## A LOGICAL ANSWER TO

# THE DOWNWIND TURN

by Arthur Schultz

A dozen pilots sat in the moonlight, facing a dying fire on the beach under Sleeping Bear. The waves from the day's soaring breeze still pounded the broad sandy beach. The trend of discussion shifted from marshmallows to soaring.

The day's soaring had been fine. The glowing coals helped kindle their imaginations. Why not a soaring flight across Lake Michigan to Chicago! Why not soar like the albatross—straight across the lake—and not have to depend on the right winds striking the dunes? Dr. Prandtl had already explained the soaring flight of the albatross, a truly dynamic form of soaring flight. His theory is based on the presence of a velocity gradient in the wind, the velocity near the surface being considerably less than that aloft. The albatross soars in a circle whose axis is tilted at an angle to the surface of the water, downwind on the high side of the circle and upwind on the low side. The alternate circling flight from a zone of high velocity to one of low velocity provides a means of accumulating energy from the wind, thus permitting of dynamic soaring flight. Why could not a sailplane do likewise?

Fine thoughts these—very inspiring—but no one has ever done anything about it. As an offshoot of this idea of wind velocity gradients, a discussion brought up the accompanying remarks which appear to be the answer to the why of the upwind and downwind turn perplexity.

It has long been the instinctive conviction of pilots in general that downwind turns near the ground are akin to suicide. Engineers, and others who ought to know, say pilots' fears are all imaginary—that the whole trouble is a psychological one. Yet any one of the whole bunch of them would rather crash ten fences in a row than make one downwind turn in a pinch. There must be something to it.

Various observations taken from gliding and soaring flights whose fidelity can be attested by any glider pilot of moderate experience, form the basic facts for the explanation.

The first simple observation has been experienced by all pilots who have done a little slope soaring in very smooth air. When the wind strikes the ridge at an angle instead of square on, the lift is always best when cruising up wind and poorest when running down wind. The effect is not psychological. Pilots who have gone up with the avowed purpose of eliminating any psychological influences claim that while they can cruise upwind along a ridge at 27 miles per hour with absolute confidence in the feel of their controls, running downwind they must speed up to 32 miles or more to obtain the same feel. Whereas the sinking speed upwind would be +1 foot per second, downwind would be —1 foot per second. The actual existence of this difference in control upwind and downwind is beyond dispute.

The second simple observation, which merely supplements the first, hinges on the differences noted between upwind and downwind landings. In the first place, downwind landings are regularly made by other types of heavier than air contrivances than pelicans. Glider pilots make them all the time. Cross winds, tail winds and angling tail winds, are all a matter of routine. Just put the nose down 'til the air speed gets around the 50 mark and a glider can land safely in any direction—and in winds as high as 25 miles per hour. It's being regularly done. It gets the glider back in the corner of the field, and eliminates a lot of laborious ground handling. Pilots who do this kind of flying note that the ship "plunks down" quickly after leveling off when making a tail wind landing. The same ship "floats" after leveling off when making an up wind landing. The effect is more marked the higher the wind velocity. Some sail planes have been known to float halfway across a wide airport when a slight headwind was present. Thermals and psychology have nothing to do with the problem. There's an aerodynamic reason.

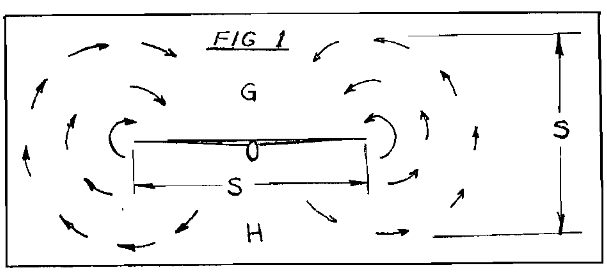


Figure 1 is a sketch common to all textbooks on aerodynamics. It is a circulation diagram showing the "zone of influence" about an airplane, and its significance is clear to most readers. The point to be noted here is that the height of the zone of influence equals the wing span —as much as 60 feet for sailplanes.

Figure 2 is also not new. A particle of air moving from A to B has a longer way to go than a particle from C to D, hence must go faster. Bernoulli's theorem then says if this is so, the pressure at E must be less than the pressure at F. That is one way of looking at the question why wings lift. An alternate way of putting it would be to say, if the wing is lifting, the air at E must be moving faster than the air at F. This condition exists in diminishing amount throughout the full depth of the zone of influence. The important point to note here is that the actual difference in the mean velocity above at G and below the wing at H can not really amount to very much—just a matter of several feet per second or so—but it is this that