The Duration Glider and The F5J Competition.

Adrien Gallet

2020/2021

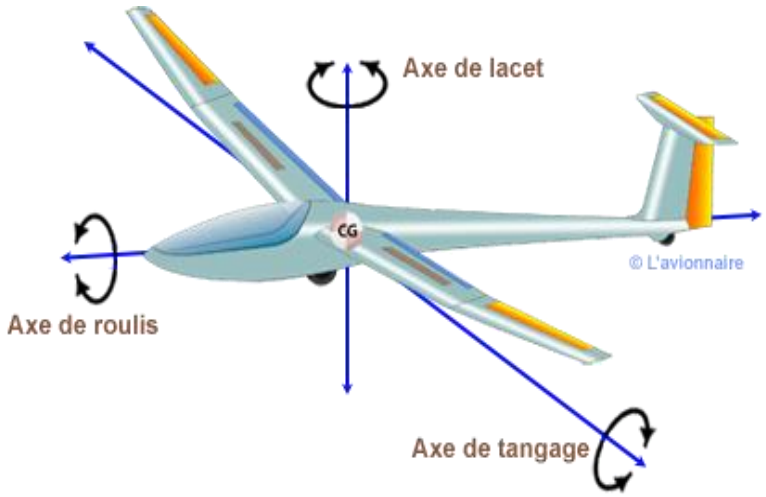
Summary:

My name is Adrien Gallet, I was born in 2003. In 2006, my father put an transmitter in my hands since he never managed to take it away from me. My favorite discipline is the glider, regardless of the size of the models, from the F3K to the GPR. Nevertheless, competition is in my opinion, the most motivating and rewarding.

I decided to write these few pages to share my experiences. The ideas conveyed are personal. They are not the absolute truth!

Glossary:

The roll: The axis of the Ailerons
The Pitch: The axis of Elevator
The yaw: The axis of Rudder
CG: Centre of Gravity
Diff: Differential is the difference in travel between positive and negative deflection. For example, the aileron descends less than it climbs.
Mix: A mixing abbreviation, where one control acts on another.
Snap: Snap-Flaps is the mix that mixes the elevator with the curvature of the wing
Cz or Cl: Lift coefficient
Cx or Cd: Drag coefficient
Vz: Vertical speed of the model.
Vx: Horizontal speed of the model.
V Longitudinal: angular difference between the wing and the stab. Not to be confused with the stalling.
Stalling: The wing or stab is stalled in relation to the fuselage flight line.
L/D : The aerodynamic criterion that is defined by the ratio of lift to drag. For example, a glider with 25 finesse will travel 25km for a loss of altitude of one kilometre.



II Preparation and model settings:

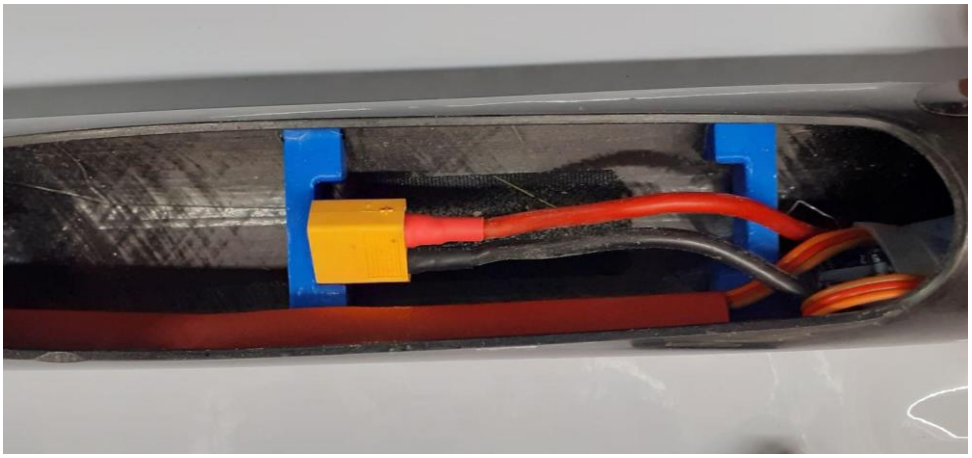
In this first part, I will talk about all the steps that lead us to the competitions. We will deal essentially with glider settings (for a 4 control surface or 6 control surface model, the method is the same).
First, we'll see what we need to do to optimize our machines while in the workshop.
Then we can fly. One must try to work as hard as possible according to the "snail method". Once you've gone through all the adjustment steps, you can go back to the beginning to confirm the adjustments made previously. After the first flights of the model, we always start by trying to understand its general behavior. A few flights later, we can tackle the heart of the subject, with the settings that allow us to adapt to this new model. We have to try and get the best general behavior. Finally, the "fine" adjustments will be made. For example, the Aileron/Rudder mix, the Differentials, the Flap Settings, The Curves.

Assembling the Model

The assembly of your model is the Genes for the preparation of future competitions. This is a step not to be overlooked. Since our models are only assembled once then we have to do it correctly!

We must focus on the fact that we must always make our models as reliable as possible to avoid problems in competition, for example, technical problems. The pilot who has never had any technical problems probably does not fly enough!

We must not overlook that our machines must be easy to use. It is important that the battery is easy to change. The position of this should never change, to avoid variations of cg! To ballast the glider it must be simple and fast in order to be changed even in the last seconds of the preparation time.
We often forget to provide an installation to quickly change the ARMT to allow the organizer of the competition to put a 2nd Alti in your model, to carry out a check!



Here's what I use to keep my batteries in the same place. I use heat shrink as a guide, to pass the controller wires.

Settings in the workshop and layout of the transmitter:

After assembling the model, it must be adjusted on the transmitter. It's not yet time to fly!

Let's start with the layout of the transmitter.

I have long underestimated the importance of choosing my switches. It is important to choose the switches that allow the greatest comfort of use. This will reduce stress or build muscle memory for your future competitions.

For example, the motor switch on the left side if you launch your glider with your right hand. For me, on the left side of my radio, it is all the switches that manage my motor and timers. In a way, the first portion of the flight is on the left side of the radio. On the right side, I have all my flight modes. These little details can make it easier for us.

Of course, you have to understand your radio to be able to make all the adjustments in the field.

For our glider to fly well, we're going to need a center point. Without this, it will not be easy for us to adjust all the settings. We must begin by setting all the surfaces to the same throws. For example, the two ailerons must have the same positive deflection... Be careful! The horns of each servo must be set to avoid having a dead band at the end of the movement (no more travel on the last part of the movement). This is the first step to get a machine that reacts symmetrically on each of these axes (roll, yaw, pitch).

Tool to accurately measure the travel of surfaces to symmetry the settings for example.

Once this step is well done, you will save time in the field. This will make it easier to change a setting without misalignment! So why deprive yourself of it?

Set your machine:

Why do we spend time setting up our models?

Well to make the pilot's job easier, It should not be forgotten that during competitions, the competitor is more stressed than in training. This factor is very important, so as not to overload the pilot. Flying a glider that requires too much attention, you will be less focused on strategy or Air Reading for example.

When we adjust our machines, we must always keep in mind that the model must react perfectly on these 3 axes but very separately! Indeed, a model that is badly adjusted in roll, can become very unpleasant to fly precisely. We will start by working on the overall behavior of the glider. For an easy machine that responds to fingers and eyes. Finally we will work on small settings, such as curves and other mixes.

It's important to have a setup process so not to get lost in all possible settings combinations. Therefore, it is best to change only one setting at a time to fully appreciate the difference in behavior. With our current radios it is very easy to make a copy of the radio program before changing settings. If you're not happy with your settings, just go back to your standard program! When I create a program copy I rename it with the name of the setting that I change.

To confirm the setting changes, it is often necessary to do several flight sessions to confirm these

Where to have camber settings :

There are several different points of view, and this is a subject that greatly divides the glider pilots. Some prefer to have the camber on the throttle handle, on a slider while others like me, prefer to have flight mode (on switches). It's a personal choice. You have to choose what works best for you, which is what is easiest to manage in flight but also to adjust.

The pros and cons of each method:

On the throttle handle, or a slider: This allows you to adjust the curvature of your airfoil constantly or almost in real time according to the strength of the thermal, the circling of the model, depending on your inclination or speed you need. On the other hand, it is more difficult to adjust because sometimes depending on your camber, you have to adjust the differentials or mixes. It becomes too complicated to implement easily and quickly, in my opinion!

With regard to the flights mode, I think it allows better adjustment to each phase of flights according to the use we want to make of them or to better refine all the mixes and other settings (diff, snap, ail/rudd ...). In flight, this can have the advantage of being easier to choose between thermal mode 1 or 2 while on a proportional control you have an infinite number of camber choices. I use phases of flight because this method is the simplest but especially the one with which I feel good.

V tail differential:

In the case of a V-tail glider this is the first thing I start to set is the rudder differential. I find it very unpleasant to have a glider that has adverse effects in pitching (goes up or down during a yaw input). This may mislead us when refining other settings. We tend to forget that virtually all mixes and other settings are linked together.

For this we use the warping test but this time to test the behavior of the yaw. I adjust my V stabilizer to be yaw neutral. If the glider goes down, it is necessary to reduce the deflection of the flap that is down. If the glider goes up, you have to increase the travel of the flap going down. With each change of CG it will certainly be necessary to adjust the differential of the rudder again. ! Warning: when you add ail/rudder mix, make sure that this mix keeps the same yaw differential.

I have also often heard that on gliders with V-stab, you need the maximum deflection in yaw and pitch because they are not as efficient as a cross tail. Indeed on the various V-stabs that I had the opportunity to drive I had normal yaw travel (-12/ -16) and rather low pitching travel (-7/-8). With more travel the result was not good and the glider could even become nasty on these two axes. For me, the turn was becoming too complicated to manage, with fluctuations on this axis that are caused by the stall of one of the two stab.

Dual/Rate settings:

After adjusting the differential of the V-stab, it becomes important to adjust the dual/rate. It's quick, and it's not very complicated to adjust, so let's go!

With a new machine, I usually make the first flights with quite big deflection on all axes. That's usually 20 to 30 degrees at the aileron, 15 degrees at the elevator and the max for rudder. After the first flights, I adjust the travel to the depth so that the spiral is easy (enough to support but not too much either). In roll and yaw, I regulate the travel to have the greatest authority possible without the steering becoming too complex. I try to have the greatest responsiveness even in turbulent conditions, to be able to get out of a difficult situation!

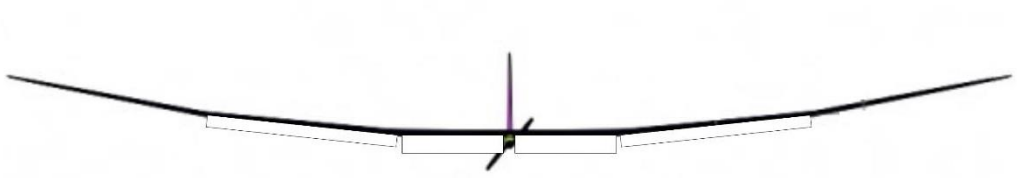
The use of dual rate or exponential is strongly discouraged. Let's say you're flying in very windy conditions and you have to counter a disturbance near the ground and you're in a bit of a bit of travel. What's going to happen? In the worst case it's a crash, in the best case you will be a nice scare. As for the expo, it is forbidden to use it because your orders will be less proportional and less natural. When you have to use the entire throw of your gimbal, it will not really be proportional. It will be difficult to react with precision!

In fact, everyone has to make these adjustments according to their tastes, in order to facilitate their piloting.

Adjusting the air brakes:

Everyone has seen someone land their glider short of their landing spot because their flaps were badly adjusted. The goal is to be able to effectively slow down the glider while maintaining the most authority on all axes.

The most effective way is to lower the flaps as much as possible and to lower the aileron very slightly. The goal is not to destroy the lift of the wing tips but rather to increase it so that the glider's recovery is easier if it has been slowed down too much. That's almost 90 degrees for the flaps and around 10 degrees for the aileron and a compensation to be set. Thus, it can be noted that the wing tip flexes a lot when the ailerons are not used(especially when the speed of the model is high before the brakes are released). Don't forget to put a compensation to counter the pitching "up" that is created at the deployment of the flaps. Normally, with this type of adjustment it is extremely rare to have to make a multi-point curve for setting the compensation, so it's easier.



In this diagram, it is clear that the central components have advantages of deflection than the others.

Brakes released, we can have a logic switch that activates high throws on all controls. In order to have the greatest authority on the model at low speed. It is often very important to disable the ailerons/flaps mix because when the Flaps are out, at almost 90 degrees. A roll action creates adverse yaw effects! It's totally out of place! Yes, you will miss the target and the 50 points will fly away!

The glider is heading for the target!

CG and VE Longitudinal:

The center of gravity is also called "CG." Adjusting the center of gravity is like adjusting the pitch stability of the model. Often when the other mixes have been set you can go back to the cg to refine it again.

To fix it, how can we do it?

With our relatively low wing loading about 40g dm2 maximum it's not a problem to fly with a neutral or very slightly rear CG. This will allow us to explore the entire centering range, without the glider becoming unstable. The most important thing is to feel comfortable with your CG. The CG does not affect pure performance! On the other hand, it plays on the overall performance. Overall performance represents all the factors that come into play throughout a flight, such as flying, machine, ease and even reliability!

The Divetest is certainly the best known test to "set" the center of gravity. I use this test only to get an idea of the center of gravity (during the^{1st} flight). When the glider dives up it is because the CG is forward, if it keeps its glide slope it is neutral. On the other hand, if it tucks its nose into the dive,it is because it's rearwards. It should not be forgotten that between each CG test, the elevator trim must be set to obtain a flat flight at cruising speed. Otherwise you won't see the difference in behavior. I find that the CG test is not the method to fine-tune its CG. Do you get to know the behavior of your glider with this test?

To fine-tune the CG one must look at the general behavior of the turn and its reaction to different types of air (Lift,Sink etc). A neutral or even slightly front CG allows the glider to be held in a spiral at wide angles to increase the rate of climb as much as possible. But also with this type of cg when the glider accelerates or slows down, it does not become unstable, the trajectories are more fluid ...

When the CG is forward, this can be revealed through the detection of air masses because the glider will change the attitude (the tail rises up in the thermal). It will also feel that the nose of the glider is heavy (it will be necessary to increase the elevator deflection). On the other hand, if the cg is rearwards it will be done more by a change in flight speed. But the glider will be less stable and therefore harder to fly. The center of gravity is the point on which the glider will rotate. The further back this point is, the more unstable the rotation of the model. On the other hand, the earlier the rotation point, the more stable!

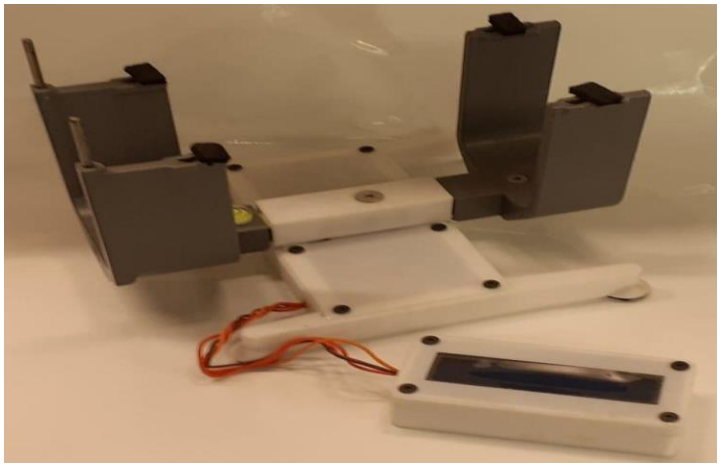
So a CG = a longitudinal V! That is, for a given cg a longitudinal V will be appropriate. The higher the CG is before the more the longitudinal V must be reciprocally important with a rear cg. In general, the easiest way to adjust the longitudinal V is to change the trim of the elevator. In fact, modifying the wing's angle will change the position of the fuselage. In both cases modifying the wing or stab angle independently will be like changing the longitudinal ve. However, by changing the position of the elevator with the trim, you can modify your ve to find a balance. So changing the trim(when the correction is very small) will allow you to gain slightly drag. But the gain is negligible in most cases.

If, for example, between two "almost" identical glider you don't have the same behaviors, but you have the same centering, you may have a slight angle problem. To solve the problem I proceed in two different ways:

- either the wrong stalling of the wing or stab is visible (e.g. a small moulding irregularity, smudge) or any other shift visible to the naked eye altering the longitudinal ve.
- either the difference Ve is so small that it is not visible so I measure the cg of the glider that serves me as a reference. Then, I adjust the glider center that doesn't work properly, to have the same as the glider referent. Then, I try to correct the longitudinal ve most often by modifying the stalling of the stab. You have to try to get the same glider as the glider referent, whether it is stability, speed and therefore dynamic behavior. The position of the elevator will help us to find out which way we need to change the stab. By changing the position of the elevator with the trim you will find a balance allowing flight.

When there is not enough V with same CG, the model retains or accentuates the descent slope during the cg test. But when there is too much V for same cg, our glider rises more during the cg test, rudder to pitch (to artificially increase the longitudinal ve).

Electronic centering balance used to measure the CG of our models.



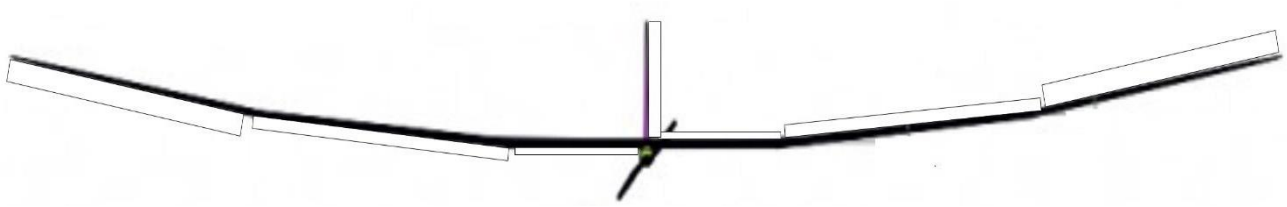
The centering adjustment step is not to be overlooked! In addition, the centering has, in most cases, impacts on other settings. So, after changing the CG, you'll need to rework your ancillary settings.

Aileron/Rudder Mix:

This mix combines aileron with rudder (stick to the right the rudder follows the aileron to the right). This function is intended to reduce the reverse yaw. And so to make it easier for the pilot, when the glider is far away! When the glider fuselage is in "drift" in circling, this induces drag! Result, the rate of climb in the thermal is lower and believe me in a small low thermal this can make the difference. Circling direction inversions are also easier and less energy-intensive. They will also be cleaner and therefore pretty to watch.

To adjust this mix, it is the principle of warping. We must put the glider in a steady motion rolling from right to left. So the trajectory must remain straight; the glider should just take the roll. (You have to do this test with the glider in front of you and once with the glider in rear view). The rule is easy, the fuselage must remain in the axis! The rolling action should only move the glider on the roll axis and there should be no reverse yaw effect! Be careful! When you change your flap or flap differential (next part) you need to check that your aileron/rudder mix is always good!

This mix gives a lot of ease in driving which is always interesting for the competition. So let's put our alter ego as a good pilot in the closet!



Here is the flap/drift mix when it is operated.

The Ailerons Differential:

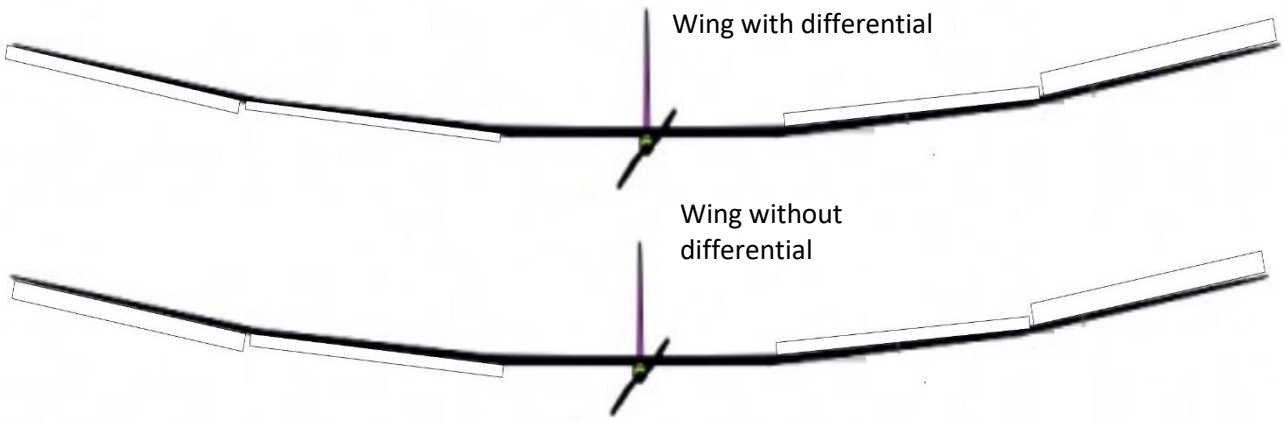
It's time to talk about the famous "Differential"! By the way, in this setting, we hear everything, some put, others not, and even some put the opposite differential ! So what to do?

To adjust the differential, no other mix is activated at the same time except the mix aileron/ rudder. Not even mixing flaps to ailerons! Generally, I start by putting no differential compared to the aileron that goes up (-20 degrees). The "warping" test is done (as with the aileron/rudder mix). Before launching the test, of course, the glider's attitude must be good and the flight speed must not be too low or too high (cruise speed). I do this test headwind, crosswind, down wind. But preferably when the wind is weak and the thermal activity is zero. So that the warp test is not distorted by these conditions.

The objective of this test is to see what is the behavior of the glider in pitch and yaw during several pulses in roll ... Therefore the glider must not go up or down, for better reliability the test must be carried out over a long distance (200m minimum). If the glider goes up it is because you have to increase the differential (minus down). Whereas if it goes down it is necessary to decrease the differential (further down).

On the other hand, with our modern glider, it is possible to reduce the using of differential. Our machines becoming steeper and steeper in yaws we can do without differential (-1° diff max) . This aims to reduce the diameter of the turn but also to increase average lift over the entire wing. However this type of setting is really advantageous for calm conditions. To spiral as flat as possible it is very effective. Nevertheless, in strong conditions, it is possible to find this type of setting disadvantage compared to settings with differential. Indeed the differential has the consequence of creating a torque "stinger" is therefore by increasing the speed of flight very slightly, to facilitate the piloting.

Be careful! Don't forget to do this test for each phase of flight or each different curvature and that with each change of cg you will have to fine-tune your settings.



Mixing alieron/flaps:

One more mix. We can do a lot of things with our models. But we have to try to make good use of its possibilities.

The purpose of this mix is to increase the reactivity of the roll. This mix is still active so no false excuse during a missed flight! It also allows, where possible, to increase the support of the inner spiral wing. To do this, it is essential that the flap settings be good so as not to cause circling side effects. So we're going to talk about differential, on the other hand it's more complicated to adjust for this because of the many possibilities.

In general, the ratio of fins to flaps does not exceed 50%.

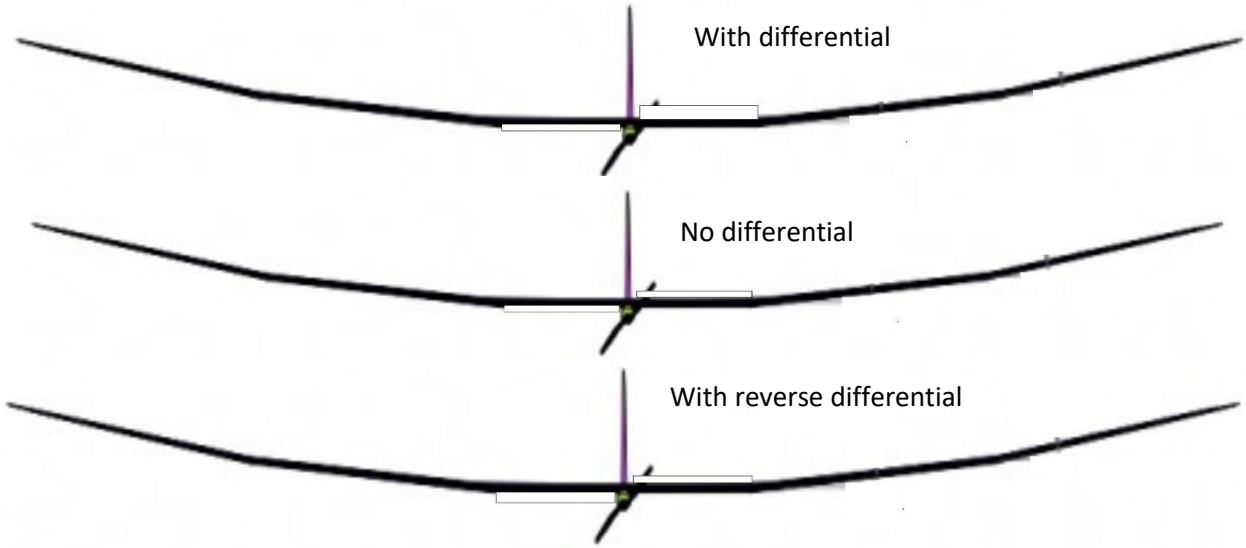
It should also be noted that it is almost never good to lower the flap more than the aileron. This could strengthen the reverse yaw. It is important to find the settings which allow for good behavior and the best efficiency versus drag.

In the majority of cases there are three possible guidelines,

*No differential (e.g., -10-10).

*"Differential" (e.g., -10-8).

*Reverse differential to increase the support of the inner wing in circling (e.g., -7-15 degrees). In general, this should not be allowed for glider that have long flaps because this can create reverse yaws and a lot of drag. And the roll tip is less good.



How do I do that?

We'll try as much as we can to compare behavior in low-power thermal.
We start without differential to the flaps. Then, depending on the glider's behavior, I put my differential one way or the other.
The value of the flap that goes down will be changed because we must be careful not to degrade the intrados of the profile too much. It is often the positive deflection (down) that is the most sensitive to adjust.

If the glider lacks support on the inner wing and you have to counter a lot in a spiral it may be that you do not have enough reverse differential on your flaps.
Be careful if you have too much reverse differential you will feel that the inner wing is dragging too much. The outer wing at too high a rotational speed in relation to the inner wing. To explain this phenomenon we can say that the inner wing is blocked, causing small changes of spiral cadences (slowing the speed of rotation in a spiral during a pulse to counter).

But it's also possible that you need to add differential. Even without diff you already notice the problems mentioned above.

Setting the flap differential is complicated, you may need several different differentials depending on the weather. For example, one differential passes everywhere, another for very turbulent conditions (more differential for example) and another for very generous thermal (reverse diff which can help increase the rate of climb). In the case of these 3 differentials I may have needed to retouch very slightly to my fins differential for each of the 3 differentials.

Finally, you have to adjust the ratio between the fins and the flaps, even if, for my part, this was done naturally when adjusting the diff. It is therefore necessary to seek the best efficiency with the lowest drag produced. I confess that for this it is the feeling that gives the direction to which the ratio will tend.

That's what fun is, you have to take your time and work methodically. The result will only be present after several hours of flights.

Elevator/flaps (snap-flaps):

You would have thought that this mix is useful only on aerobatic gliders but no, on our F5J too!

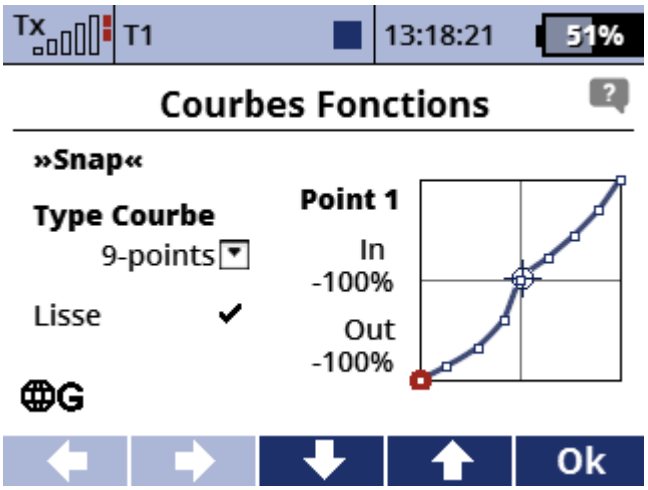
The purpose of this mix is to change the camber of the wing at the same time as the depth. The purpose of this mix is to make the spiral more dynamic with a strong tilt but also that the model is more cushioned in pitch and also in flat spiral to try to optimize the rate of climb. Or to make the glider raise faster when you pick up gear when you're pushing on the handle! I have snap in positive but also negative.

Previously, you've set your depth struggles so you won't have to touch them anymore. Beware, the setting of the snap flaps depends on the travel of the depth. To adjust the snap-flaps of the flaps in positive, one must look for the best drag/efficiency ratio and the goal is to reduce the loss of altitude of the model during a pitch action (feeling of support during a pulse to be pitched). To adjust it I often choose to spiral in a thermal quite low, stable and relatively wide (the morning without wind around 10:30 in winter for example). It must be possible to hold the glider at the highest possible angle (pitching) without it stalling. To adjust the negative snap when the glider returns to itself, we give light and fast pulses to sting, the flattening must be straightforward but the glider must lose as little altitude as possible.

When there is too much positive snap, the stall is faster and sharper compared to the settings without the snap-flaps. This is evident by small stalls on the wing (a tendency to start on the inner wing at the turn). It can also be difficult to keep a constant spiral speed. On the other hand, when there isn't enough snap, you may feel like you're running out of support on the inner wing at the turn during a pitch pulse. Once again, we must look for the best dynamic behaviour.

Then, when there is too much negative snap, the glider sinks (the rate of fall is higher). So the flattening is not sharp enough. When there isn't enough negative snap, flattening may seem a little slow. You can also feel that the glider is "stuffing." It's not the obvious thing to deal with, so by working trial and error, you'll get good results. Despite all the negative snap is not paramount.

On the other hand, it is sometimes necessary to make a curve of snap-flaps to optimize pitching behavior around the neutral. This may be like creating a reverse exposure for the positive part of the race but this may be the opposite for the negative part of the curve.



Snap-aileron mix:

After talking about the snap-flaps mix we'll see the snap-wing.

For the snap-flaps to be effective, the fins must be properly adjusted. When adjusting, the fins we will have to again, be careful not to create "induced behavior".

In general, I aligned the aileron with the flaps. Except that on few glider you don't have to go down the aileron as much as the flaps. We'll just get them down from 2/3 of the flap's snap deflection. If the glider reduces the tilt of the circling when you pull on the depth, it is because your ailerons go down too much. On the other hand, for the negative snap, I always aligned my fins with the flaps.

NB: When I created a snap curve for the flaps, I apply the same for ailerons.

This mix is useful because it allows to spread the effect of the snap flaps over the whole span. And so to improve the general behavior!

Camber settings:

Thermal, Thermal 2 or speed but why do it?

It is often quicker to adjust your glider in its smooth phase, and once properly adjusted, to move on to the next. This prevents us from getting lost in all possible settings combinations. To adjust the other flight mode, we start from the normal mode by just changing the settings of the camber and the elevator trim at first. Once the "right" camber values are found, the cycle of settings can be repeated from the beginning to fine-tune the settings in each phase of flight. In a way, we can be sure that a flight phase corresponds to a flight speed! So with 5 phases of flights you can have 5 different flight speeds.

In terms of positive (thermal) camber. I'm looking at how far camber is effective. The glider must remain stable, easy to place in the thermal and of course have a good rate of climb in the thermal. Once the maximal camber is found, I will use this information to adjust my mode of Thermal Max. Regarding the phase of Thermal mini (the one that passes in all conditions) I fumble until time to get the circling easy, a good climb rate, and good maneuverability and stability. On some glider one may be obliged not to align the aileron with the flaps. This can increase the stability in tight spiral, making it more fluid (a problem of the elliptical lift distribution of the model). One may have noticed that the more one increases the arch of the wing the more it is necessary not to lower the ailerons as much as the flaps (Between 1/3 to 2/3 of the flaps).

For my back phase, I put the down side of the airfoil flat by aligning the ailerons to the flaps. Here my method of adjustments is quite empirical since I settle this phase by flying in all possible conditions. The goal is to go as far as possible (low drop rate) but also as quickly as possible. Check the settings by putting yourself in a progeny (yes voluntarily this time!) the glider must keep its speed and the change of flight attitude should be as small as possible. The CG has here again a predominant role on the behavior of the glider in the bad air.

When we change the camber, it will be necessary to add compensation to the elevator. To avoid any variations in pitching trim. We should not neglect the adjustment of the elevator trim or risk not feeling the difference in behavior. In short, the elevator trim allows you to adjust your flight speed according to the camber.

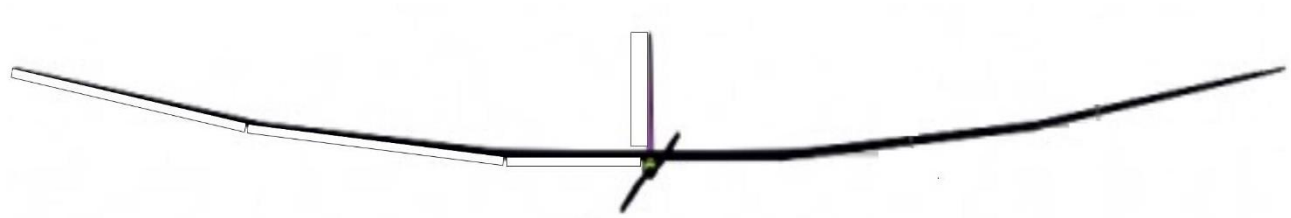
YAW/ROLL Mix:

Have you ever had the feeling that your inner wing at the turn wasn't spiraling enough? Either you get too far adrift or there's another problem!

This mix can be used to counter the induced roll caused by the yaw axis. This can sometimes be caused by heavy wings, or when the wing dihedral are not optimal.
Here, we will mix only the rudders in positive and only from the inner wing to the turn (drift handle on the right - right wing). The aim here is to increase the support of the inner wing in turn. To do this, the right compromise between drift travel and the rate of flaps and fins must be found. For this mix I have no particular method except many tests always looking for the best behavior in spiral. As for the other settings I always had a little less deflection for the aileron than in the flaps (not to generalize on all models).

! Careful! When there is too much flap and fins flaps, the glider may tend to exit the spiral turn (crab setting). This effect is totally outlawed!

This mix can be useful, on the other hand I advise you to use it sparingly. It is not always easy to deal with. This is not necessarily the best solution to solve the problems mentioned above...



Here is the representation of this mix.

The dihedral of a model:

I have often thought that the dihedral was a simple aspect to appropriate in order to identify the behavior of a model. But it no longer seems so obvious to me, and above all, that the dihedral should not be neglected!

On some models it is possible to make combinations of dihedral or have the possibility to change dihedral. The dihedral of a glider doesn't change the pure performance of the glider but changes the dynamic behavior. That is, the dihedral affects the behaviour of yaws, mostly but also rolling, to a lesser extent.

Personally, to look for the "good" dihedral I prefer to do the tests with the version of my glider that has the heaviest wings (Storm) because it is more sensitive and therefore more demonstrative to changes in behavior. A loaded glider is less tolerant so it will be easier to see what's wrong! I always look for a glider that has the most neutral reactions possible on all axes (as little as possible induced effect). You should therefore try to have an easy spiral, whether it is high inclination or still flat. The one that will require as little as possible to counter the spiral fins to manage the inclination.

-Too much dihedral often causes rolling problems, which can be equated with "permanent" roll. That is, it may tend to roll from one wing to the other! Since the glider becomes unstable at the slightest change in conditions. With too much dihedral, the flat spiral can become more complicated and energy-intensive because you will have to counter more to the spiral fins. Let's take the example of a 2 axis, it rotates thanks to the drift by the induced roll caused by the dihedral!

- Not enough dihedral, this is certainly what is easiest to detect since the drift can be soft. If you have reached the point of systematically engaging the spiral to the fins it is because there is really not enough!

Be careful not to get lost in all combinations with the possibility of being able to change a central key and the keys to the ends. I can only advise you to work with a very specific method. For example, start by optimizing the dihedrons of the exterior panels and then the central dihedral, for example.

You want to try your own dihedral, make a mold it's not that complicated! So you can try quickly with a moderate cost!

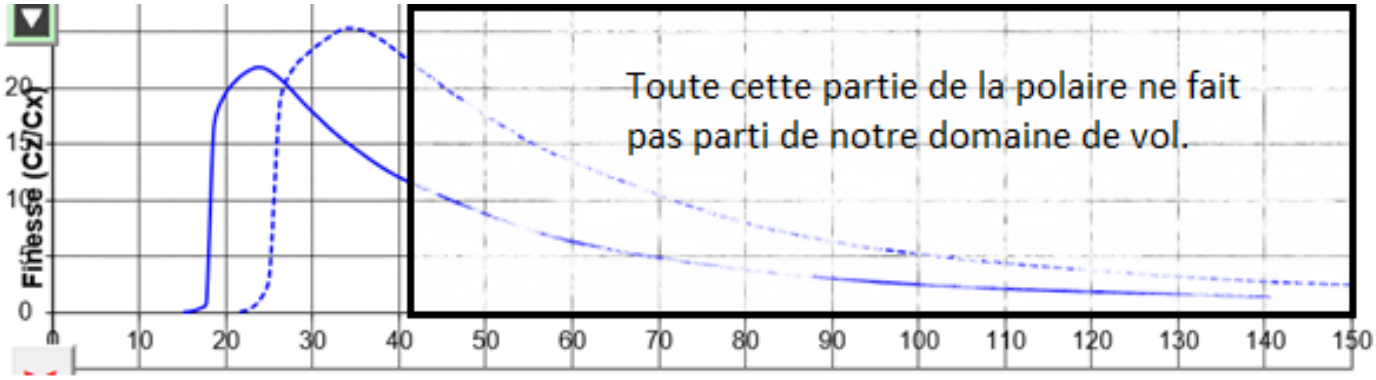
2 wing keys that have 0.5 degrees difference.

Domain of Flight and Polar:

When we think, L/D, minimum rate or speed, we think polar so let's talk about it!

Here, I will try to address simply the notion of polar and flight domain. Of course, I'm not an aerodynamicist so be forgiving, I won't be able to explain all the aerodynamics of our machines. On the other hand, I am sure that trying to understand simple things is an axis that allows progress.

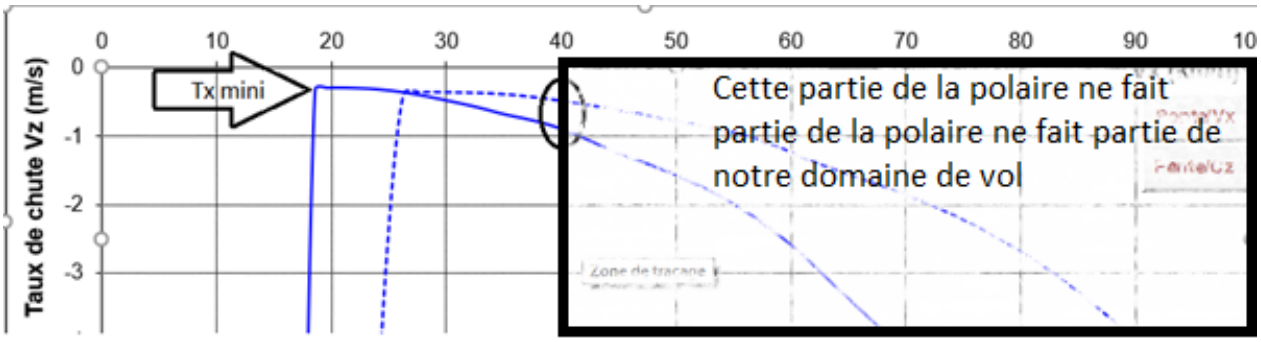
With our machines we often talk about sink rate or even L/D max but what do they represent? We have all heard or applied theories such as "it is better to fly very light but in the speed mode so as not to back down". So let's start by talking about the flight area in which our machines fly. We fly in a speed range between 20km/h and 50km/h, in most cases. In terms of the rate of fall in our model, the acceptable maximum sink rate is about one m/s. Let's say you fall to 2m/s from 200m. Then 100 seconds later, you'll be down! That's 1min 40 flights! What do you think?



Here's a polar. Here, L/D (Cl/Cd) on speed in km/h. Polar traced with Predim Rc for an F5J type glider but the values are not exhaustive. The continuous blue curve represents a glider loaded at 14gr.dm2 and the blue curve discontinues the same model but loaded at 24gr.dm2

The lowest flight speed is of course in favour of the least charged model. However, this one that has the lowest L/D will also be the most manageable because of the lower wing load. So the lighter has the advantage for the light condition with a lower turn radius in small thermal. But the one with the lowest wing load will be less good as soon as the wind rises.

The flight speed will have to be higher to counteract the relative wind. To fly, at the same speed you will have to push on the handle! And so fall faster and the finesse will decrease! It is visible on the top polar, for example to fly at 40km/h the difference in finesse is almost 10 points! In other words, by flying lighter you will go less far! And your drop rate will increase by about 0.4m/s or after 3min20 about 80m lost! This is why in our discipline, it is very rare and especially not recommended to fly at a speed that gives a Vz greater than 1m/s. That is, from 55km/h for the heaviest model in our example. And about 40km/h for the lighter model!



Here is a speed fleece (Vx on Vz). That meets exactly the same conditions as the previous polar.

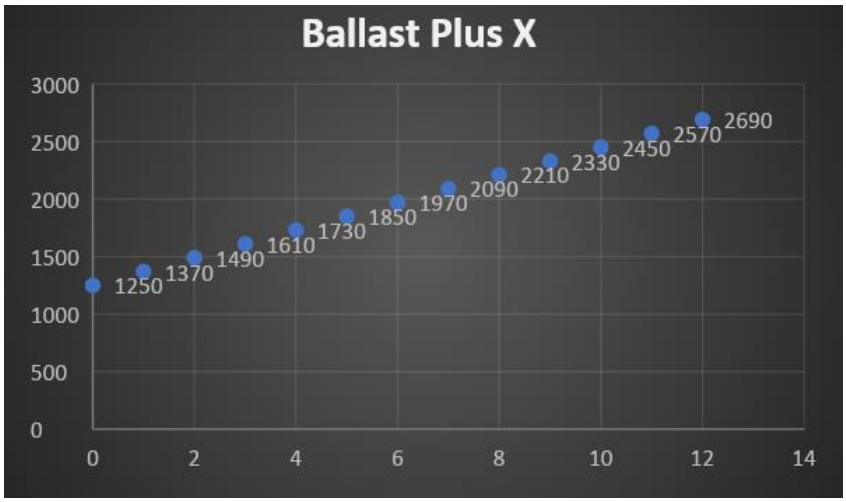
With the example we realize that to fly at 40km/h the difference in rate is significant since the rate of fall doubles against the glider at 14gr because you have to push more on the elevator! Nevertheless, the minimum sink rate of the heavier glider is less affected than the loss of finesse at iso speed. That's why you have to avoid shifting on the right side of the polar or you will go less far and the flight will be shorter!

In F5J we rarely need the max speed but work mostly on the max L/D and the minimum sink rate. The max L/D is used either to go for as far as possible an ancestry or to return from a thermal take down the wind. So pushing or speeding is useful to get out of a progeny for example. It can therefore also be remembered that it is important to not neglect the setting of the elevator trim whether in return or in thermal mode, so as not to pass the dark side of the polar.

So to conclude this part, we can say that flying light in the wind is a significant risk-taking. Indeed, by flying light you will have more trouble to properly steer your model therefore to place it in the center of the ancestry. Then you will not climb faster than a more loaded model but quite the contrary. Do we really need to take additional risks? I'm not sure! It is better to put more ballast and getting back in the 75m is the most important thing!

Note: In the black square on the polar it's means "that part of the polar isn't on our flight domain

Ballast and "Curve" from Ballast:



For a week in Bulgaria, we had most of the wind time above 9m/s with peaks at more than 14m/s.

In these conditions, we realize that our glider cannot be a simple piece of carbon that drifts with the winds.

No, by ballasting it we can make it fit to fly in these conditions!

The ballasts are used to increase the wing loading of our models when the wind is sustained, making the glider more penetrating as possible. They must be quick to install in the glider to be changed quickly even in the corridor. Ideally to reduce inertia they should be as compact as possible. When the ballasts are too long in the fuselage the moments of inertia increase. Having a significant impact in yaw and pitching. Sometimes glugs that ballast in the wings have the advantage of increasing rolling stability when the air is very agitated. However, undeniable effects are felt in roll and in some cases in yaw when the ballasts are too long. I find it interesting to be able to ballast by 1 gr/dm2 to be able to adjust the weight of the glider fairly precisely. I have rarely felt a great impact on the glider's flight area by ballasting by less than 1 gram per square decimeter except for a placebo effect on the pilot.

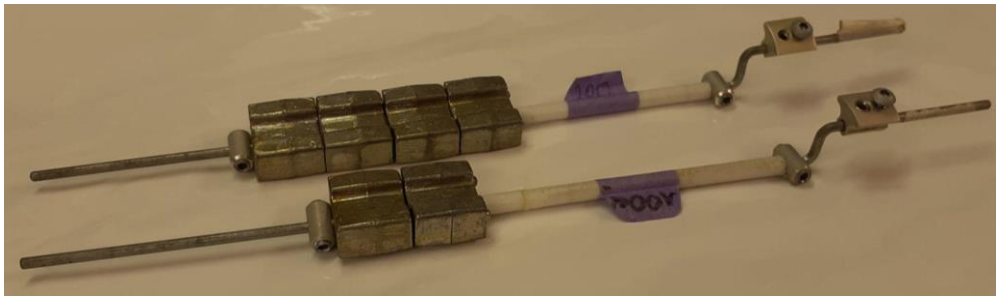
Some pilots want to use a "ballast curve," others don't. On the other hand, personally I find it interesting to have one, it allows me to ballast more serenely when there is a lot of wind and complicated conditions.

To achieve this, I will fly several times when the wind blows at 15km/h and then at 30km/h. I note at the end of each session which mass I was most comfortable with. That is, I have to be heavy enough to fit in properly, and be stable enough. Faced with the wind I do not back down but I am still able to move forward. I think the "art" of ballast is always to be as heavy as possible for the conditions of the moment. That is, it's better to always be a little heavier so never leave a little too light thinking "it's not going to change the face of the world". You never know how the flight will go, you may well need to be a little heavier to get back and forth. But if the wind drops the mass "excess" will not be a real problem to get into the thermal. On the other hand, you have to use this mass to climb faster by adapting the circling.

After a few sessions in these conditions if I got good results I average the masses obtained during these sessions to get the point at 15km/h and 30 km/h. Then I draw a straight one that passes between the two points of 15km/h and 30km/h. Then when I return to fly, whatever the conditions, I check to see if the mass of the ballast curve is good compared to my sensations. If you have the speed polars of the model you are using you can compare the fleece to your right. In my case I was always a little heavier than the speed polar.

The only variable that makes me ballast more or less in relation to the curve is the aerological activity ... The stronger the thermal, the more it is necessary to ballast. Because taking extra

mass is not a problem in this case, it is an advantage, it allows you to move better. It's useful when the thermals are strong and the disgusting ones are strong too! Conversely, the weaker the pumps, it is possible, but not necessarily, necessary to fly slightly lighter than your curve. So by betting on the fact that you will turn tighter in the ancestry, to stay in the heart of them, you will be able to fly slightly lighter.



Examples of two ballasts for plus X. here a 120gr and a 220gr. Here thanks to the fastening systems it is very easy to adjust the position of the ballast to get the right CG.

Part II: For the Competition:

In this second part, we will talk about the flight, the preparation for the competition and the competition itself.

Thermal

They are often given little names such as "thermal," or "bubble"

A thermal is you know, a column of rising hot air. This one drifts with the wind, which adds an extra factor, another one! What interests us in F5J is to be able to spot them, to leave as low as possible.

To spot them, smell them or see them, we have some tips. But before I tell you about my feedback, I can only advise you to watch Joe Wurtz's videos on this subject (available on YouTube in particular). To detect them, we have the feeling! Thanks to the temperature differences, depending on the wind. If it's hot, you're in or she's close to you. If the wind has just calmed down, it's good, it's there! Go for it! On the other hand, if the wind is cold and it is stronger for a little while then the thermal has just passed. Don't leave behind immediately! Another case, it's hot and the little gust happens because the thermal just passed behind you. So you have to go behind! Or the wind is strong and suddenly it cuts, the pump is definitely right in front of you!

Then, after feeling the thermal, we also need to know the meaning and direction of his movement. In the majority of cases, the thermal moves with the wind even though I have already seen wind (inversion layer in the higher layers).

Here, we can see the string of the fishing rod, doing the round back. It is a sign that a small thermal is at the level of Gilles and myself!

Then, to know their direction, you have to look at the prevailing wind, not the thermal wind. The thermal wind is the direction when a thermal attracts a large amount of air locally. While the prevailing wind is the wind which has a stable direction over a longer period of time. And that's how Joe Wurtz established the third Vector method. So this method is to look at the local wind and wind direction in an area relatively far from ours. Then, at the crossroads of the two directions there is normally the thermal.

We talked about one of the simplest cases. Now let's talk about bubbles. A bubble is not a pump, since it is not connected to the ground like a column of hot air. So the biggest danger

of a bubble is getting through the bottom of the bubble. If, by making a large spiral turn, you do not find the rising air then you have to transit to the next.

The uphill whirlwinds. There are phenomena that I call upward vortexes. They occur mostly near the ground. It's very similar to turbulence but travelling up. So, in this one, you have to turn as tight as possible to stay in the heart of the phenomenon. Using flaps may not be the right solution, I prefer to keep speed. It's easier to stay stable and agile to tighten the turn to the fullest.

Finally, the wave is the phenomenon that is certainly the most complicated to explain. In flight, it is not always easy to detect. It is an ascending area that can even move with the air mass. You have to try to move with this ascending area. If the phenomenon is present, you will have to exploit it. You must then adjust the mass of your model as best you can. So especially do not leave too light otherwise you will back off, without being able to stay in the phenomenon. On the contrary, if you are too heavy, it will be more difficult to exploit this phenomenon which is often of a rather low intensity.

Circling:

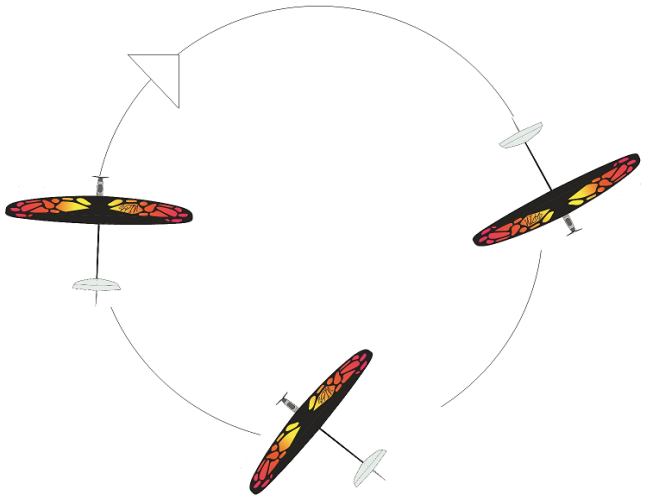
Birds spiral in the thermal to gain altitude, so it's up to us to imitate them!

For a glider what could be more normal than circling ! It's an aspect of flying that may seem simple, but it's not always easy. Who has never seemed to climb slower than another pilot? This has happened to me several times, often because my circling is not suited to the thermal. In other words, my piloting was not suitable.

Indeed, depending on the thermal, it is important to adapt the circling and its steering. Nevertheless, I think there are a few tricks to follow all the time. The circling must have a constant pace to avoid any energy-intensive recovery. What is certainly most important is that the fuselage is always in the axis of the spiral. That it never tends to be "in drift" In the illustration below you can see this. The glider with the best position is the one on the left. Its fuselage is well oriented in the spiral. It is in this position that the fuselage generates the least drag. The other two gliders do not have the right circling position. Indeed, in their positions, the wings and fuselage create more drag than if it were in the right position. On the other hand, it is better to have the nose of the glider in the spiral rather than outside. This will create a circling stabilizing effect when rudder is used profusely. So for the fuselage to create the least drag, it must always be well-focused in relation to the flight direction. It's the same problem, for circling sense reversals. For the reverse circle to be the most effective, it must be as fluid as possible, the cleanest. To do this, you have to roll the glider at the right time, then send drift to continue the spiral. The fuselage must always be well within the flight axis. So you have to be careful to use the drift well. If you put too much you will drop the nose of the model, so this one will accelerate. And use the fins sparingly to reduce the inclination. If you

counter too much, you will tend to pull the glider out of the circle (right glider is the one that represents this situation)

Illustration of the ideal position of the fuselage during circling.



Then, as I wrote above, you have to adapt the circling in the thermal. In a turbulent thermal , you must certainly give a little more speed to gain stability. You may need to tighten the circling to stay at the center of thermal again. If necessary, do not hesitate to take the inclination and speed to be able to climb in the thermal.

Nevertheless, you must also be able to circling as flat as possible, giving as few orders as possible and especially not over-piloting in order to be able to climb quickly in low thermals. To do this, you have to be as gentle as possible in your inputs.

<u>Preparing the material:</u>

Yes, you will tell me that our machines are necessarily ready! Well, no, no,

It may be important to check that nothing is damaged or that nothing has moved after many workouts. After these workouts, we can clean our machines. It is also important to empty your altimeters, to update the correct one if it has been changed for training. Normally, you had to think about registering your models for FAI contests (25mm minimum for letter height). Check the CG, if the registrations have been put away from it.

If you have the opportunity, consider taking some emergency electronics and other spare accessories that may be required during competitions. (Servo, propulsion set, LDS system etc...) Or check that your cone is a 5mm radius at the front tip (see FAI rule)

Checking the cone with a template when registering models at CDE 2018

Pilot Preparation:

At big football matches, for example, you can see the preparation of players, whether mental or physical! Then to us!

It is always beneficial for the driver to arrive serenely in a competition. This can go through rest before this contest or arrive a day before to make some flights on the field of the competition (but not too much ...). It is no longer time to adjust our machines in the competition grounds, let alone an hour before the start of the flights! Consider spotting the possible pitfalls of the terrain (Creux, ditch, pond, etc.), potential supports (level, trees, etc.), the surrounding crops to assess possible contrasts. It is also very important to relax before this event. It often has different habits to do this (micro nap, breathing, calm, but some drivers prefer to stay immersed in the atmosphere of the competition). A healthy diet in reasonable quantities to avoid bloating. Do not hesitate to hydrate, regularly (water...). And, the day before, a good night's sleep is strongly advocated to be at its maximum of its abilities on D-Day.

Mental preparation is often underestimated but it is very important. The difficulty of this preparation is that it is very personal.

It must be thought through to know each other, to know the needs we have or to know our fears ... Then, it's up to everyone to find the method that will allow them to arrive relaxed in the corridor to be at their best at the start!
For me, it goes through a routine, which becomes automatic, and that allows us to put things into perspective! For other people, breathing exercises are required, some pilots just prefer to "put themselves in the bath" a few seconds before entering the corridor. Thus, they are not stressed by flying long before. Everyone has to find the "trick" to be 100% of these abilities when the time comes, whatever the method!

*Sometimes it can be useful to have shoes on your feet if you need to move around to see the model that is very far*way.

Choice of models:

Before going to fly we often ask the question of the model we will take for the next flight. And it's not always easy!

To choose the model or models I want to use during the day or contest, I look at the weather forecast. According to the next hours, I choose the ones that will be the multipurpose. For example, 2x standard and 1x strong for a very windy contest. I remind you that throughout a contest you can only use 3 different gliders, of course you can change the parts of each model (in case of breakage for example). I do not hesitate to anticipate by putting together a model for which the conditions are not yet the best but which we may meet later depending on the weather. This avoids being caught off guard.

Here are 3 models ready for the competition.

Don't forget to check to see if all the moving parts and the engine are working well, but also if you've taped everything you need to be before you fly.

Nicolas Chansard who checks if all the controls of his model work well!

Coaching:

Very few pilots will fly without a coach, it's certainly that this one is of great importance and it has one! Even if the pilot is well prepared It's so hard to manage his flight perfectly on his own. That's why we're all going with a coach on the starting point!

Here, it is a very broad theme that can divide! Some want to be coached by only one person. Others prefer to vary the coaches to progress. I'm more of a fan of being coached only by people I totally trust and with whom I've already flown in major competitions!

To make things clear with your coach, don't hesitate to tell him or her clearly what you need during your flight. To simplify the management of the flight afterwards. It should not be forgotten that the coach is the eyes of the pilot when the pilot cannot leave his glider with his eyes. Under no circumstances should the coach make decisions for the driver (except junior very young)! The coach must not transmit negative waves to the pilot, but he must be as frank as possible to avoid any misunderstanding.

During the preparation the coach and pilot must exchange as much as possible about their strategies so that both work in the same direction!

During the preparation time the pilot and his coach must discuss the aerology of the moment but do not decide too early, the conditions sometimes change very quickly. It is very common that 30 seconds before the start I do not yet know where I will go because the lift I felt is not well marked.

I noticed, after a lot of competitions, that the coach has a role essentially in the first 30 seconds. That is to say that the pilot must be able to clearly indicate to his pilot his altitude in relation to the rest of the pack of gliders and also indicate his position in relation to other gliders. And why not, the strategy of the other competitors.

Then, if the upstream detection has been good and confirmed during engine running time normally you will find the thermal without too much problem and the flight will be easy. Otherwise the coach will have to try to indicate the best plan “B” to his pilot if possible close to the area in which the glider is flying. Thanks to temperature differentials, wind speed, lighting, 3rd vector.

After that, I really like that my coach is able to point me to a side to go home when I leave to fly in the wind. To avoid going back to the side where I am likely to encounter as much disgusting as possible that could endanger the return of the model in the 75m around the target.

Managing the competition itself.

Yes, we've all wondered how we're going to manage our contest according to the weather or our ambitions?

I think the first thing to keep in mind is that you have to take the flights one after the other. It is not always good to want to look at the contest as a whole (additional pressure or vice versa). Just because a contest started badly doesn't mean it's over! On the contrary, it is only when the last flight is over that the result will not change, not before!

Risk management is a very complex issue for which several factors are considered such as the weather conditions, the objectives set during the competition, the part of the competition (qualifs or fly-off) ... From now on, I assume that we have to take the most points all the time. If conditions permit, you have to go! If it is possible to cut to 30m you have to go, and the goal is always to try to create a gap with the 2nd of the round. What for? We don't know how the rest of the contest will go so we might as well try to get all the points from the start. On the other hand, do not go into binary mode 0 or 1000. It is easier to fly at the end of the competition to fly-off, rather than having to take risks to get into the fly-off. On the other hand, if the weather conditions are disastrous and you have to climb to 200m then don't hesitate! In extreme conditions, it may even be interesting to cut a little above 200m to pass in a higher layer, more favorable to hope to land last. You have to make the right decisions at the right time, to be able to win the round and the contest.

With the current level, I would say that the 50 points to the target is no longer an option because the vast majority of drivers will be the target. So not making the target is very penalizing. For example, losing 50 points to the target loses 80 points in the 1000 ratio! However, in qualifying, it is not necessarily necessary to want to play the last second or risk

making an Over-time and lose all the target points for 1 or 2 seconds of flights (80 vs 3pts). For the cut height if you want to make a good run (± 980 pts) you have the right to cut 20m above the lowest, refuel and target!

If you have the opportunity to have the results after each round, be sure to check that your score is consistent with your flight to avoid any errors. And don't forget to sign your flight ticket after checking it out. If you do not agree with the timekeeper (error, penalty, etc.) do not sign your ticket and ask the contest director to clarify the situation). Having the results can also allow you to refine your strategies in addition to the flight laps (if you fly against the 1st and you are 2nd why not try everything for the whole and maybe go ahead?)

Start a round! It's beautiful all those models that leave at the same time! The models all go into the hypothetical lift that was detected by the pilot.

Flight management:

I am confident that flight management begins before the preparation time, when you leave the storage area of your models. You have to choose the right one and even choose the ballast that you are going to put or not in the model?! For example, you have to think about not forgetting anything. To help yourself, you can memorize small checklists.

Then when you are in the corridor, that is when you can get a fairly accurate idea of the conditions of the moment. To decide the strategy to adopt (low, medium, high cut) but also where to go? In which area?

When the "buzz" of departure sounds, it's gone, you have to go where you planned. You have to think about using the 30s motor entirely. After the engine shutdown there are two possibilities: either your detection was the right one, you are in the lift, everything is fine, or you are not in it you have to move to a better area. Nevertheless I strongly advise 20s to move without knowing where to go. Also, embarking on a very large transition can be a very bad idea if you have no idea of the position of the life-saving pump. It may be interesting to start by exiting the descending area and heading for an area that may be conducive to the triggers of ancestry.

Do not hesitate to change the rhythm, the direction of the spiral, etc. to always stay as much as possible in the heart of it. You will therefore need to be very attentive to your glider's behaviour. To feel the best, pump and quickly climb into it.

Once you've gained altitude in the pump, you're going to have to go home to make the target or look for another ancestry. So I advise you to always go back to the side with the highest probability of encountering air. For this, we can use other models, the 3rd vector, temperature differences, wind speed etc. Making more distance can be much safer than trying to cross a bad patch for example!

To make the target, I can only advise you to have a routine. This makes things much easier especially when the flight has been stressful, the nerves would tend to let go too early. Personally, I prefer to get high, in the axis of the target and manage the distance and height to the AF by making landings. This can have the advantage of avoiding and preventing collisions, always arriving well in the same crosswind axis. For the rest, everyone manages to get the 50 points of the target.

The pilots and coaches of the France 2018 team, when they watched the previous flight before going to fly!

I hope to have swept away the majority of the topics dealing with F5J and competition. Thanks to JB, Guillaume.P, Fred.F, Hervé.C, Marc.H, Marc.P, Anthony.R and my loving mother for helping me write this little opus! Thank you vey much Josh for your help to translate my opus!

Adrien GALLET.