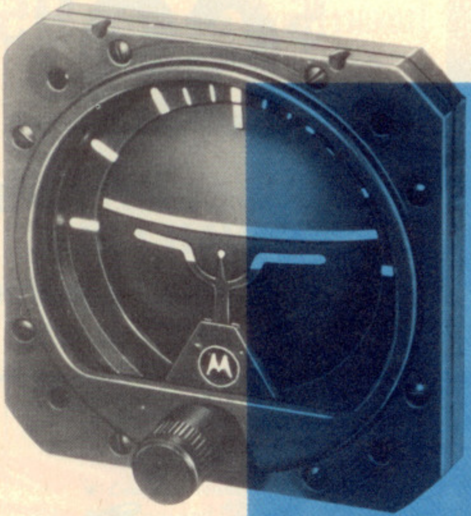
Proper Takeoff Attitude



Accurate attitude horizon can help inexperienced pilot equal performance of the old professionals on takeoff without unduly worrying about airspeed indicator

The other day in a hanger flying session a friend of mine who has been flying for many years made the statement that when he is heavily loaded (full gross) he pulls his nose up higher on takeoff than he would if he had a light load. He went on to state that the attitude he used on takeoff depended fully on the weight he was lifting off in his airplane. In other words, the lighter the load, the lower the attitude; the heavier the load the steeper the attitude.

After our discussion concerning the use of the same attitude on each takeoff, the thought occurred to me that there must be many pilots who are of the same opinion.

Of all the flight segments—takeoff, en route, holding, and descent—takeoff is the most critical. Therefore, I thought it would be interesting to look at the reasons why going to the proper attitude is so important after the airplane is rotated during takeoff.

Before we go any further, it is necessary that we understand attitude flying. All of us who have taken flight instruction within the past 10 years are familiar with our instructors telling us to adjust our altitude with power and/or flap and to adjust our airspeed with elevator and/or trim tab. In other words with a predetermined power setting and a predetermined airspeed, we know the aircraft will assume a certain attitude and certain performance. Therefore it can also be demonstrated that with a predetermined power setting and a predetermined pitch attitude we can immediately go to a predetermined airspeed without having to chase the airspeed indicator. Attitude plus power setting equals performance.

Now the question arises: why is airspeed so important? To get this answer we must look at the definition of lift and at the same time we should recall that excessive lift makes us climb and that during takeoff as well as climbing to higher altitudes we are looking for the airspeed and lift that gives us our best rate of climb.

Lift is defined as the coefficient of lift (angle of attack times the chord of wing), times the density of the air, times the area of the wing, times the velocity squared. Now, if we take a close look at this definition we see that the part of the definition that has the most effect on lift is the velocity, as a difference of velocity (or airspeed) changes the lift on the airplane in proportion to the difference in the two airspeeds squared.

An airplane manufacturer determines by test flying a certain model airplane the best rate of climb speed for that particular model airplane. Therefore, if we use an airspeed that is lower than the best rate of climb speed we are losing lift in proportion to the difference of the airspeed squared.

As an example, let us compare a climb speed of 100 m.p.h. which we will assume is the best rate of climb speed assigned by the manufacturer to a certain airplane and compare what happens if we climb this airplane out at 95 m.p.h. Even though we have increased the angle of attack, the increased lift is only proportional to the increase in the angle of attack which can be very little. However, we will decrease the lift and rate of climb by 10.25% as the difference between 100 m.p.h. squared and 95 m.p.h. squared is 10.25.

To illustrate: 100 x 100 = 10,000; 95 x 95 = 9,025; 10,000-9,025 = 975; 10,000 ÷ 975 = 10.25. Therefore, if the rate of climb on this airplane at full gross load is 800 f.p.m. at 100 m.p.h., the rate of climb at 95 m.p.h. will be close to 720 f.p.m. and the rate of climb at 90 m.p.h. will be close to 650 f.p.m.

The next thing that should be considered is the effect of angle of attack on drag, and thus horsepower required. We all know that increasing the angle of attack of an airplane increases the induced drag. From a practical stand-

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point "the power required curve is identical to the drag curve for any given aircraft."

Since we are using maximum power on takeoff, increasing the drag decreases the thrust horsepower available for climb and consequently the airspeed because we are using this thrust horsepower to overcome drag. Hence, by using a lower airspeed at takeoff and during climb with full power, we have increased our angle of attack and thus we have increased our induced drag. As a result of increasing our induced drag we have reduced the thrust horsepower that is available to help us with our climb by having to use this horsepower to overcome drag.

Consequently, we can readily see that my friend is actually decreasing his rate of climb when he uses a higher nose attitude for takeoff as he is using a lower airspeed than if he would use the same attitude and airspeed at each takeoff. By using this lower airspeed, he has decreased his lift and at the same time increased his induced drag, thereby lowering the thrust horsepower available to him for climb. We know that a certain attitude or pitch angle, plus given power setting, will give us a predetermined airspeed—the airspeed which has been established by the plane manufacturer as the best rate of climb speed. Therefore, it becomes evident that getting to this pitch attitude-airspeed without delay becomes of paramount importance on takeoff especially if there is an obstacle to clear. This is where a properly calibrated attitude horizon can help even the most inexperienced of pilots to obtain the same performance on takeoff as the old professionals.

Most of us are familiar with our instructions showing us that we should have the wing on the horizon two bars width above the horizon after rotating the airplane and while in the climb segment. However, you have to keep looking at the airspeed to make sure you are at the proper attitude because it is nearly impossible to pick out this two-bar width and the situation becomes very difficult if someone has been moving your wings on the artificial horizon up and down.

If an airplane has an artificial attitude horizon, however, it simply becomes a matter of the pilot setting his wings for this predetermined attitude before takeoff, and upon reaching safe takeoff speed, the aircraft is rotated (nose up) until the horizon bar becomes aligned with the present position of the attitude reference indicator. Power is then reduced to climb power and the airspeed and rate of climb will accelerate until climb speed and optimum climb performance are attained. If this procedure is followed, the pilot can be assured of maximum performance on each takeoff. This is true for single-engine and twin-engine aircraft, and serves to further point out the importance of using the correct Vy (best single-engine climb-out speed) for engine out on multi-engine airplanes. ●