BEES BREEZE

RC BEES of Santa Cruz County, Inc.

AMA Chapter 144

Newsletter October 2018

Editor: Alan Brown, 388 Aptos Ridge Circle, Watsonville, CA 95076-8518
Phone: (831) 685-9446. E-mail: alangwenbrown@charter.net. Web site: www.rcbees.org

Next meeting

Thursday, October 18th, at the EAA building, Aviation Way, Watsonville Airport, 7:30 p.m.

July Meeting

The monthly meeting was held on September 20th at the EAA building in Watsonville with fourteen members present. Dan Morris presided and opened the meeting promptly at 7:30 p.m. Our president, Steve Boracca, was unable to attend because of recent shoulder surgery. We wished him well.

The minutes of the previous meeting were approved. Rich Ludt, our treasurer, could not be present, and so no treasurer's report was presented. It can, however, now be seen on the members' section of our web-site.

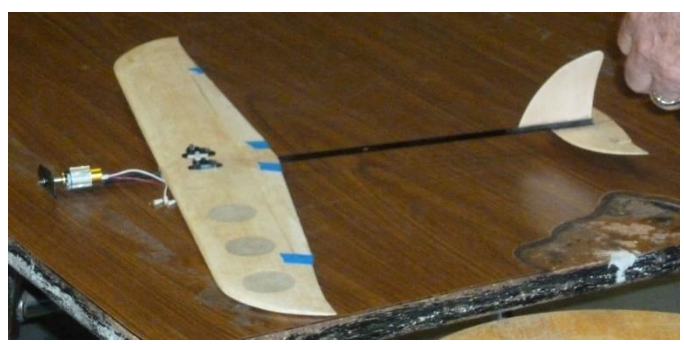
Dan told us, following up from his e-mail a couple of days earlier, that the final competition of the year, following a suggestion from Richard Tacklind, would be a scale model competition for airplanes, whose originals were designed before 1920. This would be held on November 11th, which is a Sunday and the centenary of the end of WW I – so very appropriate! This gives us plenty of time to prepare, so we look forward to an interesting entry list.

The rules will include having a good back-up description of the original airplane, so that scale details can be verified. So get to work, and see what you can come up with.

Allen Ginzburg reported that the camera system was up and working correctly as of three weeks prior to the meeting. Thank you, Allen and your helpers, for all the time spent on this project, which has more than once been damaged by intruders.

Show and Tell

Jerry Arana came second to Richard Tacklind in the pylon race held last month and so decided that he'd better build a copy of the winner, with maybe a couple of small improvements. Here it is.



Don Jocius brought an airplane which he bought from the large John Nohrden collection, but unfortunately your photographer wasn't quick enough off the mark to capture it, so perhaps next month!

Richard Tacklind took his prize from the recent pylon race, another John Nohrden airplane, a Lazy Bee (see last month's newsletter), and dressed it up as seen below. The original was in red and yellow, and it now looks very dashing in blue and silver with lovely eyes peering out of the front window! The landing gear is now fully sprung.

That concluded our fairly short meeting, and we wound up soon after 8 p.m.

<u>Down by the River</u>

Michael Hushaw took these nice pictures of Rod Bartz' Elite Cirrus at our field on a Saturday morning. This is a popular and very pretty airplane.

Rod and his friend Brian Shaw were visiting from Monterey/Pacific Grove. Good to have you both here!

Allen Ginzburg goes over the intricacies of setting up Hugh Chalmers' latest drone.

Bob Frogner showed us a nice, simple-looking delta wing airplane where he's experimenting with different masking techniques for his paint jobs. This one, not too obviously, used a fine net to go from one color to another. The propeller is sensibly located to get the c.g. in the right place without too much effort.

This is followed by an old warrior that Allen Ginzburg must have dug out from his original first airplanes' collection.

New young member Aden Scheftner put together a foam version of the old favorite Flying Lawnmower, and here he is with it.

Mike Hushaw got some great pictures of it in flight.

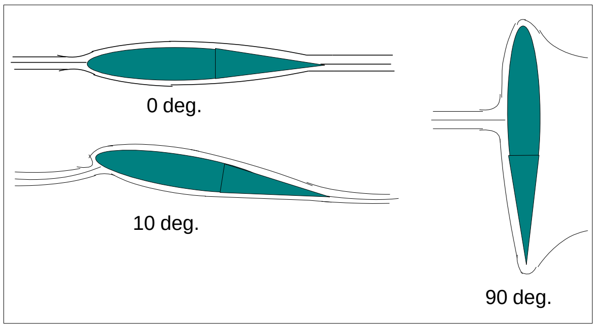
In contrast Mike Evans' latest aerobatic airplane rolls past – and lands. (Hushaw pix again).

<u>Aero 101</u> How wings really work.

I've had one or two questions recently at the field to do with how wings really get their lift, so thought that I might review some of the history which went into arriving at our current knowledge. I'll stick to low speed flow, which is our main interest with models, and not get into compressibility or supersonic flow.

Aero 101 **How wings really work**

A number of articles have been written in model aviation magazines, supposedly illustrating how wings work and how they generate lift. Most of them have had serious errors in them, and so this article will attempt to correct them. The first thing to note is that there is no dispute among professional aerodynamicists on this subject over the last 350 years! Here is a picture of flow patterns around a symmetrical airfoil at several angles of attack.



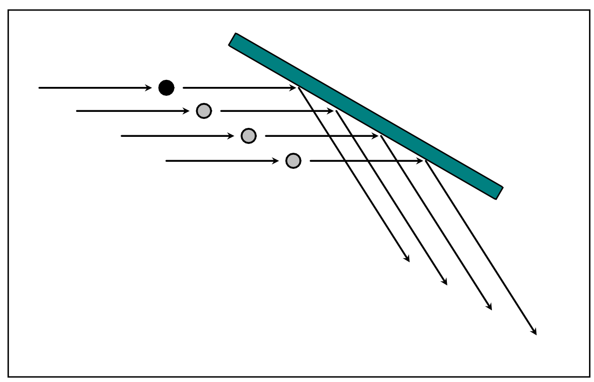
The sketches at 0 degrees and 90 degrees seem quite reasonable. Clearly, the flow over a symmetrical airfoil at 0 degrees will divide symmetrically at the nose and continue symmetrically to the trailing edge with no lift generated. At 90 degrees, the airfoil is like a flat plate at right angles to the stream direction, and air will flow around both sides, probably separating as it tries to go round the edges.

However, it's the intermediate 10 degree position that seems to get people into trouble. There is a common assumption that the airflow divides right at the leading edge of the airfoil despite the obvious fact that it couldn't be true at 90 degrees. In fact, an article was written some time ago allegedly proving that modern aerodynamic theory must be all wrong, because if one measured the distance round the top and bottom of a Cessna 172's airfoil, and used that information to calculate the pressures on the wing from Bernoulli's Theorem (more on that later), there wouldn't be enough differential pressure to sustain the weight of the airplane. The answer is, of course, that the writer's initial assumption is incorrect, and the dividing point for air that goes over the wing, from the air that goes under the wing, is underneath the wing, and not at the leading edge.

Many general aviation aircraft have mechanical stall warning devices which are triggered by a small floating lever on the underside of the wing which is pushed backwards at low angles of attack (angle of attack is the angle that the airfoil sees from the incoming airflow, and which varies with the airplane's attitude). As the dividing airflow point moves backwards, there will come a point where it is behind the lever, and will force the lever forward, thus alerting the pilot to his critical angle of attack.

Now we can see that a symmetrical airfoil can experience lift at an angle of attack because the air has to accelerate in going round the corner, thus reducing the pressure on the top side of the airfoil. We'll get to the equations that describe this in a few minutes.

Now let's go back into history. In the 1670's, Isaac Newton, a very bright physicist and mathematician, applied his postulated laws of motion to the flow over a wing, using his momentum theory, as shown below.



He assumed that the air could be thought of as a bunch of little particles striking the underside of the inclined surface, and giving lift via the change of particle momentum. He tested this, and I don't know exactly how, perhaps by hanging his wing outside his coach window while his coachman drove at a known speed (England had milestones on all major roads in his day). Surprisingly, he found that the lift measured was almost three times what his momentum theory calculated, and so he realized that he was missing something in his analysis.

It was in fact left to another brilliant man, Daniel Bernoulli, to come up with the mathematics that explained the dilemma. In 1738 he published his classic book "Hydrodynamica" which explained how mass and momentum conservation in fluids could account for the different pressures and velocities associated with the streamlines through pipes and around bodies.

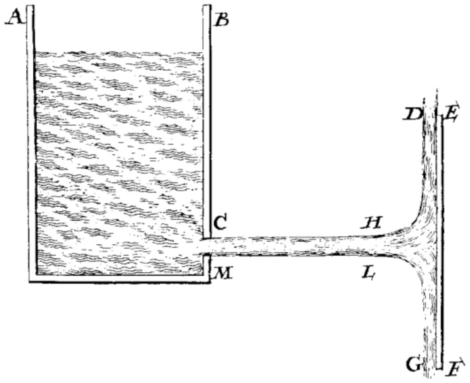


Fig. 4-3. Liquid jet flowing from a vessel and impinging onto a flat plate. From D. Bernoulli, *Hydrodynamica* (Strasbourg, 1738), fig. 84.

This is an illustration from his book, and here are his two fundamental equations as adapted to airflow. As he was mainly concerned with water, the weight of the water was part of the total head or total pressure in his equations, not present here.

$$H = p + 1/2 . \rho . V^2$$

where H = total pressure
p = static pressure (measured on surface)
ρ = air density
V = velocity

Mass Flow Continuity

$$\rho . A . V = \text{constant}$$

where A = area of stream tube

The first one says that what we call the total pressure, nowadays we measure it with a pitot tube, equals the sum of the static pressure, as measured nowadays by holes drilled in the surface of the airfoil or body, and the dynamic pressure generated by the local velocity of the airflow. Furthermore, for an airplane operating at a given speed and altitude, the value of H is given by free stream conditions, and remains constant over the surface of the airplane. The equations are completed by noting that along what we call a stream tube, the mass flow must be invariant, and so as the area gets reduced, the velocity must increase, which means that the static pressure must go down. Here is a graph of pressure over a wing with various flap deflections. Let's look only at plain wing first, and come back to the effects of flap angle later.

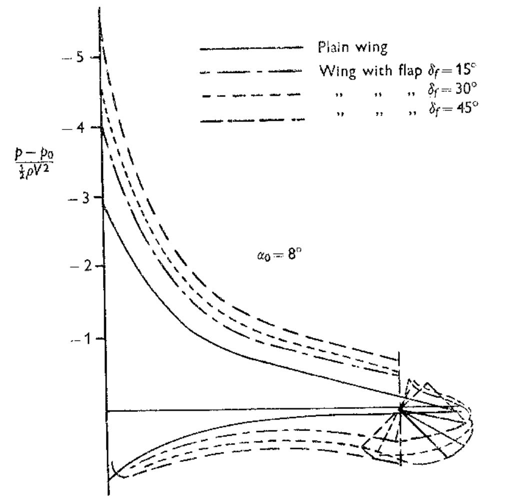


Fig. 14·2, 2. NACA 23012 section and 0·2c plain flap. Change in pressure distribution due to flap deflection.

The wing, NACA 23012, is what we generally would call a semi-symmetric airfoil, 12% thick, at 8 degrees angle of attack. The flow round it will be similar to that shown for the symmetrical airfoil at 10 degrees in the first figure of this article. Just to confuse the reader, we generally plot pressure upside down, so negative pressure is upward and positive pressure is downward, corresponding to the upper and lower parts of the airfoil. The first very striking thing is that within the first one or two percent of the distance back from the leading edge, the pressure goes from a maximum value on the lower surface representing the total pressure where the air has come to rest, and rapidly as it moves round the leading edge at very high speed drops to a minimum value on the top surface, well below atmospheric pressure, p_0, (the zero line on the graph).

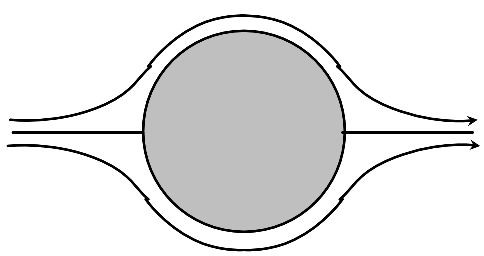
So the smallest pressure, and therefore the greatest lifting suction, is very close to the leading edge on the top surface. This is why good shaping of the leading edge is of paramount importance in obtaining an efficient lifting surface, much more so than tapering the trailing edge, which predominantly affects drag due to the width of the wake, but has little effect on lift.

You can see that as we move backwards over both the top and bottom surfaces, the pressures move steadily towards the atmospheric value, being almost, but not necessarily exactly, equal to it at the trailing edge. Here we can dispense with another common fallacy. The molecules on the top and bottom surface do not necessarily rejoin their original free stream mates at the trailing edge. They are not smart enough to do that!

The reason why we balance our models typically at the 25% point on the wing is that simple theory shows that this is where the overall lift acts, based on the dominant pressures being well forward on the wing. This lifting point is essentially independent of angle of attack until the flow breaks down due to incipient stall.

So to summarize up to this point, Bernoulli's equations give a very good result to explain lift on an airfoil as long as viscous effects, like flow separation and boundary layer, are not significant. Fortunately, that is generally true for most of our flow regimes. Newton's original application of his momentum theory does not explain lift at all, and so it is completely erroneous to talk about Bernoulli versus Newton in explaining how lift works.

So how did the theory come about? We can work with a thing called a Stream Function to produce a simple picture of the flow round a circular cylinder, which looks something like this. Note that we can't, at this stage, represent flow separation behind the body. It can be transformed into an airfoil shape, and we'll get into that in our next issue.



And that's it for this month. Hope there's not too much theory!