Trimmed Speed, and Why it Matters!

A conventionally configured aircraft has stability in the longitudinal (pitching) plane because of the relationship between its wing and its tailplane. The wing produces upward lift, and the tailplane generates a small amount of downward lift.

Because the model's thrust line and CG are fixed throughout a flight, the balance between wing and tailplane is adjusted by elevator position. In order to maintain this balance "hands-off", we adjust the elevator in fine increments by using the trim on our transmitter.

Let's look at how this stability works.

Imagine a model cruising straight and level. It is correctly trimmed, and so will happily do this without much input from the pilot. Now the model is caused to pitch up, perhaps by a gust or even a momentary elevator input. The immediate result is that the model slows slightly, so the wing produces less (upwards) lift and the tailplane less downward. The wing sinks and the tail rises: the model pitches down again. In reality it will overshoot slightly, then pitch up and down again over a few cycles, so the flight path looks like a diminishing sine wave. We can't really test this with a model, as it would fly out of sight before settling down fully, but it definitely works with a full-size aircraft.

This is how stability is defined: the tendency of an aircraft to resist changes in attitude, and to return to its original attitude when disturbed. We want different amounts of this depending on the purpose of the model – a trainer should be very stable and thus easy to fly, while an aerobatic model should easily change direction and keep going wherever we point it.

It's important to realise that this balance of wing and tail lift will only occur at one speed. To achieve the same relationship at higher or lower speed will require adjustment, in the form of elevator position. If we want to do this long-term, we will have to adjust the elevator trim or otherwise keep a constant deflection on the elevator stick. So, when we say that a model is trimmed, we can really only claim this at a particular speed. If we normally fly around at ¾ throttle, that's the speed at which we will trim it.

Now, here's the good bit. Assuming the CG and thrust line are correctly set up, *the model will always seek to fly at the trimmed speed.* This means that it will pitch up or down, on its own, to achieve this. The effect is that we can change power setting, and the model will simply climb or descend at the same speed. Adding power will cause it to pitch up and climb, and if we close the throttle completely it will simply go into a glide at the same speed.

All of this is easily proven. First, fly straight and level at ¾ throttle and ensure the model is trimmed to do this hands-off. Now retard the throttle slightly and maintain S&L. You will need to hold a little aft stick, and eventually apply up-trim to achieve S&L at the new (lower) speed. Having done that, now gently close the throttle, and watch the model magically begin a stable glide.

So what relevance does all this have? The answer, when it comes time to land, is: lots!

Let's assume we have a well-performing model, which stalls at 20km/h but cruises on ¾ throttle at 60km/h. We fly around for a while at that power setting, perhaps throwing in a few loops and rolls, and then enter the circuit for a landing. If we retard the throttle on base leg, the model will pitch down and descend, still wanting to do 60km/h. It will be doing this speed as it comes over the boundary of the field, and this presents us with a problem. We can't land the model at that speed, so we endure an extended float across the field as we wash off the excess. Now the end fence is approaching, so we succumb to the temptation to force the model onto the ground. It still wants to fly, so it either bounces back into the air or grinds nose-first into the grass and whips around into a groundloop. Either way, not pretty!

Instead, let's go around from that approach and have another look. This time, on base, as well as retarding the throttle we apply a little steady up-elevator. This will change the trimmed speed to a lower value. The model now approaches at, say, 40km/h – still comfortably above stall speed but without so much excess to be dissipated during the flare. The result is a more dignified arrival, with much less float and a far shorter ground run after landing. It would of course be possible to trim out this up-elevator on base, but it doesn't need to be held for very long and we'd need to remember to reset it before the next flight. All things considered, it's better just to hold the pressure for the 30 seconds or so that the base / final / landing needs.

And this has another benefit. If we accept that a small amount of up-elevator lowers the trimmed speed, and full-up would take the model all the way into a stall, then it follows that the amount of elevator applied is a good indication of what airspeed the model is doing. Remember that airspeed is what makes the model fly, and is all it cares about. If we can hold a constant elevator position, we can then achieve the ultimate goal of using the throttle to control flight path on approach. Elevator stick position can be used as our airspeed indicator, and the model's stability will ensure that it changes attitude to correct for any outside disturbance. We just add or subtract power to keep the approach path constant.

Note that this is not so apparent with a lower-speed model such as an EasyStar or a glider. This is because they climb, cruise and descend at pretty much the same speed, so a single trim setting works for every flight phase and even on approach. But it can still be proven: go to full throttle on the EasyStar and try to keep it straight and level. It will need down-trim to stay there, just as the faster model does.

A side-note on the effect of flaps: small deflections of flaps add both lift and drag, but the initial increase in lift is more pronounced. Thus, the model will initially pitch up as the delicate equation of wing and tail lift is changed. Again, this will need down-elevator and possibly trim to compensate. Further extension of flaps causes drag to increase at a greater rate than the lift, so the model now wants to pitch down. We have also increased the effective incidence of the wing on the fuselage, so we need to fly at a lower nose attitude to follow the same path. Maintaining the original attitude can result in the airspeed getting uncomfortably low.

To summarise: by all means trim the model to maintain the flight path you want, but be aware that this has to change every time the desired airspeed is altered. Let the model's own stability help you to fly it. And, when it comes time to land...

Slow down!

Glenn Bridgland
Chief Flying Officer