be obtained by experiment, and that these experiments were on-going, but gave no

The Penaud Planophore of 1871 had wing tip dihedral and a fixed tailplane to give stability in flight as well as introducing propulsion by means of a twisted rubber band driving a propeller.