

# The great Bernoulli-lift-illusion

## 70 years of an incredible misunderstanding.

The earlier wing calculation methods approximated the air to an idealized completely incompressible "perfect" fluid. The flow geometry, i.e. the velocities and streamlines, for such a nonexistent "fluid" would be completely independent of its mass content. Many theoreticians therefore forget that the motions of the real, always slightly compressible, fluid's are governed by mechanics i.e. of the fluid's inertia. In their arguments for pressure changes they had to reverse the physical relation between pressure and velocity relative to how it was described by Bernoulli himself in his book 1738.

This has caused the erroneous "Bernoulli-lift-illusion", which however now even leading aerodynamic experts to the JAA-FCL-committee, recommends exchanged for Newton's laws.

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Answer to Göran Blomberg in Övertorneå and others.

**You are on the right road  
Göran. If you use the  
Newton laws you will  
come right!**

Considering all pilots which today flies around quite happy with completely erroneous ideas about how wings work it can be questioned if they really need to understand why they do not fall to the ground. In some cases, however a better knowledge could mean the difference between an accident and not. If time and cost is spent on flight theory therefore this must be physically correct.

That I should have said that it only should be the bottom side of the wing that is active is a total misunderstanding. I describe in my "Mach"-article, as well as in all other earlier articles, quite clearly that the lift in detail is a result of the difference between a decreased

pressure above the wing and an increased pressure below it. If you read the article once more you will see this.

### **Newton's laws controls the physics.**

It is to these laws that the Bernoullilift explanations are contradictory. The positive in your article is that you understand that the liftcreation is built on these laws of mechanics. Regrettably it seems however as if you yourself had not sufficiently thought about what they really mean, especially not his 1st law, "*that if a mass shall change its momentary state of motion or rest it must be activated by an external force*". This law is also called "*his law of inertia*". His 2nd law, defines the size of the force necessary to cause a certain acceleration. In todays school books this is called "*the law of force*".

## "Perpetuum mobile".

It is thus to these "*the basic laws of mechanics*" that the version of Bernoulli's law used in pilot training (ICAO) is contradictory. That version states "that the a velocity change of the inertial air mass causes the same pressure change that is the absolute prerequisite, for the force to create the same velocity change. A clear case of "*perpetuum mobile*"!

How large the horizontal force between a car tire and the road is, that can be calculated based on the mass of the car and it's acceleration or retardation. Nobody would however ever dream of saying that the force would be caused by the cars velocity changes even if it is be *indicated* by them. That is however exactly what the aviation authorities for seven decades have forced all flight instructors to believe in. A completely fantastic nonchalance of reality.

## The new European licensing rules, hopefully on the right road.

As it was impossible to act through the Swedish aviation authorities the author had to make a completely private action directly to the JAA-FCL- committee to prevent the old mistakes to be further preserved in the new European licensing rules.

It succeeded because the French and British aerodynamic experts understood the errors in the Bernoulli explanations and supported the author's proposal to exchange the Bernoulli "sayings" and instead introduce the basic

Newton laws for the new JAA-FCL rules.

Therefore in spite of earlier Swedish "conservatism" there is hope for rules no longer contradicting the basic "laws of nature".

## The physics of the reality.

In order to understand what happens to the initially resting air when an aircraft flies by, think of the air as split up in small softwall packages of air mass. At ground level this means 1.25 gram inertial air mass per cubic-decimeter. Try then to think how their inertia will influence their motions when they are forced to move aside (upwards and downwards) in accordance with the Newton laws. In principle this is acceptably easy to imagine but to calculate it in detail is a very difficult problem due to all interaction between local pressures, local velocities and local flow curvatures.

It is the very special mathematical technique to manage this problem that has been misunderstood and therefore caused the physically reversed Bernoulli relation.

## The technique for the calculations.

By assuming an absolutely incompressible, purely hypothetical and fictitious, fluid it became in the year 1918 possible to find a useable method to *simulate the velocity* distribution around the wing contour. The result will be a purely "virtual" picture of the flowfield. It will however everywhere satisfy the very important requirement of balance between local pressure forces and the air

mass inertia for all individual small air packages if they are filled with real air mass.

By a physically reversed use of the Bernoulli relation between the velocity and pressure it is however possible *to deduce* what the pressure in a certain point must be in order to create the velocity indicated in the calculated virtual velocity picture if the packages are filled with a real inertial mass content.

### **Misunderstood Bernoulli.**

For those points where the calculated velocities are high the conclusion can be drawn that the pressure must be low. Observe the order!

This must be, what already in the 1920-ties, caused some theoreticians erroneously to interpret the high velocity as the physical *cause* of the low pressure. Instead it just as the velocity meter in the car only *indicates* it. They did not fully understand that the incompressibility assumption gives only a mathematical model approximating the reality.

### **Physically erroneous lift explanations to pilots and public.**

Those theoreticians could probably not themselves understand the physical cause for the local pressure changes. They had only learned how *to calculate it* with a mathematical technique they not fully understood. Therefore they had to find arguments for the calculated velocity changes, which however became physically quite false. To this error was then further added a row of physically completely false experimental demonstrations of

the physically reversed Bernoulli relation, sucked up papers etc. All those demonstrations show in reality only effects of other physical phenomena than the change of velocity as such.

*Bernoulli himself* has in his famous book "*Hydrodynamica*" clearly pointed out that exactly what the aviation authorities prescribe should be *avoided!*

### **Indifference by the university teachers.**

Since the aviation people once had been misled seven decades ago they have not themselves had the competence to see the errors or to dare to correct them. The aeronautically "learned" with sufficient knowledge have instead lacked all interest. Although the question is of vital importance for the physical understanding of lift it does not influence the treatment in an already developed computational technique.

For this astonishingly controversial work background discussions with specialists on both old and new computational techniques have been of vital importance. For this I specially have to thank the earlier Head of SAAB Aircraft Dr. T. Gullstrand, Prof. em. Hydromechanics, KTH, B.J. Andersson, Prof. Aeronautics KTH A Rizzi, Dr. P.G. Löfgren and the earlier Head of the theoretical section, S.Hedman, both at the FFA.

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