words: **Andy Ellison** pictures: **Andy Ellison**

The racing line

With set-up tips aimed at slope racers, Andy Ellison's thorough advice should help any flyer wanting more from his model

Modern moulded slope racing gliders are highly efficient tools capable of extreme performance, so getting the best out of the ultra-strong composite airframe, multi servo wing and computer-generated aerofoils can tax even the best computerised transmitters. Setting up a model for optimal handling and speed can make the difference between a competition win and a placing as first loser.

Of course, these gliders are not just the tool of the racing elite; they also make exceedingly good sport models. No matter if chasing trophies is not your bag, you should still realise that there's a lot to be achieved from a good set-up on a multi servo wing glider. It will fly faster, climb better, track nicer, turn tighter, stay aloft easier, be less work to fly and generally increase performance levels in every aspect of the flight envelope. So, if you want to be the envy of your own particular hillside you need to get trimming mate!

Now, I'm not just talking about a few digital beeps here and there to ensure straight and level hands-off flying. No, we're going to get right down into the mechanics of mix ratios, flight modes and differentials, working your computer radio to the limit of its capabilities and realising the full potential of that lovely moulded machine you so fondly invested your hard earned cash in. The process may take many sessions and, even then, the tinkering may never cease. I still find myself tweaking a mix by 1% here and throwing in a beep of trim there and this continues for the life of the model. The important thing is to start the process somewhere which means going right back to the radio and linkage installation.

The model should be assembled right first time. Often scant information is provided with moulded gliders. It's a paradox I've never quite grasped, indeed the more you pay the less you get

Initially, ballast can wait until we have a good base set-up to copy onto our other flight modes.

Clubmate Lee Smalley with his new JR 11X radio. It's a mid-range set as far as for glider mixing is concerned.

V tails are a mystery to some. Consider each half as a vertical fin to get the rudder direction right but make sure each half deflects equally in pitch.

With (typically) four control surfaces, a whole magnitude of characteristic-changing trims are possible for different phases of flight.

Control surface differential must be considered at the installation stage. An offset servo arm can bring in a mechanical element which can be of some use to us.

Trimming is a process which never really ends. Different set-ups for different conditions and even changes in your experience and flying style will see some element of tinkering throughout the life of the model.

it seems. Thankfully the internet is your friend and there's very often somebody else who will have already posted lots of install and set-up information for the world to see. Obviously, you should take note of the designer's recommendations first but occasionally a user will point out some shortcomings and will have made improvements that are attractive to you.

SERVOS

Select your servo's according to what will fit in the airframe, their speed and, of course, operating torque. Decide the voltage at which you want to run the model and set about getting your equipment into the airframe with solid, no-slop linkages and a serviceable install. No double centring should be present and you should try to keep the pushrods as straight as you can whilst optimising the model for maximum available servo torque at the linkages. This means using the innermost servo-arm hole you can get away with.

Start with 100% end point adjustment in the transmitter programme for all servos and try to set mirrored linkages with the same geometry, observing any offsets and noting the horn lengths at the control surface. Essentially, you need to try and make sure that you do not have to battle your installation with electronic gimmickry at the transmitter just to achieve a good starting point. If you find you have to do so, you're already on the back foot.

A little mechanical differential across the wing servos can't hurt. With no mixers set you'll naturally get more up aileron deflection than down and more down flap than up. You might find that one servo spline offset, off square, will be adequate.

Choose which arm you use on the servo horns carefully too, as most makes offer a few degrees of offset dependant on which numbered arm of the horn is used. Setting the initial C of G can be a bit of a minefield. Take a good average from the settings you'll have obtained from your investigations and then add a small amount of extra weight to shift it slightly forwards. The C of G of the glider will change as we go through the setting up process so you should make it possible to remove or add nose weight at the slope.

THROWS

With the research done and the installation achieved it's time to set the initial control throws. Hopefully you'll have ascertained a recommended starting point from either the designer or another modeller and can achieve these throws without too much fuss at the transmitter. It's vital to ensure that you measure ailerons, flaps and V-tail control surfaces in pairs. For example, the left aileron should have the same up and down deflections as the right aileron and the left flap the same as the right flap. You may need to tweak the ATVs to achieve this properly and overcome any mechanical differences between linkages. For V-tails both ruddervators also need the same deflection in the same pitching direction. It is not so critical if the deflections in the yawing directions are different.

Ensure that you set reduced rates for primary flight controls assigning them to a switch and that you have rates on separate switches rather than bundled onto one. I suggest you have 60% of full throw on tap for the first flights in case you find the model too twitchy on full rate. Avoid using exponential for the maiden

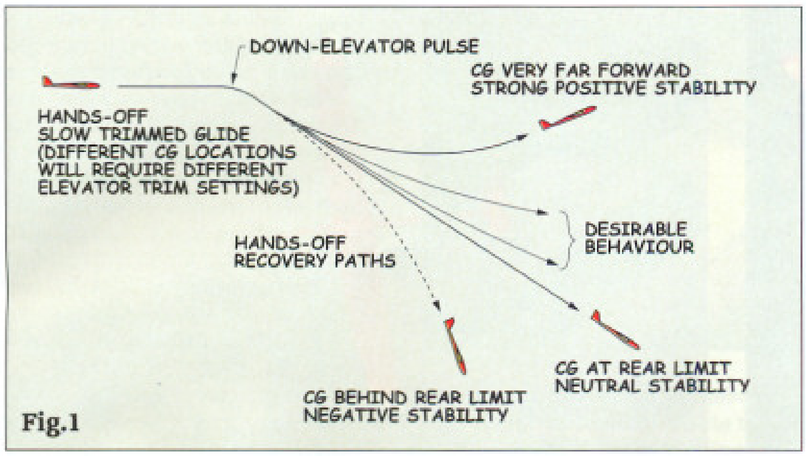
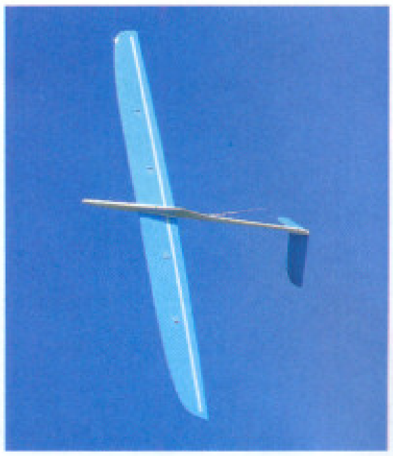
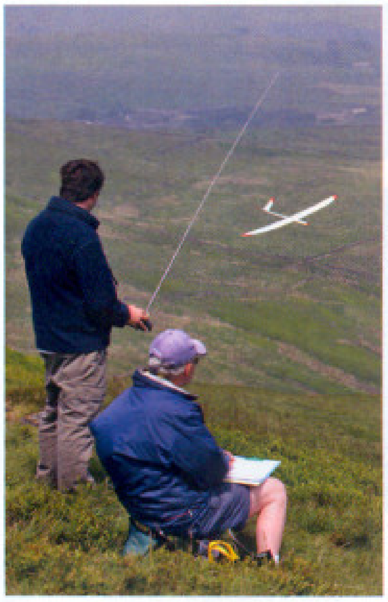


Fig.1



Done right the correct aileron and flap differential will ensure perfect tracking of the models fuselage around the turns. Minimum drag equals maximum speed.

Here's what to look for when checking the centre of gravity.



To the winner - the spoils. Every tweak in the right direction improves performance. It may be just enough to send you home with something for the trophy cabinet.

unless you're absolutely sure you'll need it. The key to a proper set-up is acquiring a feel for the model over the first few flights and exponential on either rate setting can muck that right up.

In preparation for the first flights there's some considerable computer programming to be done. Modern gliders are designed to exploit the abilities of today's R/C equipment and they will tax the functionality of low-end radio gear. A pilot flying with anything other than a middle of the range set is always going to struggle to unleash the full potential of his slope racer. Though these radios may well be able to get one in the air well enough, when we dive into the detail they'll be found lacking and compromises will have to be made. Typical mixes that a four-servo wing glider will need for optimised performance are as follows:

- **CROW braking (Butterfly mix.** On a standard four-servo wing this will be flaps down to their maximum extent (perhaps 45 to 90 degrees), ailerons raised to around half of their normal up travel to de-camber the wing tips, and some compensatory down elevator throw to counter the upwards pitch from the flaps.

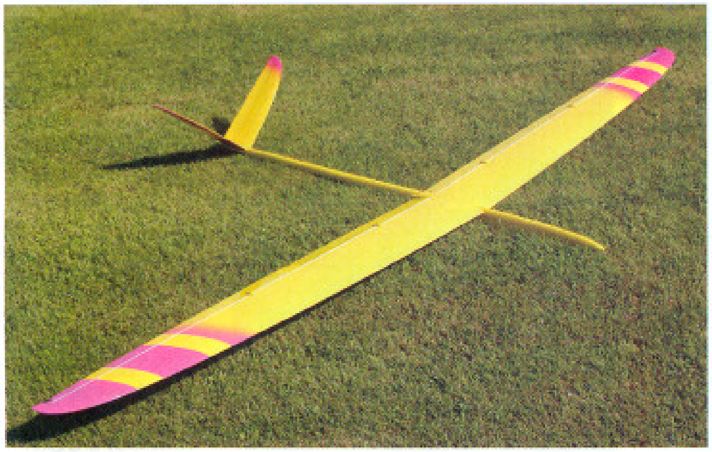
Deployment of CROW braking should be proportional and most commonly the throttle stick is used with the mix being activated by a switch. This may eventually become the landing flight mode switch depending on your transmitter, but it's the elevator compensation that, more often than not, will require adjustment.

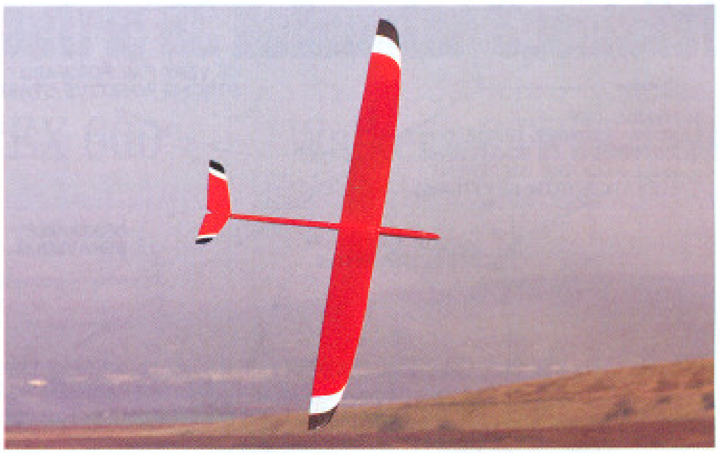
Use of CROW braking permits rapid deceleration of an otherwise slippery model or indeed a steep, committed descent to the landing zone. Proportional deployment of CROW braking allows a good deal of accuracy and precision in the landing and, more often than not, you can pick your spot before setting the model down.

- **Aileron / flap mix.** This mixes together the flap and aileron functions so that the flaps move in the same direction and at the same time as the ailerons. This is a common glider mix on most popular transmitters and is aimed at giving the model more manoeuvrability. The entire trailing edge of the wing acts as one long Aileron increasing the upwards and downwards forces on the wing and with it the roll rate and reaction time of the model to a roll input. Very useful when racing at high speed and often more efficient than using just ailerons alone for roll control.

It is often not possible (because of the gap seal on the model) to deflect an up going flap to the extent of the aileron and more usually only around 50% of the aileron travel is set on the flaps.

The deflection of any control surface creates drag and you might think a mix like this counterproductive. Certainly that





Modern slope racing gliders are designed with the exploitation of camber changing flaps in mind.

Blended aerofoils optimised for racing can be fussy over their set-up. If you want to get the best out of them you'll need to follow this article closely.

Fast models like the Skorpion can be ruined in the turn by a poor set-up, thus stifling the advantages designed into the airframe.

may be the case in slow moving thermal flight but, slopeside, and trying to get around a full speed F3F turn every 100 metres needs powerful steering. Using ailerons alone can see them working very hard indeed to get an adequate roll rate with proportional drag increases from the increased throws. Switching in an aileron / flap mix (I leave mine active in every flight phase) can mean reduced throws for the same roll response with a corresponding net drag reduction.

● **Flap / aileron mix.** Much like the aileron / flap mix which slaves the flaps to the aileron function, the flap / aileron mix slaves the ailerons to the flap function and can be utilised to raise or lower the ailerons in the same direction as the flaps to change the operational section or camber of the wing.

Again this mix is usually a standard glider mix on most computerised transmitters and comes in to play for camber, reflex and snap-flap settings. Generally, the more cambered the wing

section, the less outboard aileron you want acting as flap thus reducing the chance of inducing a tip stall and spin, or a flick if used at high speed.

This mix is usually operable across two switches. One position of a three-position switch for camber, the opposite for reflex (with 'normal' in the middle) and a separate two-position switch for snap-flap used either 'in' or 'out'. The three-position switch will normally dictate 'thermal' (or launch), 'normal' and 'speed' flight modes on a slope soaring glider.

● **Camber / reflex.** These gliders and their aerofoils are designed to make best use of camber changing flaps. Drooping the trailing edge across the wing slightly is known as adding camber, or camber mix. Raising the trailing edge slightly is known as adding reflex.

When the flaps are lowered slightly the aerofoil is modified to one that will produce more lift, raising the lift coefficient at the point where the aerofoil has the lowest drag. With the wing in this setting the model will fly slower at a minimum sink setting. With enough lift this means it will climb better for the period after launch and any thermalling.

With the trailing edge raised the aerofoil is changed to a state where it will produce less lifting force and the lift coefficient is lowered at the point where the aerofoil produces the lowest drag. Now the wing will fly better faster compared to its state under neutral flap. This is the position of the 'speed' flight mode.

Camber is generally set at around 3mm deflection but some aerofoils will take as much as 6mm. Reflex offsets are more usually around 1mm across the whole trailing edge but notably some Quabeck and Drela sections will take much more. It's also common to deflect the ailerons slightly less than the flaps under both camber and reflex mixes.

● **Snap-flap.** Snap-flap or 'coupled flaps and elevator' is the mixing of the flaps with the elevator function. Unlike powered models, the deflections will be quite small

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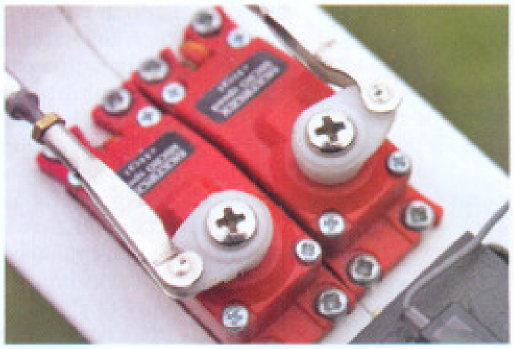


Easy access to a small amount of the nose weight is desirable when making C of G adjustments at the slope. You really don't want to be digging out receivers!

Servos may need a little clevise fettling to ensure their clearance around the hub of the arm.

Trailing edge flaps can be drooped slightly to add camber to the wing section. Raising the flap is known as adding reflex.

– maybe 3 - 6mm in each direction depending on the wing section. Up elevator produces down flap and vice versa. As we will also have an aileron to flap mix operating, a pull back on the elevator stick will also produce a drooping of the ailerons as a slave to the flap. This mix is used to produce a tighter turn and a better inverted performance by adding either camber with up-elevator and if desired, reflex with down.

Most of our sailplane airfoils are more efficient in a turn with a little added camber. This reduces drag on the wing in a high alpha attitude like a pylon racing turn. The camber is not needed in straight and level flight and it's quite common to see the mix applied disproportionately on a free mix curve, with flaps deploying from around half stick on the elevator. Many pilots have the mix only operating on up-elevator, dispensing with the flap deflections on 'down' but some prefer to keep it operational to aid recovery of a cut turn where their preferred method is to input down elevator rather than loop back for the buzz.

● **Aileron differential.** Control surface deflection on the semi-symmetrical aerofoil sections of our gliders cause drag above and below the wings. Unfortunately the down going aileron creates more drag than the opposite up going aileron for a given surface deflection. This drag can cause adverse yaw in the opposite direction to an aileron induced turn. The result is that the fuselage and tail of the model do not track straight around the turn and the model flies slower because of the increased drag this causes. Consequently we use aileron differential to electronically reduce the travel of the down going aileron until the drag throughout the aileron input is more or less equal on both sides of the model.

Differential settings are always a compromise and even with the correct ratio set, on some models it's still be necessary to add rudder input to overcome the effect.

The amount of differential required depends on the wing's angle of attack and we can never have it exactly right, however with today's wing sections we can get near enough! The slower the flight the more differential is needed (i.e. more up than down travel). Conversely, the faster the flight, the less differential is required.

Switching between flight modes for camber and reflex, offsets the neutral position of the trailing edge of the wing. Alternative differential settings will be needed in each flight model to overcome this.

● **Flap differential.** Essentially the same as aileron differential except that the flap linkage geometry is normally set to naturally produce more down flap than up, compounding the adverse yaw issue. Some radios permit the setting of flap differential separately from the ailerons to help overcome this but many more do not have the facility to do so. This is one area where lower end transmitters fall down. Here, flap differential is always a compromise and rarely right. The aileron differential also having to be set incorrectly, this time to promote proverse yaw because it also has to overcome the additional adverse yaw created by the opposite down going flap.

As a guide for the first flights, the ratio of up aileron to down aileron and up flap to down flap should be the same.

● **CAR (Coupled aileron and rudder).** Exactly what it says. A movement of the aileron control will induce a slaved movement of the rudder to compliment the turn. I'm of the opinion that most slope racing pilots have opposable thumbs which allow them to move two sticks simultaneously so this mix is not widely used on the slope racing scene.

FLIGHT MODES

The use of flight modes assists a pilot in optimising the performance of his glider in different flight scenarios. For instance, a typical F3F flight consists of a launch, a climb out, a dive in, the racing of the 1 Km course, and a landing. Factor in different lift conditions and different hill profiles and you can see the problem with having just one set-up for all eventualities. A flight mode is akin to having a switchable model set-up within the overall model memory and in each flight mode (some radios now sport as many as eight or more flight modes for each model memory) different mixers can be active, different settings across the wing can be made, different control throws can be in place and different trim settings can exist. All achievable by the flick of one, or a combination of switches.

What flight modes cannot do (in my experience) is change the base set-up of the model, i.e. reversing servos, changing sub trims or reapportioning ATVs. Where they pay the biggest dividends is in the aforementioned management of aileron / flap differential for different camber settings. With either camber or reflex set in to the wing for a 'launch', 'thermal' or 'speed' flight mode, the trailing edge of the wing is offset from its central position. Hence the differential set for 'normal' positioning of the trailing edge will now be incorrect. Setting alternative differential across the flight modes is quite essential, especially for models flying at speed under reflex where the effects of adverse yaw are much more destructive.

Also, switching between flight modes can be used, for example to eliminate additional movement of the trailing edge under camber / reflex / snap-flap when in the

A dive test is the easiest way to get somewhere near the correct C of G. The further rear it goes the nearer to zero-zero incidence and the lower the drag.

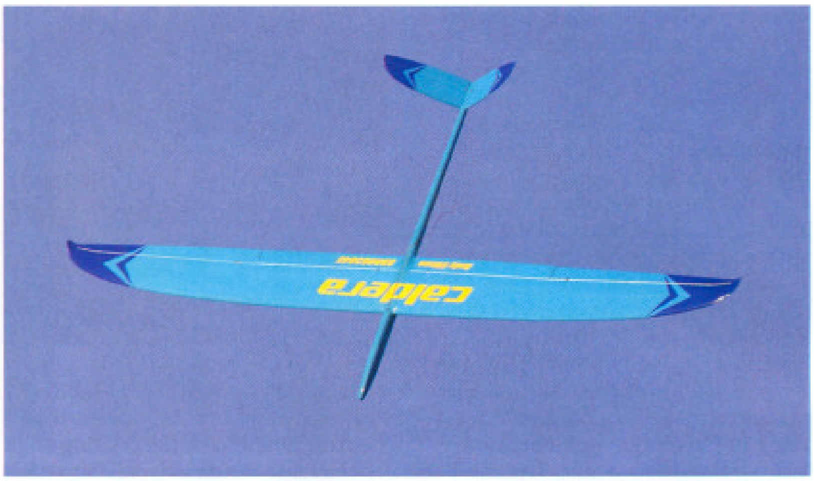
landing mode to ensure that too much surface deflection under CROW braking is prevented and with it any possibility of suffering binding linkages.

A launch or thermal flight mode may have increased camber on the wing, snap-flap, CROW and reflex mixes unavailable, increased up elevator trim and reduced aileron rates. All aimed at improving the models ability to climb in the available lift. Conversely a speed or race flight mode will have reflex on the wing trailing edge, snap-flap mix active, higher aileron dual rate throws, increased down elevator trim, but the CROW and camber mixes unavailable.

An aerobatic flight mode may have no use in a racing environment but if utilised might switch out camber, reflex and CROW while having snap-flap active, increased throws all round, and with aileron differential optimised for axial rolling rather than coordinated turns... And so it goes on...

The key to utilising flight modes successfully is to forget about trying to programme them until you have a well-defined basic one, i.e. 'normal'. This means carefully setting up all the other mixers, C of G and control throws before you even start to think about running different model set-ups under one memory.

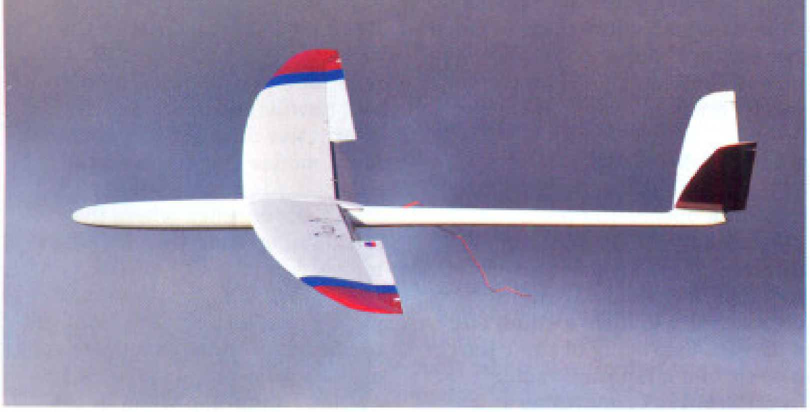
When you're ready to start adding or removing mixers from the 'normal' mode to make the others, ensure that you do so with the minimum of switch flicking to swap between them, thus reducing the workload on the pilot.



This Erwin DS has exited the turn with the nose high and the fuselage is not tracking correctly, thus causing unwanted drag. Any second now the pilot will have to push down elevator to avoid losing forward speed and to get back to the racing line.

AND SO, TO THE AIR

So, this now leaves us with the final setting up of the model in the air and the inevitable tweaking that's necessary to hone the aircraft to be the best you can achieve. There are a few vital changes to some of the mixes and settings we've discussed which can distinctly affect the way the aircraft performs. These are elevator throw, differential, snap-flap and the all-important C of G. To a lesser extent, the amount of camber, reflex and down elevator compensation under CROW will all need a tweak but it's on the others that we will focus here. First we'll get that C of G right.



Crow braking provides a predictable and efficient way of slowing down your slippery glider for landing. Get your mixes right and this method makes it easy to pick your spot for touching down.

GOOD BALANCE

Where the Centre of Gravity of your glider is located for your best performance depends on a huge number of factors including wing section, wing location, moment arm, tail size and, of course, the pilots preferred method of flying. Some people fly with the C of G well forward, others seem to fly with it as far back as they can tolerate.

I personally try to fly my slope soarers with neutral pitch stability. That is they will hold a diving line without zooming or tucking and need little if no down elevator when inverted with moderate or higher airspeed.

The closer a pilot can get the incidence to zero-zero, the lower the drag; the lower the drag, the faster the model. It's possible to go too far back with C of G but to decide what's best for you, you first need to find that aft-most neutrally-stable C of G location by using the dive test.

Keep a very close eye on the elevator throws and responses as you do so and then if you feel the need, move the C of G ahead of that point by gradual amounts until the glider behaves as you like.

DIVE TEST

The dive test (Fig.1) is fairly straightforward. With the model at height, at low or no forward speed and facing across or into wind, push down elevator to establish the model into a steep, straight dive. This need not be vertical. 45 to 60 degrees will give you the results you need. With the model in the dive, release the down elevator input and observe the flight path. Unless the model is set for neutral

words: **Andy Ellison** pictures: **Andy Ellison**

Good control response is required if you're to get the best of the racing line close in to the hill. Mixing flaps to ailerons improves roll rate and quick corrections can be made.

stability it will quickly become apparent that there will be some response in the pitch axis.

With the C of G rearward the model will continue in a straight line or begin tucking very slightly as if down elevator had been applied. For a model with a forward C of G the it will begin to pull out of the dive as if up elevator had been applied.

There are pros and cons for both extremes. On the slope a neutrally stable model will hold good forward speed, stay on an established racing line or hold decent downward lines in aerobatic patterns. Move the C of G back a little and it will demonstrate a faster forward speed but be increasingly unstable in pitch and require reduced elevator settings for normal flight. Move the C of G forward and the model will 'zoom' more when flying into stronger lift (as opposed to accelerate) and will require variances in pitch trim throughout the flight envelope.

With a satisfactory C of G setting tuning can now move to properly setting the elevator throw.

ELEVATOR

Here we're looking for the point where the model can safely turn as tight as possible but without causing the deflection of the elevator surfaces to stall the tail in the process. The result of said tail stall has an effect very much like a high-speed wing tip stall wherein the model can flick out of control.

In order to properly set the throw for best turning effect you'll need to climb the glider to a decent height and make a reasonably fast run away from the slope into the wind. With the wings level pull full up elevator for a tight loop. If the model flicks out of the loop, back off the elevator throw and try again. Obviously, if the model does not flick, increase the throw until it does and then back off a little.

When correctly set you should be able to pull two consecutive tight loops at speed as small as you can without the model flicking. This, then, is your high dual rate position for elevator.

If the model feels soft around neutral then a little reverse elevator exponential is needed. Avoid increasing the elevator throw to get the feel you want. The model must be aerodynamically safe at full up throw. Down-elevator travel can now be set on that servo's ATV to get a balanced response.

World champion pilot Andreas Herrig uses snap-flap mix in both directions with elevator to assist in cut recovery... Not that he cuts very often, you understand!

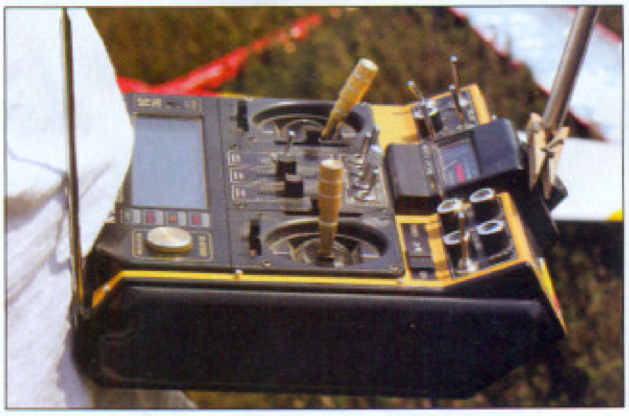
SNAP-FLAP

With elevator and C of G set we can start to assess the snap-flap inputs. Bearing in mind that soaring conditions and ballast can have a big effect here, setting up gliders with the optimum amount of snap-flap is simply a case of evaluating a number of different settings. As a general rule the more flap you have mixed with the elevator, the tighter the model will turn. This is fine up to the point where the deflection of the wing's trailing edge starts to add too much drag. The latter becomes apparent when the plane will still turn in a small radius but will scrub off lots of speed.

The best compromise is obviously the tightest turn without slowing throughout it. I start with only a small amount of snap-flap with full up elevator and keep adding it until the model slows down, before backing the mix off a little. Some people move the flaps the same distance as the ailerons. I tend to move the ailerons slightly less (by about 0.5mm or so). Put the mix on a switch so you can see the difference easily and then set up each turn entry exactly the same, time after time after time until you're happy with your setting.

AILERON / FLAP DIFF'

The biggest contributor to speed retention and improved performance is yet to come in the



Graupner and Multiplex radios are very popular where R/C gliding is at its strongest. It's hard to think of something that the Graupner MC24 doesn't offer.

A lot can be gained from increased height gleaned from the energy of the launch.

Racing is all about the turns and flying accurately. Not having to battle the model set-up while doing this pays large dividends in the long run.

form of setting the correct aileron / flap differential, an area where many pilots struggle.

Setting the differential correctly can be quite tricky and time consuming. The first step is to set the model up with the aileron response that you and the model prefer. Note that modern blended aerofoils can be incredibly fussy on aileron throw and while you as a pilot may like shed loads of travel, you have to consider that it may not be good for the model's aerodynamics. Keep drag in mind at all times.

Once you have the throw sorted out, perform a simple roll across the wind, avoiding any intermediary rudder or elevator input. Your airspeed should be reasonable but not so fast as to

make this roll unavoidably axial. If you and your radio are capable of in-air programming, you should have the memory open at the aileron differential screen. You are trying to achieve the perfect axial roll across most of the model's speed range (but not too slow). This is your baseline starting point and most likely the setting you'll end up with in any 'acro' flight mode, so make a note of the mix percentages. Now increase these settings by, perhaps, 10% and fly the model across the hill on an imaginary F3F course. At the position of the turn, lift the nose slightly and roll the model 135° to almost inverted. Watch the line of the fuselage carefully and, as you pull elevator through the turn, try and ascertain if the nose is exiting high or low. If the fuselage is sitting nose high during the turn you need to increase your differential, i.e. reduce the amount of down going aileron even more. For a left turn this, of course, will be the right aileron. If your model seems to be thrown or 'hooked' more in towards the hill, exiting the turn nose low, try easing off the differential a little and increasing the travel of the down going aileron.

Exiting the turn nose high will need further input from down-elevator and, of course, every unnecessary control input adds drag and slows the model. Exiting the turn nose down usually results in a panic (as the model heads for the hillside) and opposite aileron deflections to regain the racing line.

A flying session in good lift will see aileron and flap differential properly dialled in to an acceptable level for most situations. Bear in mind that lighter conditions may need more differential again and a flight mode reserved for this kind of air can also be useful.

ALL UP

My apologies once again for the technical nature of this feature but to dumb it down would not be doing the topic justice. It's a complicated process and the correct set-up of the model will pay dividends.

Take your time when you're programming. Choose a good day for your test flights with little or no turbulence but enough slope lift to facilitate flight.

Avoid using ballast until you've a few flights in the bag and your tweaking has started. Approach your test flights in a logical and planned out manner but try to get a feel for the glider before you make any subtle programming changes.

It helps to have a mate taking notes as you narrate the flight so you're not scratching your head trying to remember the changes you need when you land. It may sound like a lot or work but you can get pretty well sorted on a good day once you know what you're doing. Also, avoid making dozens of changes at a time or you won't remember what worked and what didn't. When you think you have it perfect do some tweaking on the C of G and see if more performance is hiding in the model.

Most of all enjoy the experience that flying a well tuned glider can bring to the hobby.

I'm always available at slopetrashuk@gmail.com if you have any queries arising from this article or follow me on Twitter at @slopetrashuk as I set up my own models in real time.