THE PHYSICS OF FLIGHT

By Dave Pickenpaugh

Chapter IV - Glide-path, airspeed and rate of descent

For full-scale aircraft, the pilot's operating handbook clearly spells out the proper airspeeds for most situations the pilot will face. What is the proper airspeed for a full-flap final approach? How about the best-range, engine-out airspeed? Simple, just look in the handbook and read the numbers. In R/C flying, it is much different. We don't have an operating handbook to look up the answers, so we have to rely on the information the kit designer provided and on experience with similar types of aircraft.

Part of the difficulty of landing is that the aircraft is operating at the low-end of stable airspeeds. A pilot needs to understand how the airplane behaves depending where it is on the flight path stability curve. Let's take a look at a stabilized approach for landing and assume that the power setting remains constant through out the procedure. Keeping the power setting constant allows us to explore how changing just one variable -- airspeed -- affects the glide-path.

The airplane is perfectly established on final with a suitable power setting. The approach speed is suitable for the conditions, and the airplane is on a glide-slope of about 2 degrees below horizontal. To fly a slightly slower airspeed, a little up-elevator is applied without changing the power setting. The increase in the angle of attack slows the aircraft and reduces the rate of descent. Flying slower still (with more up elevator) and the flight path becomes even shallower. At some point additional up-elevator will result in a climb rather than a continued descent.

So far this airplane is behaving just as we would expect -- applying up elevator decreases the rate of descent and the airspeed. This is called flying on the "front side" of the flight path stability curve. In simple terms, down-elevator increases the angle of descent and the airspeed, and up-elevator decreases the angle of descent and airspeed.

At some point as more up-elevator is applied, things get screwy! Once on the "back side" of the flight path stability curve, the slower the planes goes the steeper the descent angle -- unless we add power. When on the back side of the curve, up-elevator initially makes the glide path shallower because "pulling back" increases the airplane's lift. Unfortunately, this is only a balloon effect because the increase in lift carries a corresponding increase in drag. The additional drag reduces airspeed which makes the descent angle steeper. Let's look at that again -- up-elevator increases the rate of descent!

This is the insidious nature of flying on the back side of the curve. At this point we have two choices. One, we can lower the nose and accept a temporarily steeper descent until the airspeed increases. At the faster airspeed the descent angle will become shallower. The biggest problem is that this procedure goes against pilot intuition -- lower the nose to reduce the rate of descent! Another problem is that with the ground approaching quickly the pilot wants to pull back to avoid a sudden uncontrolled contact with the ground.

The only other option to reduce the rate of descent is to add power. Either way is a "salvage" effort at this point, and it probably is better to go around. Add power, clean up the airplane, increase airspeed, and climb to pattern altitude. On the next pass maintain a little higher power setting which will lower the rate of descent to the proper glide-path.