A wedge-tailed eagle takes dead aim at a Bird of Time over Mount Terrible in South Australia on May 9th, 2021. (image: Allen Moore)

# In The Air

## Are those dark clouds gathering on the horizon?

Terence C. Gannon Follow
May 3 · 9 min read

My first RC sailplane was a *Boss T* designed by Seattle's Don Burt of *Superior Flying Models*. Along with my older brother, I mowed lawns to abstraction in the early 1970s just so we could eventually fall slightly short of the money needed for the SFM kit, accessories and associated Heathkit GDA-1057 radio control system. Our parents faux-begrudgingly plugged the remaining financial gap and after countless hours in the 'shop' (actually a corner of the bedroom my brother and I shared) we emerged with a pretty fair example of the type. We took it out to the expansive athletic fields which still lie just east of Thunderbird Stadium on the University of British Columbia campus. We stretched out our high start and simply started flying. It wasn't without incident, but generally it was a successful enterprise. Dad (RIP) admitted years later that he 'just about had kittens' every time we launched that thing. It did set the hook for a lifelong fascination with the pursuit, so it seems like it all worked out well in the end.

I share yet another personal anecdote — as if you haven't heard enough of them already —to underscore the point that there was little, if any, 'paperwork' required to make all that happen. I think we may have taken out a license for our 72 MHz radio but probably let it lapse once the renewal came up and we couldn't afford the fee. Or more likely spent that money on *Hot Stuff* or *Klett* hinges to replace the ones where the pins fell out into the shag carpet in our bedroom and were irretrievably lost. But the last thing we even thought about is whether it was OK for us to go flying out at UBC. We just did. We used our heads, though. We never attempted to compete with *actual* athletics on those fields. If the *Thunderbirds* were scrimmaging on the pitch we either waited for them to finish or simply came back later. Once it was finally our turn, the only 'heat' we ever attracted was by the unarmed, disarming and oft-portly UBC security detail who had their hut just to the east of the fields where we used to fly. If they paid any attention at all — which was almost never — it was just as likely to ask 'so where do you get one of these things' or 'what is the range' as opposed to wanting to see if our licensing was completely up to date and in order. Truly, it was a simpler time.

I fear, however, that those days are gone forever. The two-edged sword that are drones, along with those who insisted on flying them too close to airliners, put paid to that forever. Around the world, the reaction has been to institute various forms of regulations which while not specifically aimed at RC model aircraft, has swept them up anyway. It's a fact: we are entering a new era of regulation that will have a direct impact on how we pursue this activity.

However, before I go any further, I want to short circuit any discussion — either **for** or **against** — with respect to the validity of the imposition of these regulations. In other words, whether they **should** or **should not** happen. It's a perfectly valid point to discuss, but it is likely going to generate more heat than light and there are lots of places to have that discussion. Just not here. And, candidly, it's likely that ship has already sailed anyway.

Age has made me a realist. When I was a younger man, I was prepared to fight city hall. As I get older I would like to think I have lost none of my fire to 'fight the man' but a perceived, growing shortage of time has made me more realistic. To accept the inevitability of some things and then simply figure out the best way to deal with them. So it is with the talons of the state which are descending, seeking to pluck our carbon fibre goodness out of the air. Consequently, I assert there are three things which are likely to occur in the future, for all of us. These *opinions* are based on an admittedly cursory review of the first iteration of regulations from various jurisdictions around the world:

1. There is likely to be light-to-no regulation of any aircraft which weighs less than 250g or about 8.8 ounces. For the foreseeable future, if you're flying with a plane that fits into this weight class, it will be the closest thing to the days of old out at the UBC flying — er, athletic — fields. Find a decent landing zone and lift band and just fly. Subject, of course to your city banning flying model aircaft in city parks, as some cities do, for example.

2. It will be possible to designate certain areas — your club's slope site, for instance — as a place where model aircraft are routinely flown. Once designated as such, it will be possible to enjoy the lift zone more-or-less the way we always have. The burden, of course, will be getting your favourite flying site designated in that way. I'm assuming that this will all be front-end loaded work that once completed, won't have to be done again. After that designation is received, however, your favourite flying site will have its rightful place in the national airspace and we can go about our business much as we did before. Within the boundaries all that hard work determined, of course.

3. The third reality — and the most draconian by far — will be if your activities don't fall into one of the previous two categories. This is going to involve some sort of contrivance onboard your aircraft likely accompanied by more contrivances on the ground all of which are intended to automatically and precisely report, in real time, the position of your aircraft — **and maybe the pilot's position, too** — to the national airspace system. Think that the regulations will differentiate between a rogue, multi-rotor photo drone from your cream puff *Bird of Time*? Think again. We're all going to suffer the same regulatory blunt force trauma.

You are free to disagree with my assertions above. You'll notice, though, I have cleverly avoided being too specific about anything because the details are really not the point. Also, they will undoubtedly vary somewhat from country to country and likely over time, as well. The real point is that assuming that the assertions I have made are roughly correct, where does that leave us, exactly?

Surprisingly, I think it creates some interesting opportunities. The first which comes to mind is what I'll call the *250g Grand Challenge* (#250GC perhaps?) That is, what is the absolute best that you can do with that one, simple weight limitation? F3K machines would seem to be there already or close. But what about those F5F speed demon devotees out there — can an aircraft be designed that would provide the same kind of thrill but still fit in under the 250g rule? The *MicroMAX* reviewed by Pierre Rondel in the March RCSD seems to be trending in that direction. Perhaps there is room for some design competitions? Perhaps there have already been some of which I'm simply not aware?

The second, of course, is for entrepreneurs to be thinking about the best and least expensive way of addressing 'the third reality' requirements mentioned above. This is an area where I am totally out of my depth — I hope that someone who is an expert in the field might write a future article? — so I won't spend a lot of time trying to convey expertise I simply don't have. On the other hand, if all the time and trouble has been spent getting compliant, what things might it enable in the future that might present interesting challenges. BVLOS (beyond visual line of sight) cross-country racing is one thing which comes to mind. The other is long distance dynamic soaring such as practiced by those astounding pelicans and albatrosses to whom it comes completely naturally.

OK, I had better wrap it up before you, dear reader, think I have completely lost my mind. But I would love to hear your thoughts on the above. Please consider writing a response to this below — it will be welcomed. Or, better yet, dive in and write an article (or two) for a future issue of RCSD on these subjects. One way or another, this thing we do that we love *will* continue. I'm confident it will simply adapt to whatever future reality is out there.

You can watch the entire story of Allen's day at Mount Terrible in his latest video which is well worth watching. (images: Allen Moore)

We have another great issue which almost contains too much to mention here, particularly given I have already spent quite a bit of your time already.

In addition to the continuing and very welcome contributions of James Hammond and Pierre Rondel, we have a few additional treats in store. Off the hop, there is the first of a three part autobiography by Bob Dodgson, the legendary sailplane designer and manufacturer of many outstanding aircraft in the 1970s, 80s and 90s. Even if you've read a version of this story elsewhere, we've added something unique to Bob's words which we think you'll enjoy.

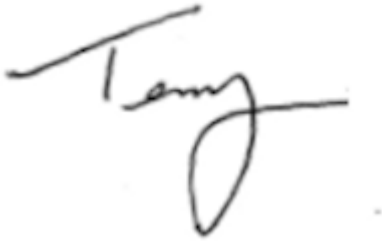
We also have the second instalment of Norimichi Kawakami's build log for his magnificent *Mita Type 3.* It is one of the most meticulous journals we have ever seen and we present it both in its original Japanese as well as an English translation.

Next, we are relaunching the legacy *RC Soaring Digest* regular feature entitled *PSS Candidate.* It provides details on a full-size aircraft likely well-suited to power scale soaring. But here's a twist: this particular article is written by the designer — and he's prepared to take your questions. You simply *have* to check it out.

We are also joined this month by the man behind the very popular *RC Soaring Diaries,* Michael Berends. We're delighted to have Michael aboard as a regular contributor where he provides some of the 'inside story' not in his videos.

Plus we have Tom Broeski back with another one of his brilliant tips, Peter Scott talks onboard computing power and, as usual, you may find a couple of additional surprises thrown in there for good measure. Thank you *so much* for reading, I hope you enjoy this issue and until next month…

Fair winds and blue skies!



*The gorgeous cover photo for this month's issue was taken by Laurent Ducros at Ménez-Hom in the Brittany region of northwest France on May 13th, 2021. The aircraft is a Polish* Mucha *design which was built by pilot Quentin Philippe and his father Paul during the first COVID lockdown in 2020. It took three months to build. The radio is full Jeti with MKS and Graupner servos. Laurent reports that day was made complete by "beautiful weather with wind from the northwest, 4/8 clouds and great thermals." Thanks, Laurent, for the opportunity to present this beautiful work. Now, we'd be honoured if you turn to the **first article** in the May issue or go to the **table of contents** to find the exact article for which you're looking. Downloadable PDFS: just this article or this entire issue.*

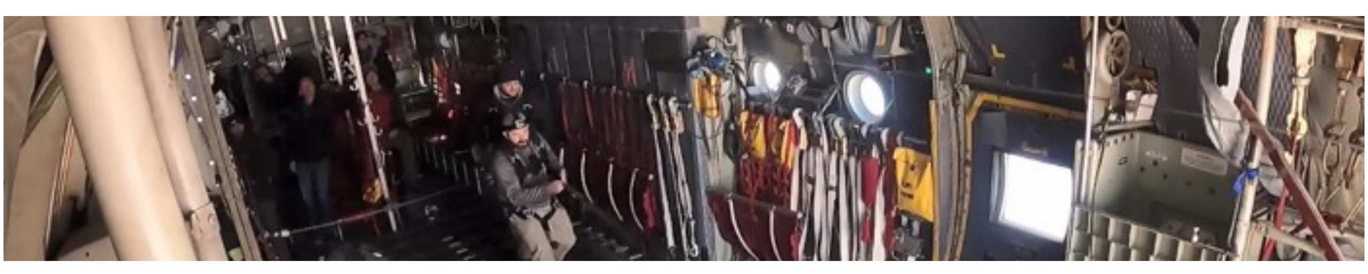
The view aft from the host C-130 'Hercules' as the Silent Arrow starts on its glide to the target.

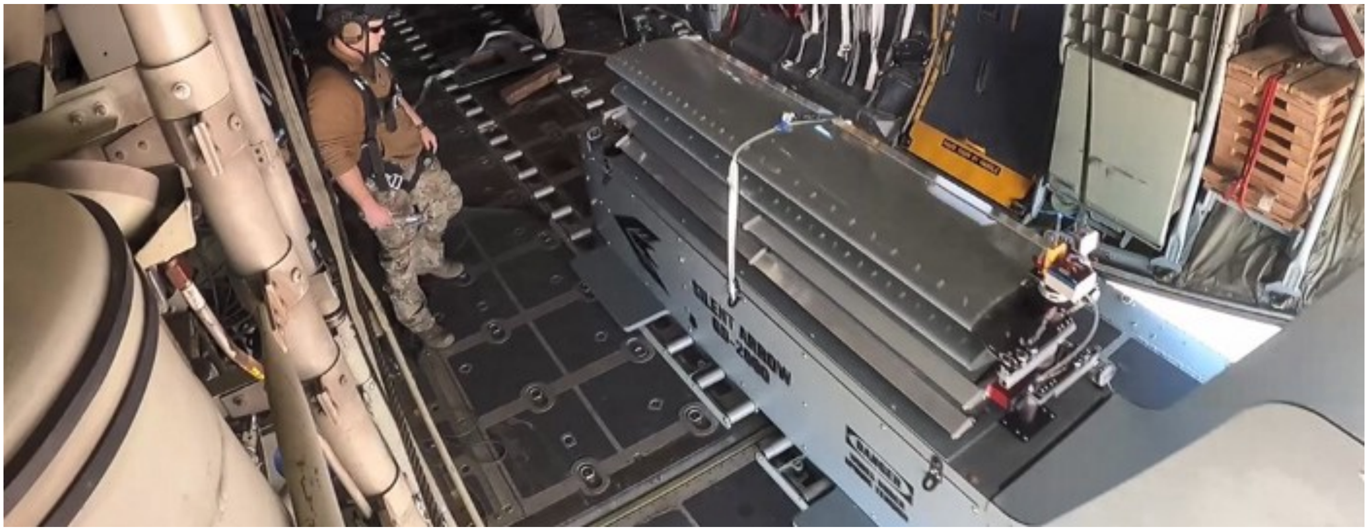
# Silent Arrow Passes Next Phase of Testing

Recently declassified images of the groundbreaking cargo carrying glider reveal C-130 tests in the desert.

The NEW RC Soaring Digest Staff Follow
May 14 · 2 min read

Updating a story we first reported in the February issue, Chip Yates of Yates Electrospace provided these recently declassified images and video to RCSD.





C-130 ‘Loadies’ get ready to “kick [the Silent Arrow] out the door”.

He also provided the brief comment: “C-130 Silent Arrow deployments carrying a record-setting 1,000 pounds of emergency cargo, rigged as a CDS [container delivery system] bundle, loadies kick it out the door, wings spring open and *Silent Arrow* turns away on course for these completely autonomous flights. Proud of this team!”

The Silent Arrow looking back at the C-130 from which it recently departed.

In the next image, a camera mounted on the *Silent Arrow* looks back at the C-130 just to the lower left of the sun. Chip also provided the short video below which more clearly illustrates the *Silent Arrow* concept.

RCSD will continue to track this fascinating project so we can bring updates to readers. We hope it serves as inspiration for other similar commercial projects which are clearly 'RC soaring adjacent'.

Also, Chip Yates has committed to a future article which will go over the project in detail. But that will have to await some downtime for him which, based on these images, we think might still be a ways off!

A short video edit of the recently-concluded C-130 deployment tests.

 *Also, did you know that we actually carried this breaking news on our Twitter feed a couple of days — follow us there for early access to all sorts of exciting stories. Now, read the* ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents****. Downloadable PDFS: just this article or this entire issue.*

Greg Dakin doing a little grass trimming with a UK Team Redshift. What compression band? (image: Mike Shellim)

# Designing for a High Performance 3M Racer

## Do you feel the need for speed?

James Hammond Follow
May 13 · 17 min read

*In this instalment of my four part series, I'm going to go through the basic thinking and outline design process used for my high-performance Redshift 3M model, and this is why there are so many references and pictures of it only as I don't really know how others do their designs. I'm not going to call my design an F3F Racer per se, as I think it has a far wider flight envelope than just hard, repetitive competition use so, let's just call it a 3M Racer. Though some if it may be a little controversial, these are my ideas and given honestly. Now actively developing the Redshift Mk II Spada version, I hope that this article will help to give you an insight into the thought processes behind where I was going, and incidentally still* *am, on the model's design evolution. I may reiterate or repeat parts of previous subjects here and I hope the reader will forgive me but the recapped points are important and relevant to this article, and in any case, I can never tell who has read my previous work. Hopefully it won't be too boring. — JH*

## First Thoughts…What Do I Want from a 3M Racer?

Development. I have a few 3M Racer designs already under my belt and there is nothing like learning from a previous design, so with that in mind; in order of appearance — I'd like to see: outright straight-line speed, great acceleration, fast controllable turns, overall agility, light or heavy air capability and convenient ballast adjustment all wrapped up in a good-looking package, and let's not forget strength and toughness. Actually, most of those requirements are complementary, and with the knowledge we already have under our belt, none of them cancels out any other, which is useful.

## Let's Get Down to It — What Do We Already Know?

### Wing Span

Well it's called a 3M racer, so it may as well be a 3M (120") racer — but why? Over the years this kind of model has gone from slightly longer flying surfaces through phases leaning towards slightly smaller wing spans. The thinking has been that a slightly larger span could fly in lighter air or maybe carry more weight and still be FAI legal, while a smaller model can be more agile and turn faster, and each is undoubtedly true — though which is the more valuable, performance-wise could be something of a dispute. But the mean tends to remain close to 3M, or 120-inch span and that's what I have found to be the best size. So, lets kick off with that.

> Takeaway: There are an awful lot of Racing models out there these days, all close to the 3M benchmark. Ergo: Unless many of us are wrong, 3M is the best size for the job.

**Photo 1**: Greg Dakin readies his model under supervision from the admiring (I hope) usual suspects. (image: Mike Shellim)

### Lift

With a 3M racer its absolutely essential to get the lift pattern distributed along the wing in the places where you need it, and ONLY where you need it. There really is no point at all in having large chords out near the wingtips. It's not needed there and it can actually be harmful to the overall performance at both high *and* low speeds. Just like an Allrounder slope model, the 3M racer needs to have a planform that optimized for its job — only even more so, as some of the 'wannahaves' on an Allrounder become 'gottahaves' for the 3M Racer. The most important Gottahaves are straight line speed, fast, crisp control response in three axes, energy retention in turns, and out of turn recovery acceleration.

To recap a little from the last article in this series, we need lift to make our model fly, and we know that lift can easily be swapped for speed, but there is a balance needed here. We know that we need to optimize the planform shape in order to have an elliptical lift pattern span-wise across the entire wing with the most lift close to the fuselage, and the least amount at the wingtips.

We have also learned from the Allrounder design that while a true ellipse might be great for the lift — at least in theory — it's actually not so good for model flying qualities. What tends to happen is that the Mean Aerodynamic Chord (MAC) and the Centre of Gravity (CG) can find themselves too close together, which can lead to instability and a tendency for the wing to stall if even mildly provoked. Conversely, separation of the CG and the MAC by too much, can lead to over stability and sluggish control responses. We know that a true ellipse that extends to the tips will bring problems, plus we know that the pesky chord distribution might also have an effect too. As on any self-built model aileron chord and span problems are OK because we can deal with them after the model is made.

**Photo 2**: Lola Chen our Office Manager with a newly arrived model. (image: Julia Liu)

We need to control the wing chord size to limit it to what is needed to put the lift in the right places. I also need to control what happens at the tips. So, putting those together, just like the Allrounder, I come out with an elliptical shape but with the rear (Trailing edges) pulled back to make the rear curve flatter, and the front part (Leading edges) more bowed — so that should sort out the MAC Vs CG problem very nicely, but I'll still keep my elliptical lift pattern. For the tips we'll just cut them off and give a more focused and controlled point for the isobars to depart in a more organized manner. A bit like sweeping the wings back on the straight-edged model, I know I am going to give up a bit of pitch and roll maneuverability, but I'll gain stability and control, and best of all limit the tip stall possibilities.

## Wing Aspect Ratio

This shot shows the Redshift's 19:1+ aspect ratio — pretty high for a racer. (image: Julia Liu)

This is an important if not critical part of the wing planform design that at least on my designs plays a large part in the flying quality and speed potential. The Redshift is designed at over 19:1 aspect ratio, where many of the older designs are around 16:1. On my model this is no accident. I have said that putting the correct amount of lift in the correct place is possibly THE most important part of a racing model design. Having broad chord wings will not help with anything except the ability to carry weight. The model needs to be able to carry weight up to the FAI limit of 5Kg in total weight with a loading of less than 75 $g/dm^2$ and no further than that, Ergo: having really large wing areas will not help anything except the ability to fly really slowly in very light winds. My problem is — and maybe I'm wrong — I don't design racing models to fly, slowly…in really light winds… To be honest, if I encounter that kind of conditions, I know there will be no race, and the model will stay in the car anyway. Large wing chords and carrier deck wing areas are simply not needed on a racing glider and at 3M span will only slow it down.

**Ailerons**

From the Allrounder design we know that the tip shape and the position of the ailerons is also critically important. An elliptical or rounded tip shape is likely to cause a lot of trouble as will ailerons that end too close to the tips. On a racing model expected to perform fast, tight turns any disturbance at the extreme ends of the wing is a recipe for disaster so it's good policy to keep the wingtips clean.

> Takeaway: The importance of a well designed and developed wing planform cannot be over-emphasized on a 3M racer.

> Takeaway: Put the lift in the right places.

> Takeaway: We don't want the problems with the wingtips so keep them clean.

**Photo 4**: Redshift waiting for a maiden at Tick Point Ca — along with a Schwing 88 and a Stormbird 2M — a couple of my other designs. (image: Julia Liu)

## Aerofoil

I don't know if all would agree with this, and I suspect that many will not, but as I have said, this is how I do it: There are many aerofoils out there. Unfortunately, there are also many that are "proprietary" or "secret" — there are even those that are available for a price (!) I hope you will forgive me, I but strongly oppose this doctrine for two reasons:

1. I'm a commercial model aircraft manufacturer, but I maintain that it's not in the true spirit of aeromodelling or progress in model design to restrict the information because of commercial reasons. It's not only about the money, guys.

2. Over the years much progress and a hell of a lot of fun has been had due by sharing information. I'll say it again: I am a commercial model sailplane designer and producer and yet I still admire and always do my best to help those who want to design for themselves, and that includes open-source availability of my aerofoils.

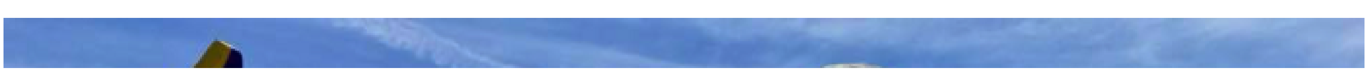


**Photo 5**: John Phillips is looking happy — he's just got fastest time at one of the Eurotour events. (image: [tbd])

### The Best One?

I'm sure that this is going to be controversial but anyway. This is a myth. There is not and never can be a "best" aerofoil as the way that the aerofoil is used and is positioned on the wing has such a huge effect. Good ones? — Yes, Great ones? — Probably. Best one? — Nope.There really is no one killer aerofoil that will blow all the others away, nor will there ever be one.

### Why?

Problem is we demand a lot of different things from our aerofoils and some of those demands influence others, so at best we end up with a bit of a "Jack of all trades" — even if we are lucky enough or smart enough to come up with a good one. Some work better in outright speed, while some work better in the turns, just as some carry ballast better — which is better?

### Is the Aerofoil the Most Important Component of a Fast Model?

This is where I will get into trouble, but the answer here is no. It's an important contributor for sure, but not the most important part of the whole. Having a good, fast, responsive, low drag aerofoil working for us is very important, but not the key.

*Fact*: Wing planform, or how the (good) aerofoil is positioned and thus the lift distributed over the entire wing is far more important and influential. Yet, surprisingly many people think that the aerofoil is the single biggest deciding factor in deciding what's a killer plane versus an "also ran" Logically it's really no good having a super aerofoil if it's distributed in the wrong positions across the wing, because however good it is, it just can't do its job properly.

**Photo 6**: Wayne Flower of Aloft Hobbies flying a Redshift at Tick Point, California—that was a gorgeous day! (image: Julia Liu)

### So, Let's Look at a Couple More 'Digital Myths'

*Fact*: Yes, some sections may be better than others when compared on a computer simulator, but the actual flying difference is slight and not enough to give any kind of clear advantage. There is in fact little practical difference in performance between most of the more often used aerofoils — and I have lost count of how many I have wind-tunnel tested over the years, so I can promise you that this is true.

*Fact:* Computer simulations may give some idea, and can help to compare one aerofoil against another to some degree, but believe me folks, it ain't necessarily so. The results that you get on a computer simulator, and it doesn't matter which one, can be quite different to what the aerofoil shows in wind tunnel or even more accurately, flight testing. Just think about it, if computer simulations were perfect, or even in the ballpark, then why would organisations like NASA spend so many millions and millions of dollars constructing huge wind tunnels? Has anyone ever seen the test unit at NASA Ames? You can lost in there.

A good example of this digital world vs real world phenomena is a series of profiles that were specifically designed for use with flaps some years ago by a well-known and highly respected designer. When tested on a computer simulator they did not show up too well, in fact the results were possibly below average. But — put them in a wind tunnel, and more importantly on an actual flying model and they were really good.

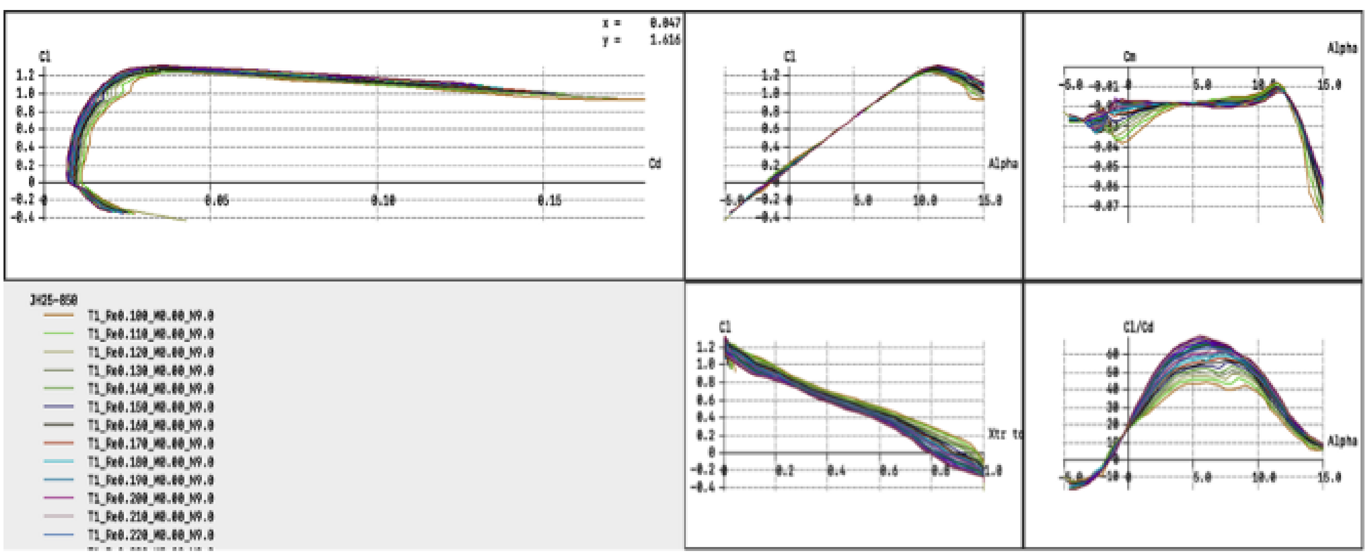



**Figure 7**: JH25 curves — this is a good all-round section especially designed for racing.

## Why the Difference?

First, computer testing is done in a digital, number-based bits and bytes environment and not in actual gaseous air. Yes, all the numbers can be manipulated to simulate different linear conditions, but the big problem is, we don't fly in different linear conditions — we fly in constantly varying conditions.

In a computer simulation the digital air flows smoothly over the digital section and the results are displayed digitally according to the parameters we input.

But, on the slope the nonlinear air flows erratically over our physical section.

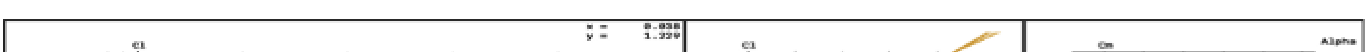
On just one pass, observing his model's behavior, what passes through the controlling pilot's mind could be:

- more lift on the right side?
- more compression?
- thermal coming though?
- too close to the edge?
- climbing slightly?
- diving slightly?
- Whoops…too close (MOM).

All of these variables in most cases would result in small correcting control inputs… therefore the aerofoils spatial position changes constantly. This is reality.

**What's the Solution?**

In fact, the aerofoil needed will be very similar indeed to that required for a slope Allrounder, so to recap: What's required is a semi symmetrical section (not flat bottomed) with a thickness of between 7.5% and 8.5% — and a camber of around 1.8% to 2.5%. This is the sweet spot. Why? because at this thickness the camber line of the section will have a good curve, and will create enough lift to carry ballast if needed, and it should still be quite responsive.



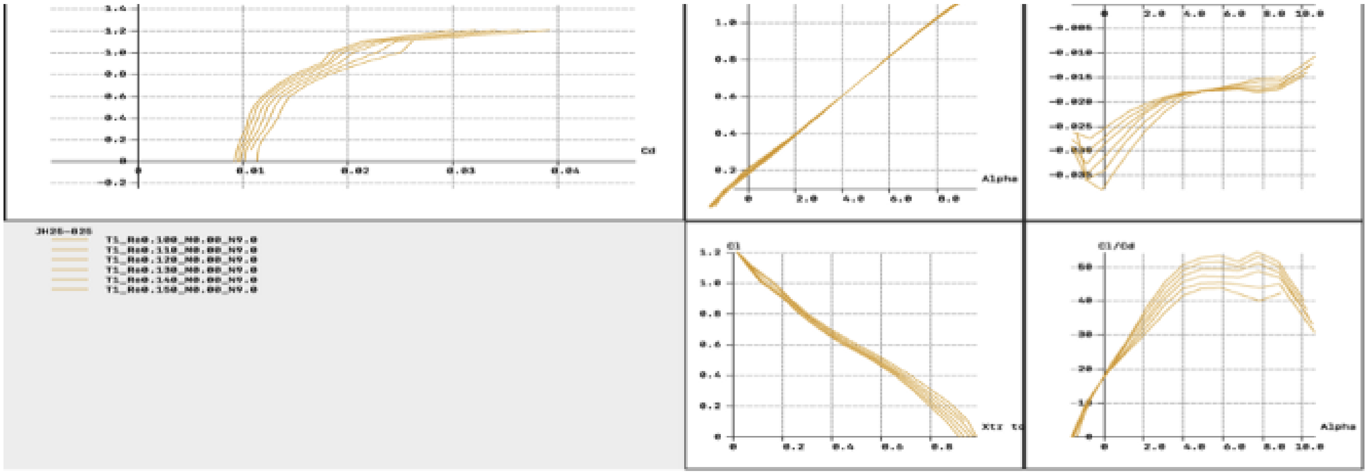



**Figure 8**: JH25 Curves.

At this thickness range the section can deal with a large variation in model weight, yet its thin enough to be low drag, while still being thick enough to be structurally viable and capable of withstanding high aerodynamic loads. There is no point going below a thickness 7.5% because there will be little or no advantage on a slope soarer, and even possibly a loss of performance due to the wings having to be strengthened and made heavier to compensate for the lack of structure. By the same token there is no point in going over 8.5% as the extra lift is simply not needed, while the drag escalates pretty fast with thicker sections.

Last but not least: any modern aerofoil with a decent alpha performance does not need any rigging angle.

> Takeaway: Don't think that the aerofoil selection alone is the ultimate path to a fast model. Wing planform is far more important.

> Takeaway: Don't believe that a computer simulation is the ultimate selection process. A computer selection is only a guideline — the actual

performance of an aerofoil in flight could be quite different so talk to people who know.

Takeaway: Choose a nicely proportioned aerofoil between 7.5% and 8.5% to get the best overall performance from your model — look at what others are using.

Takeaway: Sections like the RG15, MH32, My JH25, and JH35, some of the HN sections, the HQW sect ions all fit the bill

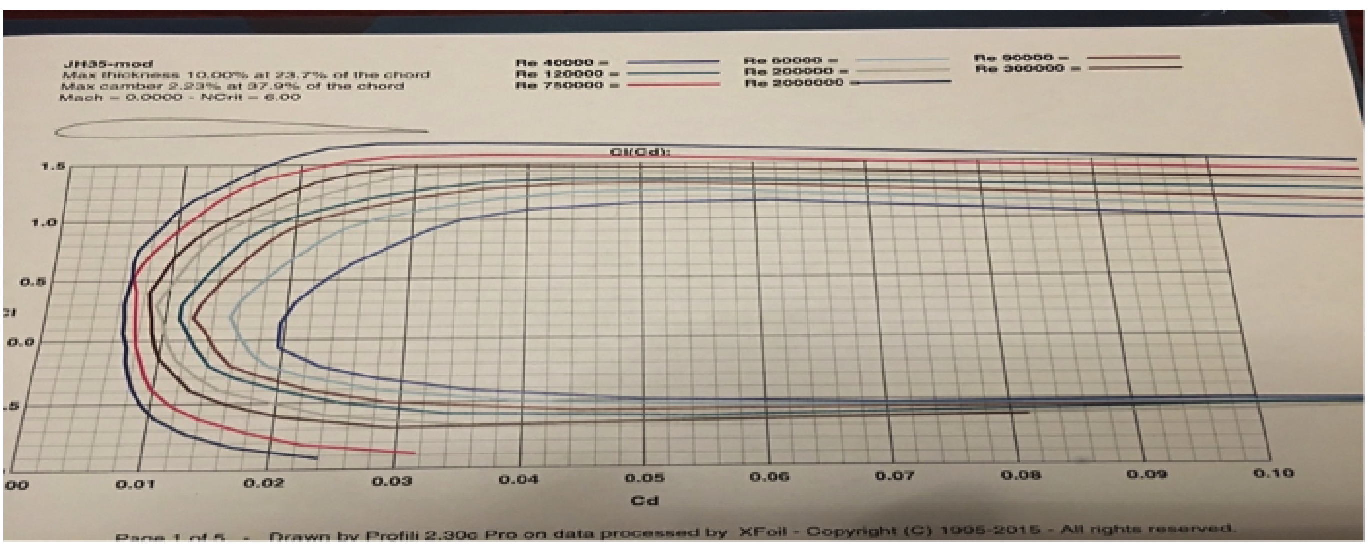



**Photo 9**: More of an Alpine soaring section, this is the JH35.

Here are some Lift Vs Drag curves for the JH35, an aerofoil that I designed for the Alpenbrise alpine soarer to give low drag with high response to control inputs. For this section, the flaps and ailerons are designed for a 25% chord position. Flight tests will tell if it works as well as I hope it will.

## The Back End — To Vee or Not to Vee, That Is the Question

The other obvious variable throughout the years of racing sailplane design has been the backend configuration: That old cookie, X-Tail or V-Tail? Both have advantages and disadvantages so, in case you did not read it, let me hark back to my last article in RCSD:

### V-Tail

*Good*: Less pieces/joints so theoretically less drag, can be helpful in stabilizing the model in strong winds, and less chance of landing damage. Also: Fashionable — I kid you not, this is also a big reason for the V-Tail

*Bad*: Loss of much of the rudder control, slightly less stabilization surfaces control effectiveness overall, little or no drag advantage in practice as the inputs need to be greater for the same model responses, not so good for nice aerobatics as the control forces can be in the wrong directions.

### X-Tail

*Good*: Better overall control, little or no actual difference in drag, decidedly better for nice aerobatics.

*Bad*: Not fashionable, more pieces so theoretically more drag, more risk of landing damage.

X-Tail, V-Tail, the choice is up to you. I have done both types through the years though many of them were back in the days where personal "one-offs" or friends group builds were the only option. But if I was asked which type is better for a racer, I'd go for the X-Tail every time due to the more open and detailed flight envelope that this type allows.

*Fact:* The world FAI F3f record has been repeatedly set and broken here in Taiwan on many occasions now, by the famous and talented "Mr. O", flying a special version of the Needle — an X-Tail racer. Alas, as a commercial model aircraft designer I have to bow to the biggest influencing factor here and that is fashion. V-tails are fashionable at this moment, and while many things can be displaced by logic, fashion is not one of them.

## Stabilizer Shape

Follow the wing shape that you have used as much as possible — this is not only for looks, but also effectiveness as the things that we have discussed for the wing shape are all valid for the Stab too.

> Takeaway: Both X-Tail and V-Tail work and both have tradeoffs — which one is better for you?

> Takeaway: Secondary considerations are the Stabilizer aerofoil to be used, and its span, plus V-angle and area.

**V-Angle**

Normally anything between 100 to 106 degrees seems to be the norm. I use 104 degrees because I'd prefer to err more on the side of elevator effectiveness rather than rudder.

**Stabilizer Aerofoil**

A low drag symmetrical aerofoil of between 7 to 10% is required. For all my recent models I have used my JHSYM-10 aerofoil, and recently the JHSYM-9 at a controversial 10% and 9% thickness respectively — more thickness than most people would go for, but there is method in my madness. Through testing the aerofoils WITH elevator movements, I quickly found that the thicker aerofoils actually have less drag and more control response than the thinner ones.

**Stabilizer Area**

Remembering that a V-Tail — if used — will need to do the job of horizontal and vertical stabilizers, if you make something about 17% to 20% of the wing area, you'll be on safe ground. In this range, the Stabilizer will be big enough to be effective, but not needlessly over large. Too small and you will need to make a lot of pitch adjustments and too large actually has the same effect as the model will be over-stable and then needs to be forced in pitch. On the MKI Redshift I erred on the side of smaller tail area — which eventually turned out to be a mistake as under some conditions the model was marginal on pitch and yaw control.

**Photo 10**: Redshift MKI tails. (image: Julia Liu)

**Stabilizer Shape**

It's a good idea to follow the wing shape that you have used as much as possible — this is not only for looks, but also effectiveness as the things that we have discussed for the wing shape are all valid for the Stab too.

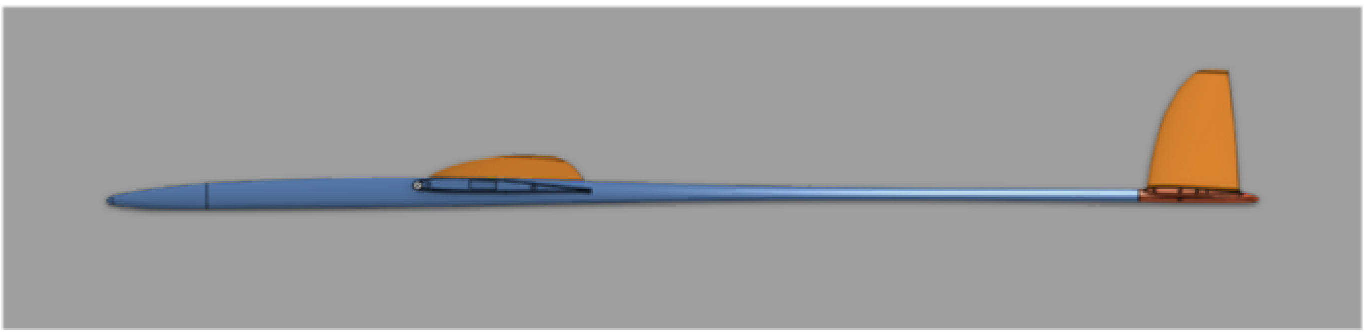
> Takeaway: Thinner aerofoils do not necessarily have less drag, and may actually lessen control response.

> Takeaway: A tail volume of between 17 to 20% of the wing area will work well.

> Takeaway: Elevator setups work better than AMT type.

> Takeaway: V-Tail or X-Tail, make the Stabilizer shape similar to the wing shape — the same rules apply.

## The Fuselage



**Drawing 11**: Redshift Spada Fuse. The eagle eyed among you will notice that there appears to be a rigging angle here, but actually there is not. The wing and the tail are set at zero-zero with the nose of the fuselage inclined downwards by one degree.

### How Long?

The first thing to be considered for the fuselage is the moment arms. By this I mean the distances between MAC positions on the wing and tail, and from there, the wing MAC to the end of the nose. Think of these measurements in the same way as levers, but remember the weight considerations too. The longer the lever, which is the distance behind the CG to the Stabilizer MAC, the easier it is to move the load which in our case is the area in front of the CG.

### Tail Moment

Tail moment distance is pretty critical as if it's too short, you will need big control movements to change the pitch and yaw, but too long and you will add unnecessary weight behind the wing and all of the weight behind the CG needs to be counterbalanced by adding weight in the nose.

For the tail moment, a good ruler is somewhere between 3, to 3.3 x the wing chord. Shorter and you will get into dead pitch response problems, and longer, maybe have to add a lot of weight in the nose.

**Nose Moment**

Here again we have a lever — this time one that acts in the opposite way to the tail moment and counterbalances the tail end. There is no harm in having a nose that's a bit longer than "normal" as the extra leverage length allows you to use less added nose weight, and the drag penalty is almost unmeasurable. In a perfect situation, the battery is all the nose weight you need. Practically a nose length of between 1.6 to 1.8 x wing chord works well for all considerations.

**Cross Sections**

Most racing model fuselages tend to break in front of the wing, behind the wing, or just in front of the stabilizers. This is always due to a rough landing involving sudden whip of the rear parts. I have tended to make my racing fuselages a tad wider than is the norm to counter this and to give a wider cross section in these sensitive areas, but in fact as we are making our own here, sensible use of materials can eliminate most of the danger. Look at golf shafts, and I bet you have not seen too many broken in play. Sensible tapering and careful arrangement to avoid stress raising of the cross sections will pay off. No sudden changes in diameter and try as much as possible to stick to around or triangular cross sections that aligned to resist the horizontal whip risks

**Photo 12**: Konrad Dudek's Red at the SLoT. (image: Konrad Dudek)

### Cool Factor

One last parameter for the fuselage: Make it your signature! Fool around with the lines until you have something that not only looks good, but also has large enough — but not too large — cross sections that will handle landing whiplash etc. — especially before and after the wing positions. The strongest cross unidirectional section is the round shape.

## And In Conclusion…

Overall folks, there is a lot of value to the saying that "if it looks good, it flies good" — especially for really quick slope soaring models.



*This is the third part of a four part series. Read the previous instalments* Designing for Slope Aerobatics *and* Designing for a Slope Allrounder *in the March and April 2021 issues of RCSD respectively. In the fourth instalment, coming up in the June issue, author James Hammond turns his attention to really big alpine soarers. Don't want to miss it? Best* subscribe to our mailing list*! All figures and photos are by the author unless otherwise indicated.* *Read the* ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents****. Downloadable PDFS: just* this article *or this* entire issue*.*

**Photo 1:** Onboard picture above the mythic slope of Col des Faïsses in the French Alps.

# Wasabi F3F, the New Kid on the Block

Aviatik Composites makes an impressive debut with their brand new, all-composite ship.

Pierre RONDEL Follow
May 14 · 12 min read

## Introduction

**Photo 2:** Final check list before reaching for the sky.

The market for all-composite F3F gliders is going well. Just look at the longer delivery times and rising prices from some manufacturers. Moreover, competitors are, in their majority, often very conservative and it is not uncommon that they buy the same glider as their neighbor, not because it is the best glider, but because they do not want to take any risks. As a result, we sometimes approach one-design competition, which is a pity. It is therefore interesting to look at the newcomers and see what they offer. It is with this perspective that I propose you to discover a glider recently introduced on the market, manufactured by ***Aviatik Composites***, based in Slovakia: the *Wasabi*. We will also check, in the following review, if the performance is as spicy as its name suggests!

## Overview

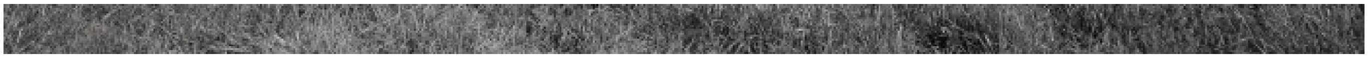


**Photo 3:** The Wasabi standing on my preferred fence.

The aerodynamic part of the *Wasabi* was thought out in collaboration with Dirk Pflug (*Pitbull 1* & *2*, *Quantum*, *Orden* and many other top gliders). The glider has a wingspan of 3M, which is a little more than the usual average, but remains however in the ideal dimension range for slope and F3F. The wing shape is elliptical with rounded wing tips and less pronounced sweep back. The ailerons and control surfaces of the tails are not going all the way for practical reasons according to the manufacturer. The fuselage doesn't give in to the "slim" fashion and is comparable to a *Freestyler 3* or *Pike Precision 1* fuselage. It hosts a ballast compartment like the *Pitbull 1*, in addition to the joiner and wings ballast. We will see later that the fuselage ballast may have its interest.

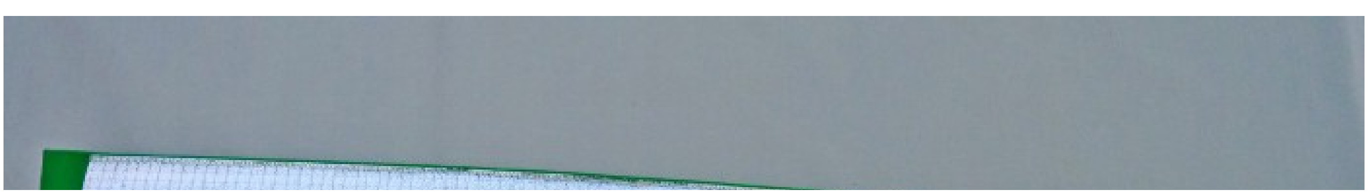
**Photo 4:** The Wasabi waiting to be thrown in the air.

It is important to note that the *Wasabi* can easily exceed the FAI limit of 75gr/dm² if all the ballast compartments are full. It is therefore necessary to remain vigilant in competition in order to respect the FAI rules. The *Wasabi* is proposed in several versions starting from the simple carbon 160 at an attractive entry price, to the double carbon 160/160 while passing by lighter layups such as the simple or double carbon 90. In short, everyone will find a shoe to fit their foot according to flying habits and objectives. Personally, I choose the double carbon 160/90 version which offers a good compromise between robustness and weight. Now let's have a look at the composition and quality of the kit.

## Top Notch Quality!


**Photo 5:** The kit is top notch quality and comes with accessories, balance lead, setting template.

Once the box was opened, I discovered the *Wasabi* was perfectly packed (This is an important point because when you know how parcels are transported and handled by the carriers, you don't sleep at night anymore!!!!) The wings and tails are delivered in their nice protective bags (the fuselage bag is optional), and you can find the nice carbon servo frames and the LDS MP Jet system with all the necessary hardware to mount the servos in the wings. The wiring harnesses partially prepared and welded. The fuselage and wing ballast and spacers (joiner ballast is optional) are included and there is even a neutral adjustment template for the wing and the tail!



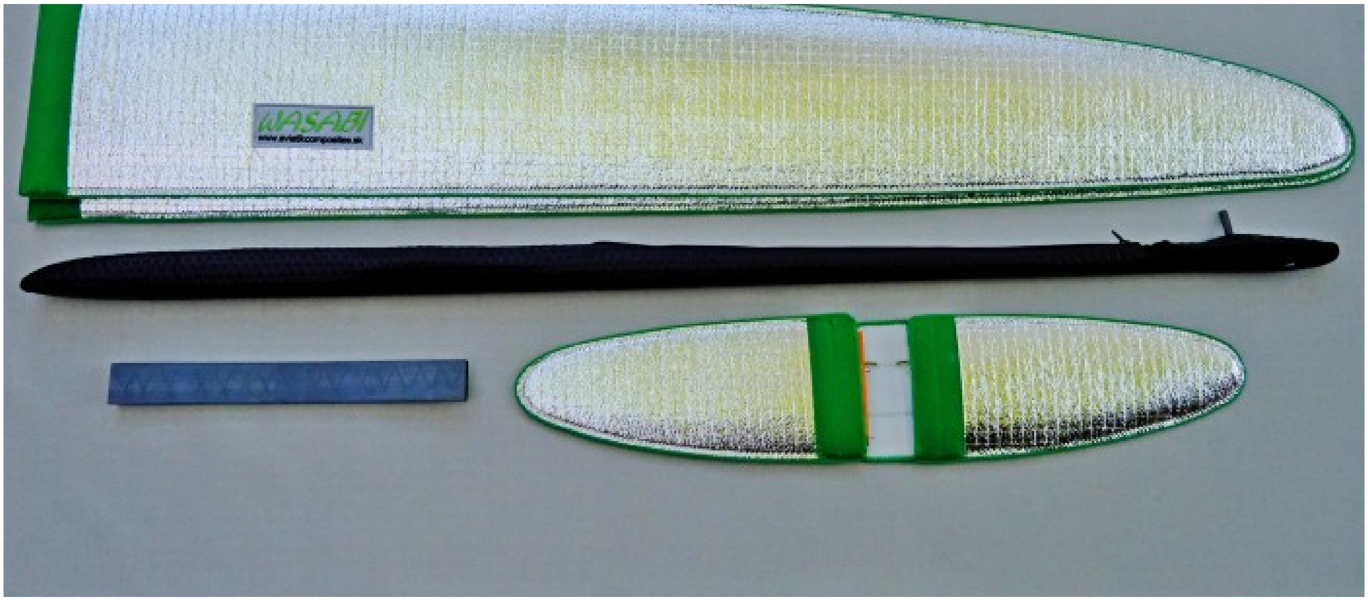


**Photo 6:** The Wasabi arrives with wing and tail bags. Fuselage bag is an option.

Let’s now take a closer look at the molded parts: they are very well made, with very nice paint and burr-free, very clean cut-outs. The wings let us guess an attention to details with, for example, the carbon root rib perfectly made with the opening hole for the green MPX connector. Even the ballast compartment or the joiner box show sharp angles and a mirror-like surface finish! The joiner can be inserted without force and without slop. The wing centering pins are of course already in place. The wing joiner is particularly wide, one-piece and inspires confidence.

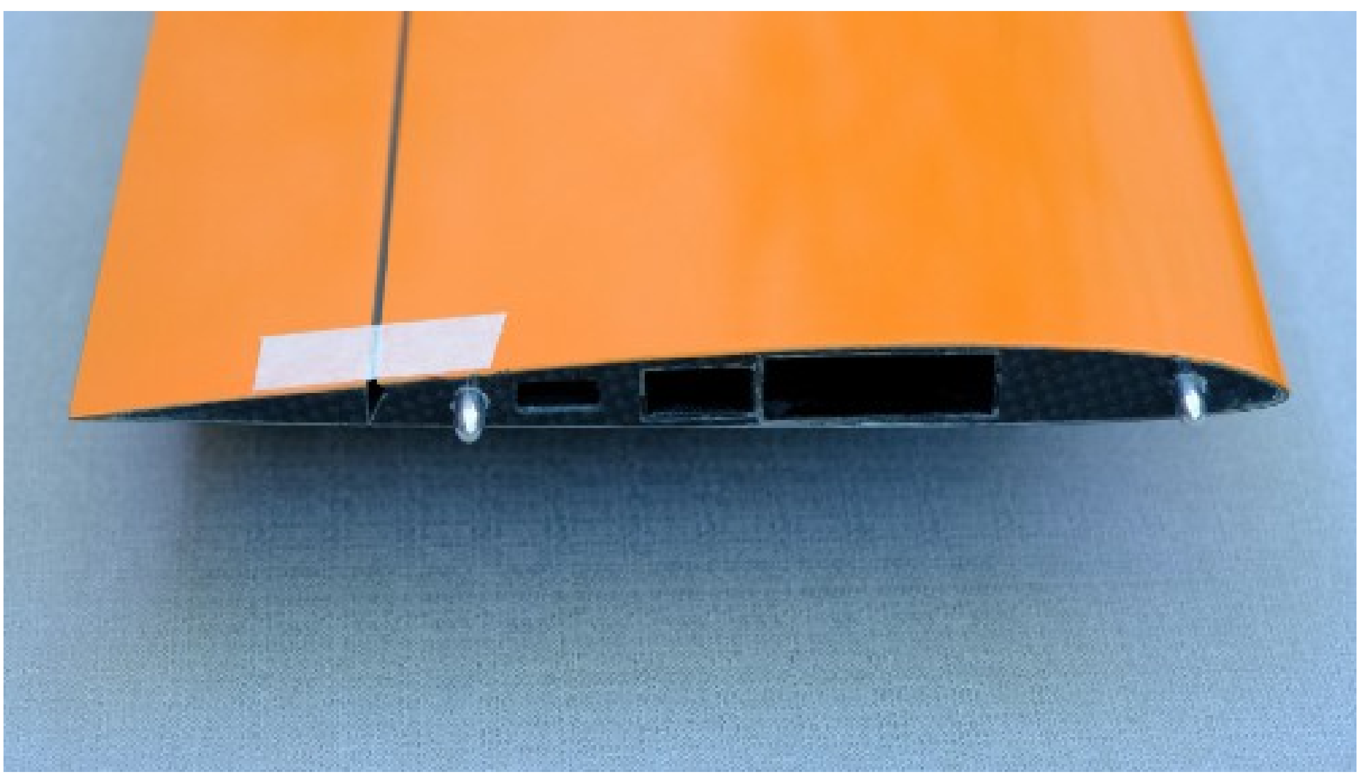


**Photo 7:** The wing root rib is carbon and shows the excellent craftsmanship of the manufacturer.

On the tail side, there is also a carbon root rib. Elevator horns and centering pins are in place. The only drawback (I had to find something!) is that the ball clevises are not completely freely accessible once the tail is in place. Only 3 or 5 mm are missing for a perfect accessibility.

The fuselage assembly is well advanced since the ballast tube is already installed; the servo plate finished with brass inserts for M2 screws is ready to receive the servos. The fuselage join line is almost invisible showing superb craftsmanship. The elevator control rods are made of Teflon coated fiberglass rods, sliding in a plastic sleeve. Personally, I like this solution which I prefer to the rigid carbon rod. The front fuselage is full carbon which was a bit of a surprise for me. This means that the antennas need to be placed carefully. Now, I guess it must be possible during the order to specify that you want a 2.4 friendly fuselage, which will ease the radio installation. The centering lead is supplied.

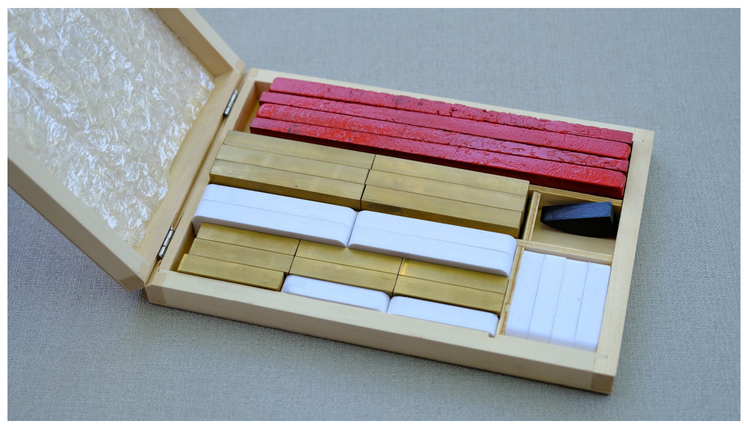
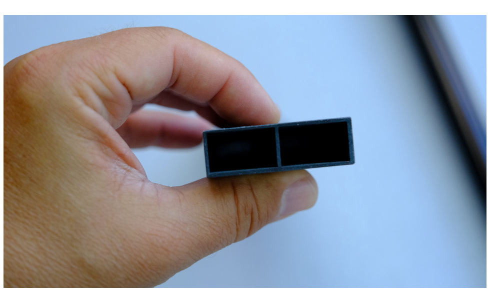
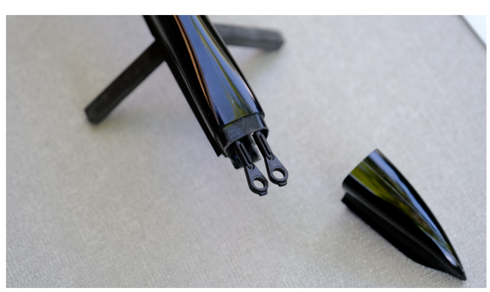
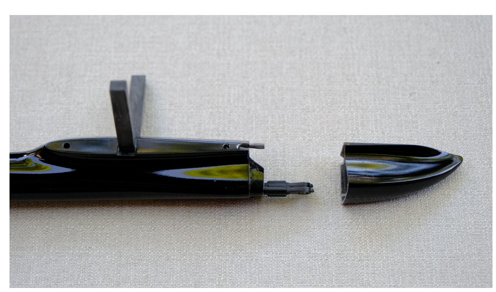


**Photo 8 & 9:**The ballast tube is already installed, and the servo tray is complete with M2 screw brass inserts / Ballast is provided except the joiner ballast with is an option.

All parts mount together easily and fit perfectly once assembled, no slop anywhere, in short a very beautiful kit!







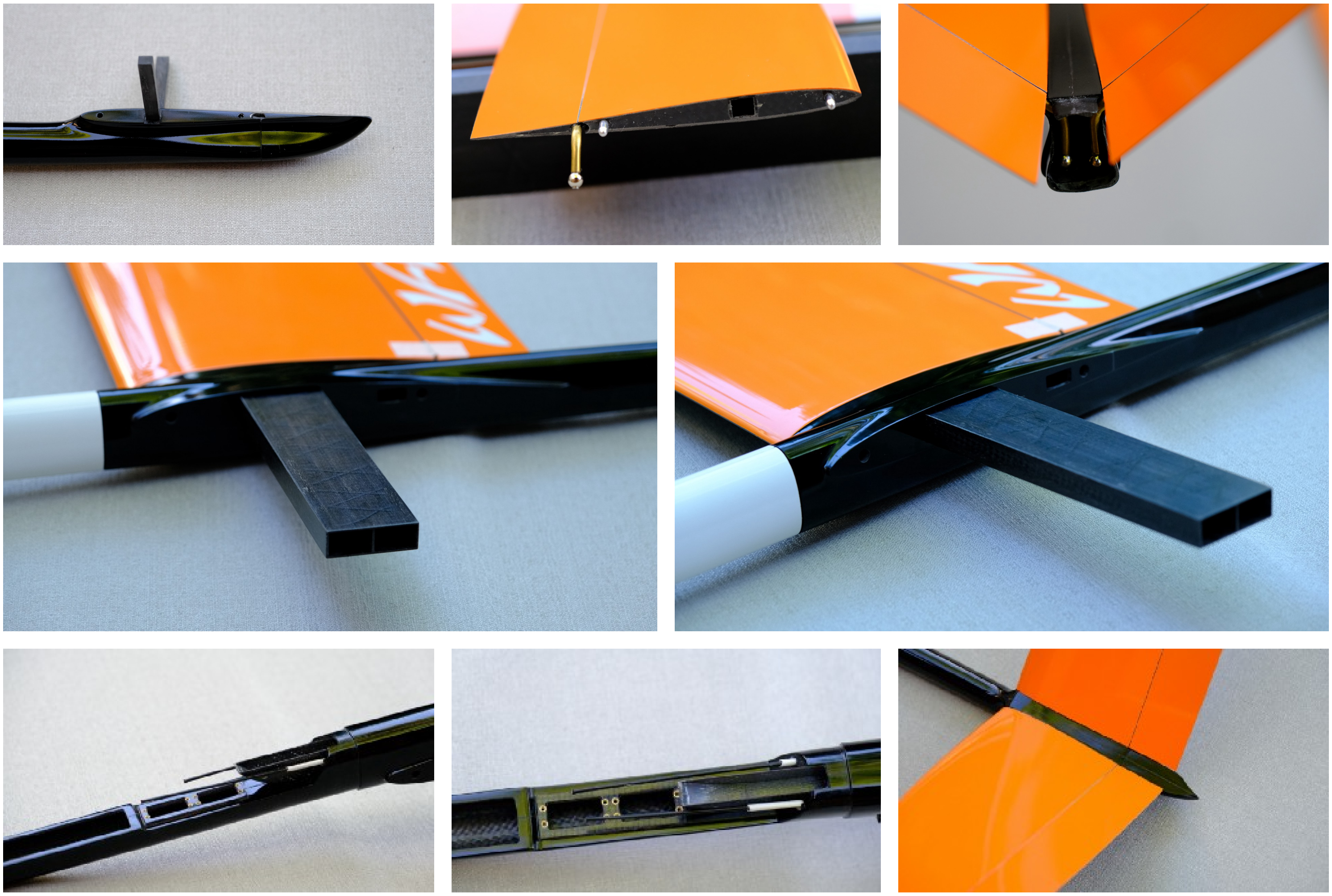


**Photo 10 to 20:** Some more pictures of the kit. Fit and finish is excellent like the tail adjustment and rear cap.

## A Quick and Clean Assembly!

I started by preparing and finishing the cable harnesses for the fuselage and wings. The one for the fuselage shares the + and — for 2 servos, which I found useless because it creates an unnecessary point of failure and draws less current. So I changed one of the cables to have 2 x 3 wires per green plug, without sharing the + and the -. This is now fixed according to the manufacturer.

Then, as on all my F3x gliders, before the installation of the green MPX connectors in the fuselage wing root, I always glue two small 1mm plywood plates crossing from side to side with a 2mm recess on each end to serve as a stop when gluing the plugs. I also use a 3D printed template which guarantees that the plug is perfectly positioned and perpendicular to the fuselage wing root while curing.

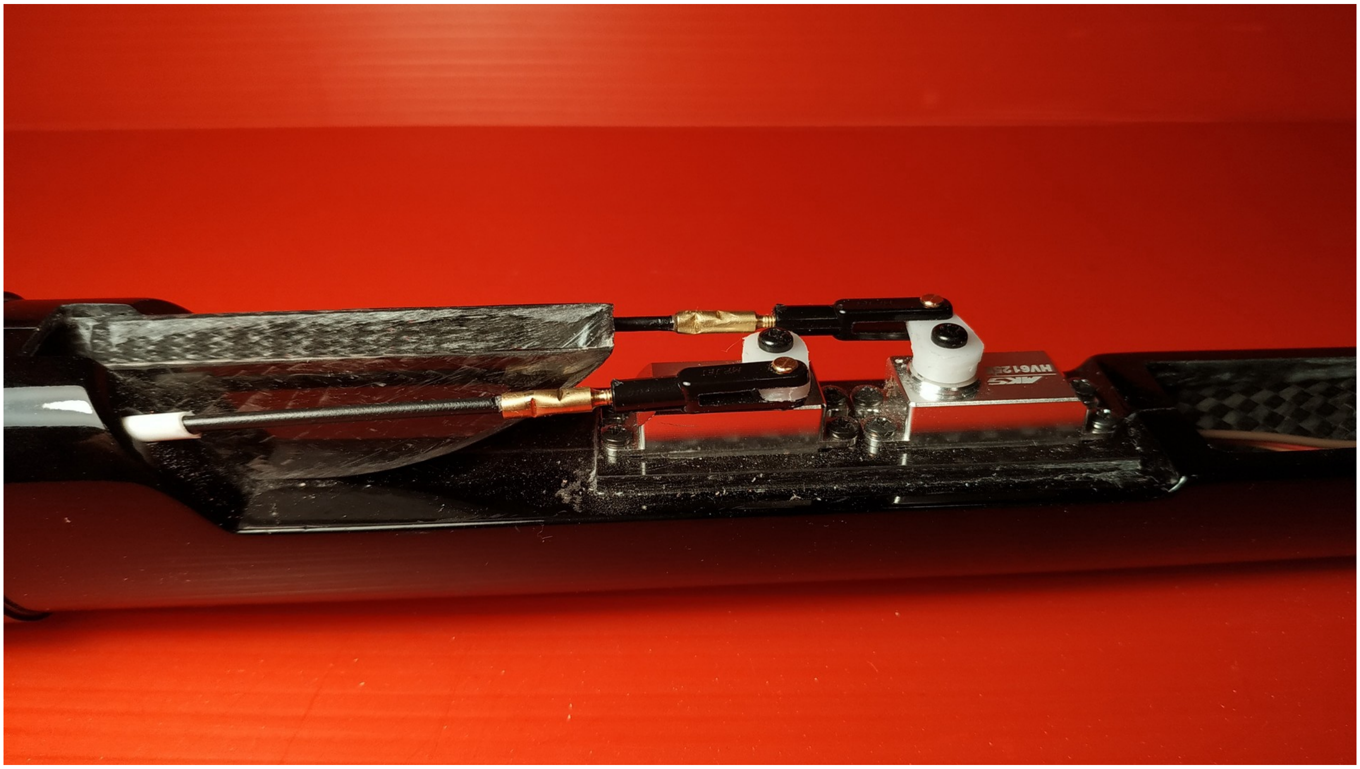


**Photo 21:** The space for the radio equipment is limited because of the ballast tube.

Mounting the elevator servos in the fuselage is a delight. No holes to drill, no housing to enlarge or adjust, MKS HV6125e servos insert effortlessly, without damaging wires, and are simply screwed with M2 screws. As I didn't have any screws supplied in my kit (I don't know if it's an oversight or if these screws are not supplied) I simply used some Futaba metal servo horn screws that have the right diameter and length and that you can find in a small bag in a specialized store. To finish with the elevator control rods , I mounted the tail on the fuselage, taped the control surfaces to the neutral position with some paper tape, then measured precisely the length to cut and to strip the Teflon layer to glue the brass threaded coupler supplied with some rapid epoxy. I replaced the M2 metal clevises by MP jet plastic/metal clevises which I commonly use on all my gliders and which I am particularly satisfied with because they don't take any slop over the time.


**Photo 22:** The excellent MP jet LDS system is provided with nice carbon servo frames for wing installation.

The fuselage is left aside to complete the assembly of the wings and do the installation of the LDS and servo mounts. First, glue the horns and the epoxy arms on the control surface side, making sure that the arm is well perpendicular to the hinge. Aileron arms are a little shorter than the flap arms because of the servo neutral and the difference in travel. Let's now move on to the servo frames. In my case, I had to install the brass inserts for the aileron frames because the position of the screw can vary depending on the MKS servos model chosen. For my part, I put the excellent HBL6625 mini. So I drilled at 3 mm and then inserted the brass claw nut with a small hammer.

We can now glue the servo mounts, with the servo in place with its servo head, but without its axis as far as I'm concerned, the frame coming any way to lean against the wing spar. Once dry, I could finish mounting the servos, with the right neutral position offset on the radio. It remains to glue (for those who wish) the green connector at the root, with 2 small wooden wedges behind the rib to increase the gluing surface. When gluing, take care to protect everything with thin tape and release agent (polyvinyl alcohol) so that the plugs do not remain glued together. The glue used is 30 minutes R&G epoxy and cure all night long before to remove the wings from the fuselage, clean the glue excess, remove the tape.

**Photo 23:** An happy Wasabi owner!

Although the fuselage volume is larger, the available length is limited due to the ballast tube and the required clearance distance. My receiver battery is 2S Lion 18650 in-line. I have shortened the balancing lead by 1cm to gain some space, and I have placed this removed lead on top of the battery. The receiver, a REX6, is located horizontally above the battery, just in front of the servos. The excess wire is hidden underneath. For more detailed pictures, you can retrieve the assembly log photo album **here**.

## In the Air

**Photo 24:** The wasabi diving to enter a F3F run. It shows very good acceleration.

My *Wasabi* in double carbon version 160/90 weighs 2.5kg empty, which is a little more (50gr to 100grs) than the weight provided on the manufacturer's website, but nothing critical here. Please remember that the weight can differ for example depending of the color: White is lighter, orange or red is heavier.

The first flight took place in ideal conditions on a nice welcoming slope and with a good wind. For this first flight, I ballasted the glider for a flying weight just under 2.9kg. As soon as I launched, the *Wasabi* showed good energy and speed, to the point that I started to do some laps to see the potential. And I was not disappointed to discover a plane showing high speed on trajectory and grip in high load turns, in addition to a real agility and reactivity on the ailerons and the elevator. I was able to do a series of laps without seeing the *Wasabi* running out of steam.

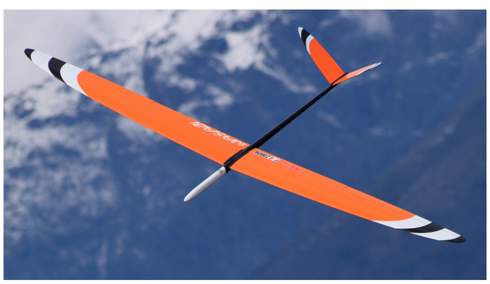

Video 25: The maiden flight!

In lighter conditions, the *Wasabi* is also doing well, but its weight (2.5kg in my case) however penalizes it a little in turn where it shows more inertia. If we consider that the ideal weight for a wind of 3m/s is about 2.3kg, it means that the glider starts to 'breathe' at 5m/s, empty, that we start to ballast it from 6m/s of wind, per 100gr per additional m/s as a first approximation, to be adjusted according to the shape of the slope, its altitude, and its efficiency.

Overall, the *Wasabi* is really performing well in the F3F task combining an excellent momentum energy restitution, accelerations, and speed retention in turns.







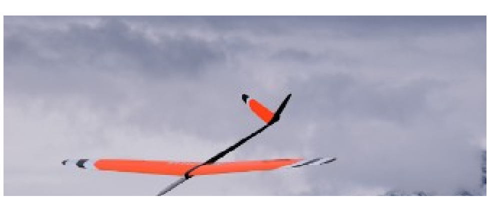
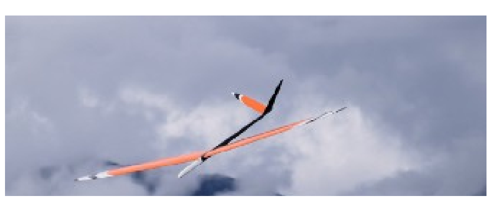
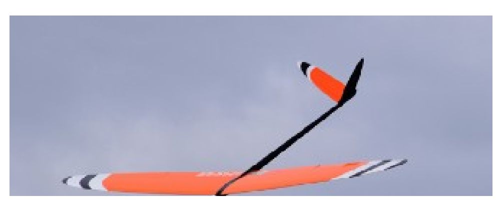
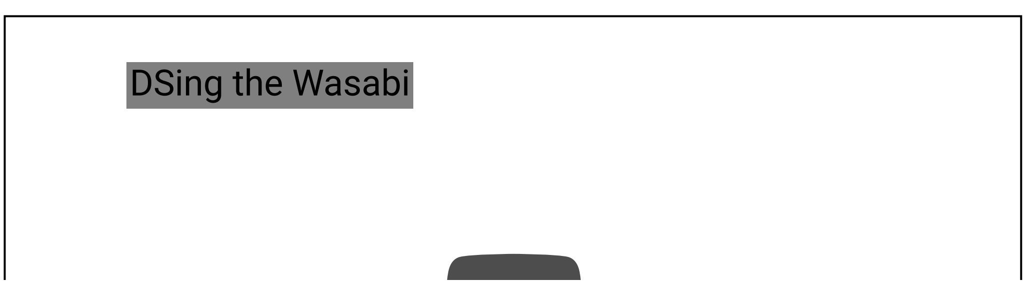
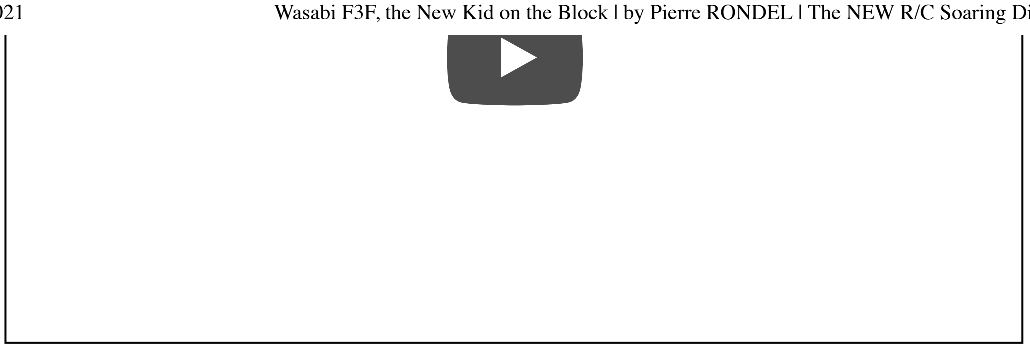





**Photo 26 to 43:** The Wasabi in flight: a very competitive F3F plane but also very pleasing for sport flying.

The ballast distribution is not the most convenient for incremental ballasting, but the ballast compartment of the fuselage allows adjusting the balance of the glider by moving the ballast forward or backward, thus allowing whatever the load embarked to remain on the initial CG, this is a good point.

In sport flying, the *Wasabi* is also very pleasant, as well in thermal 'hunting' and circling as in aerobatics. Rolls or 4 point rolls are perfectly centered and the inverted flight can hold endlessly when conditions and the flying volume allow it. Vertical maneuvers are also really good with a large amplitude and good speed. 'DSing' the *Wasabi* is also a joy as you can see on the following video. Plane is empty at 2.5kg and the wind is around 20km/h:

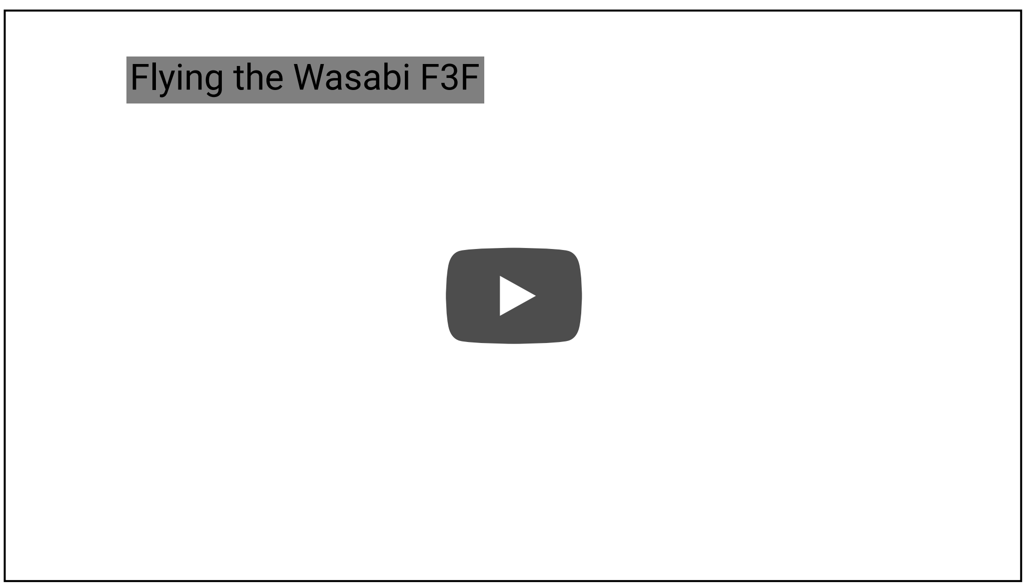




Video 44: DSing the Wasabi.

Short landings, thanks to the butterfly mixing, are a piece of cake. Just remember giving some horizontal speed just before touching the ground, especially when the glider is ballasted to avoid the glider hitting the ground heavily and vertically.

In short on the flight chapter, this *Wasabi* possesses all the qualities you would expect from an all-composite glider of this wingspan.




Video 45: Flying the Wasabi.

The year 2020, also called the 'COVID year', was very poor to non-existent in terms of F3F competition (no Eurotour or World Cup, no national league except a few competitions before the lock-down or this summer), I unfortunately did not have the opportunity to use it yet. But I'm totally confident that the *Wasabi* is competitive and will quickly prove its value over time!

## The Final Word

To conclude, the *Wasabi* F3F is a really nice surprise, with top notch kit quality and a glider full of resources, competitive in addition in term of F3F performances. It is a very efficient alternative to gliders usually met on the F3F competition circuit. Its price positioning makes it an even more attractive glider. So, if you are looking for an all-composite glider for F3F competition or more generally dynamic slope flying — because I remind you that these are extremely versatile gliders and well — the *Wasabi* definitively deserves all your attention. Good flights and happy landings to all of you!



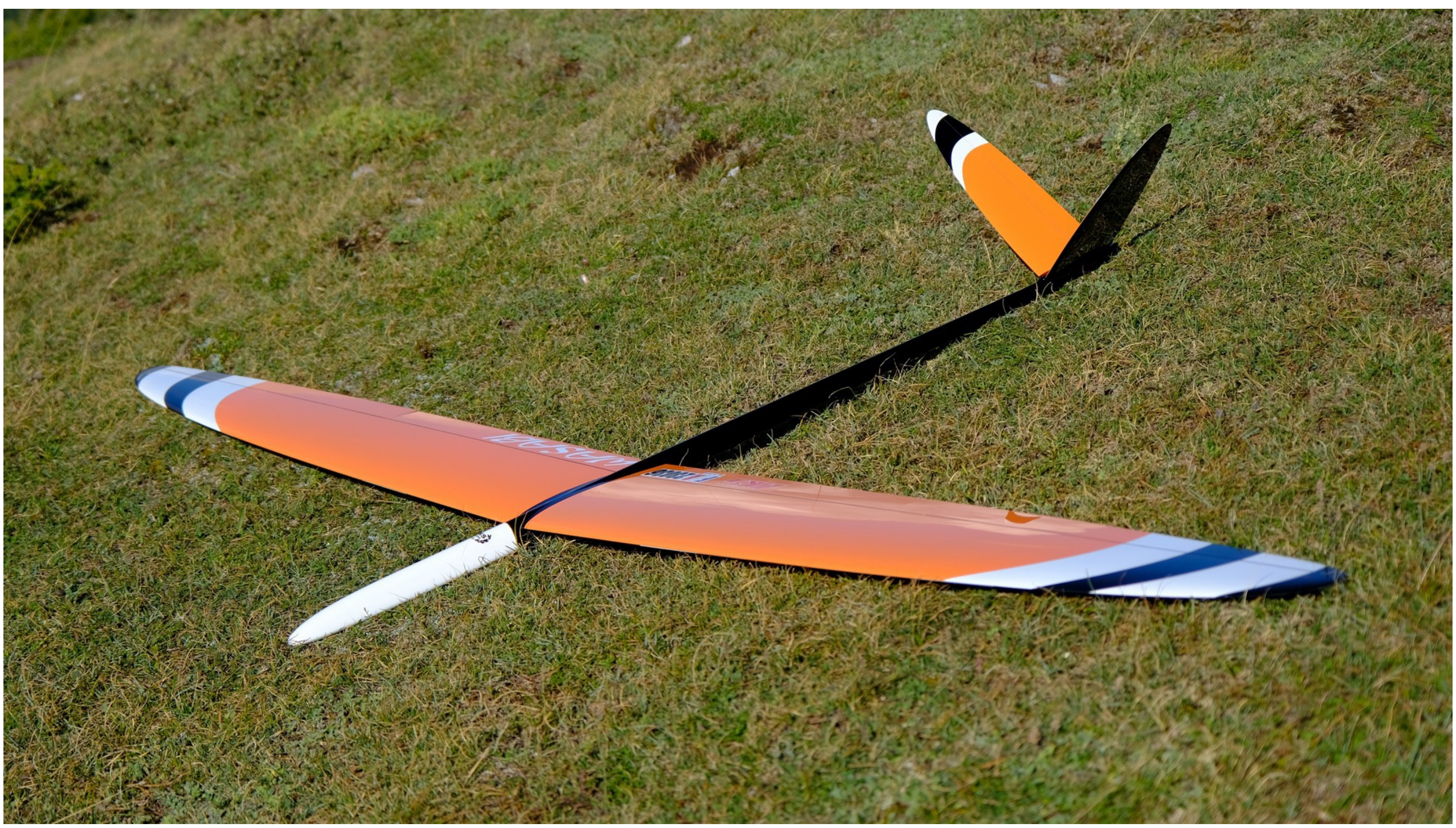


**Photo 46:** Top notch quality and excellent flying performance!

## Characteristics

- **Wingspan**: 3000mm
- **Length**: 1452mm
- **Airfoil**: DP
- **Wing area**: 56,2dm²
- **Tail area**: 5,5dm²
- **FAI area**: 61.7 dm²
- **Max FAI weight**: 4627g
- **Empty flying weight**: from 2250gr to 2500gr
- **Manufacturer**: aviatikcomposites.sk

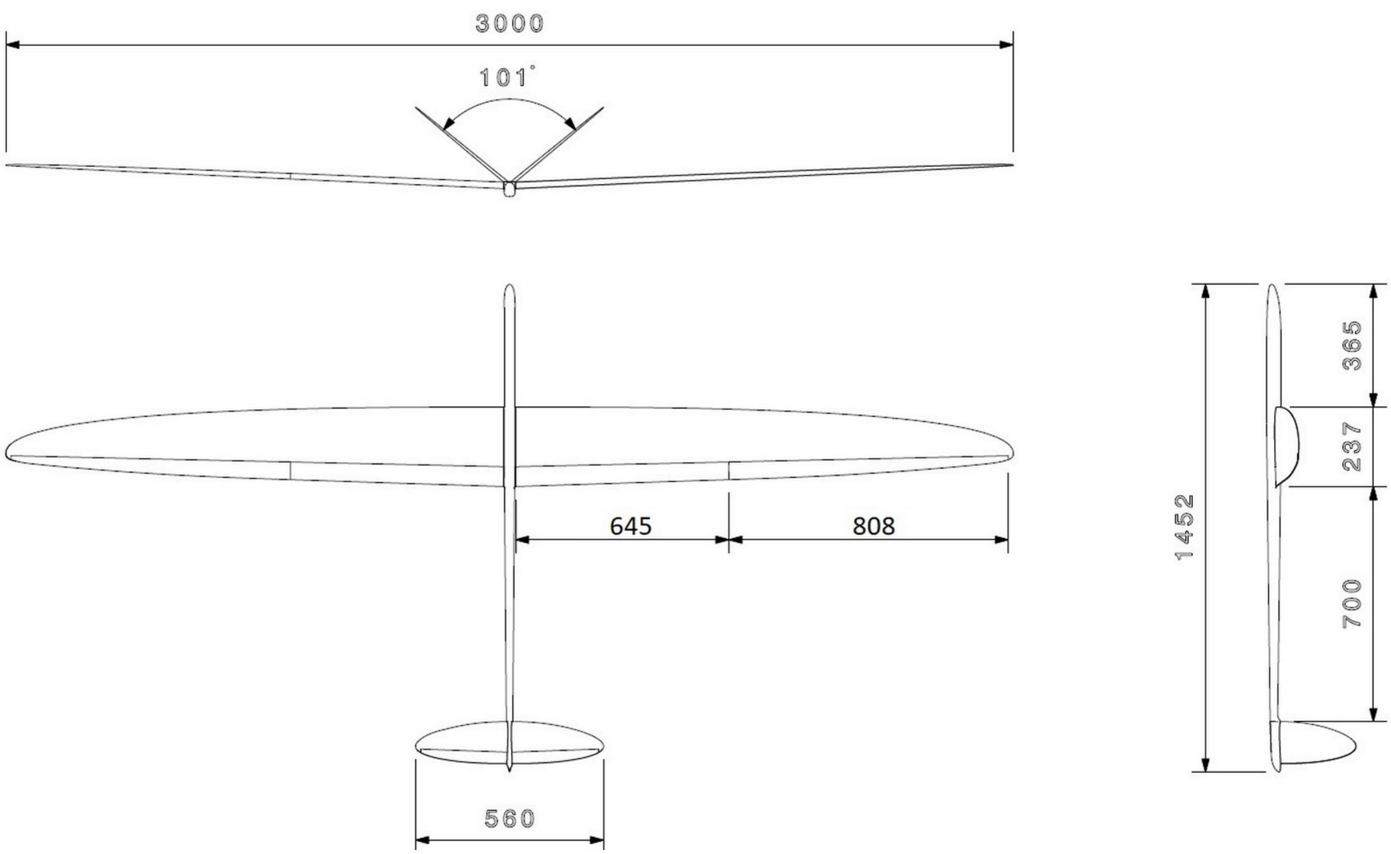



**Photo 46:** 3 views (source: Aviatik Composites)

## Settings

| Settings **Wasabi** | Elevator | Rudder | Ailerons | Flaps |
|---|---|---|---|---|
| Elevator | +5mm; -5mm | | | |
| Rudder | | +8mm;-8mm | | |
| Aileron | | | +24mm; -12mm | +17mm; -7.6mm |
| Snapflaps | | | -2mm | -7mm |
| Camber | | | | |
| *Thermal* | | | 3mm | 3mm |
| *Distance* | | | -1mm | |
| *Speed* | | | -1mm | -1mm |
| Butterfly | -4mm | | +23mm | -45mm |
| CG | 92mm | | | |

**Photo 47:** Author settings table

## Ballast Sheet

**Wasabi F3F**

| | | |
|---|---|---|
| Empty weight: | 2 500.0 | gr |
| Empty CG: | 92.0 | mm |
| Balance position: | -270.0 | mm |
| Ballast 1 weight: | 61.5 | gr |
| Ballast 1 position: | 122.5 | mm |
| Ballast 1 pieces: | 7 | |
| Ballast 1 name: | fuselage | |
| Ballast 2 weight: | 189.0 | gr |
| Ballast 2 position: | 68.0 | mm |
| Ballast 2 pieces: | 4 | |
| Ballast 2 name: | joiner front | |
| Ballast 3 weight: | 189.0 | gr |
| Ballast 3 position: | 90.0 | mm |
| Ballast 3 pieces: | 4 | |
| Ballast 3 name: | joiner rear | |
| Ballast 4 weight: | 127.0 | gr |
| Ballast 4 position: | 113.0 | mm |
| Ballast 4 pieces: | 6 | |
| Ballast 4 name: | wings | |

| fuselage | joiner front | joiner rear | wings | Weight | Weight Dif | CG | CG Dif | Balance W. | Wing loading |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | | 2 689.0 | 189.0 | 91.9 | -0.1 | -1.0 | 43.6 |
| | | 2 | | 2 878.0 | 378.0 | 91.7 | -0.3 | -2.1 | 46.6 |
| | | 3 | | 3 067.0 | 567.0 | 91.6 | -0.4 | -3.1 | 49.7 |
| 1 | | 3 | | 3 128.5 | 628.5 | 92.2 | 0.2 | 2.0 | 50.7 |
| 1 | | 4 | | 3 317.5 | 817.5 | 92.1 | 0.1 | 1.0 | 53.8 |
| 2 | | 4 | | 3 379.0 | 879.0 | 92.7 | 0.7 | 6.2 | 54.8 |
| 2 | 1 | 4 | | 3 568.0 | 1 068.0 | 91.4 | -0.6 | -6.4 | 57.8 |
| 2 | 1 | 4 | 1 | 3 695.0 | 1 195.0 | 92.1 | 0.1 | 1.0 | 59.9 |
| 3 | 1 | 4 | 1 | 3 756.5 | 1 256.5 | 92.6 | 0.6 | 6.2 | 60.9 |
| 3 | 2 | 4 | 1 | 3 945.5 | 1 445.5 | 91.4 | -0.6 | -6.3 | 63.9 |
| 3 | 2 | 4 | 2 | 4 072.5 | 1 572.5 | 92.1 | 0.1 | 1.0 | 66.0 |
| 4 | 2 | 4 | 2 | 4 134.0 | 1 634.0 | 92.5 | 0.5 | 6.2 | 67.0 |
| 4 | 3 | 4 | 2 | 4 323.0 | 1 823.0 | 91.5 | -0.5 | -6.3 | 70.1 |
| 4 | 3 | 4 | 3 | 4 450.0 | 1 950.0 | 92.1 | 0.1 | 1.1 | 72.1 |
| 5 | 3 | 4 | 3 | 4 511.5 | 2 011.5 | 92.5 | 0.5 | 6.2 | 73.1 |
| 5 | 4 | 4 | 3 | 4 700.5 | 2 200.5 | 91.5 | -0.5 | -6.3 | 76.2 |
| 5 | 4 | 4 | 4 | 4 827.5 | 2 327.5 | 92.1 | 0.1 | 1.1 | 78.2 |
| 6 | 4 | 4 | 4 | 4 889.0 | 2 389.0 | 92.5 | 0.5 | 6.3 | 79.2 |
| 7 | 4 | 4 | 4 | 4 950.5 | 2 450.5 | 92.8 | 0.8 | 11.4 | 80.2 |
| 7 | 4 | 4 | 5 | 5 077.5 | 2 577.5 | 93.3 | 1.3 | 18.7 | 82.3 |
| 7 | 4 | 4 | 6 | 5 204.5 | 2 704.5 | 93.8 | 1.8 | 26.0 | 84.4 |

**Photo 48:** Author ballast sheet to keep CoG stable

*All videos and images by Joël Marin & Pierre Rondel unless otherwise noted. Read the **next***

***article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents****.*
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Left to right: Bob Dodgson, Dave Johnson and Carl Blake with Maestro IIIs and Tom Neilson with a Maestro Megan. This picture was taken at the famed 60 Acres Park location in Redmond, Washington prior to the site's development into athletic fields and flying there came to an end. (image: Bob Dodgson)

# Implementation of a Dream

Part one of a three part series.

Bob Dodgson Follow
May 12 · 9 min read

*As part of making arrangements to publish Bob Dodgson's autobiography, we put out a call to readers for pictures of any of Bob Dodgson's designs. Candidly, we were overwhelmed, so we're selecting some of our favourites to include with each of the three articles in the series. — Ed.*

As a youth, I was enamored with model airplanes. Many 50 cents were spent on stick and tissue kits that were laboriously assembled with varying degrees of success. The bulkheads were not die cut and had millions of stringer notches that had to be meticulously hand cut. Growing up in the country caused its share of hardships to the eager hobbyist, namely that when I ran out of glue or some essential building item, the operation was out of business until the next weekly trip to town (16 miles away). Naturally, this difficult situation had one good thing about it. It definitely promoted innovation and unconventional attempts to circumvent the need for the 'out of stock items.' On one occasion, I was so desperate to finish my latest plane that I glued the tissue covering on with paste, since I had no glue. The model was a bit on the heavy side. Even with the rubber motor fully wound, the plane had a glide ratio of about three to one (I never said that all of my innovations worked)."

"I was always in the winner's circle with this Windsong. This was back in the late 80s or early 90s. It was my favorite thermal ship. Two guys from Tullahoma got tired of getting beat by it and made me an offer I couldn't refuse. At the next contest, I showed up with a borrowed Windsong that a friend just couldn't seem to get a handle on and after a few tuning flights, took 1st in unlimited again. I would love to have one again." (image: Randy White)

I could never determine why my models never would climb under rubber power and why they never really flew — until I was about 15-years-old. I didn't have much spending money and I didn't put fancy color schemes on my planes. In fact, I did not even spend money on dope for the tissue. Finally, I discovered that when the tissue was sealed with dope, things worked a lot better. My next rubber-powered plane flew great!

As most of you know, I have a stuttering problem. My dad noticed that when I worked on model airplanes, my stuttering appeared to get worse. So he, at various times, forbade me to build model airplanes. Naturally, my being perverse by nature, this putting model airplanes in the“forbidden fruit” category only heightened my enthusiasm for the hobby that otherwise may have simply died a slow, natural death.

“Who doesn’t love a Lovesong” (image: Kurt Zimmerman)

I started college in 1960 and had to start thinking about what I wanted to do when I grew up (I still haven’t figured that one out). I went the gamut from psychology to engineering and finally to architecture as a last resort. I felt architecture offered a unique blend of art and technology. I was about to become the Renaissance man of the 20th century.

After working my buns off getting through the School of Architecture at the University of Washington, I learned that my romanticized picture of the cavalier architect was not the same picture that awaited me as I stepped into the cruel world. I discovered that I was working as a draftsman eight hours a day and for not much more than a minimum wage. Where did I go wrong?

"Mike Dooley & his Dodgson Camano consulting with Doug Kyllo. Pivot in foreground. At Ebey's Landing in the mid-1990s" (image: Waid Reynolds)

During my college days, I had developed a great interest in full-scale soaring. I joined the Soaring Society of America and the Seattle Area Soaring Society and I joined the Experimental Aircraft Association. I yearned to soar with the Joe Lincolns and the Moffets, but alas, I was being put through college in part by my part-time working and mostly by my young wife Sandy's full-time job, so my limited funds left me with limited options. (Sandy was under the impression that I was going to grow up to be an architect.) Because there were no ultra-lights and no hang gliders at the time, my cheapest option was to construct a kit like the wood BG12, which cost about $2,500 or to purchase an old 1–26 or something. At that time, I could not join the Boeing gliding club to get my soaring license as I was not a Boeing employee and there was no other such club in western Washington. This meant that just to get a soaring license would cost me a couple thousand dollars in instruction and rental time. In the middle of my frustration over the high cost of getting into soaring, I read an article by Dale Willoughby in the Soaring Society of America magazine entitled *Soaring With Both Feet on the Ground*, which was about the new burgeoning hobby of radio control (RC) soaring. This idea so excited me that I bought a single-channel rubber band escapement system by World Engines (I couldn't afford the $300 to $600 that the new digital systems cost) and a $16 Graupner Weihe 50 kit with about a 72-inch wingspan. I all but forgot full-size soaring.

“Heather (we called her Todi when she was little) holding the Todi glider in 2019 (our first kit) that came out in 1972 Heather was two at the time. The Todi had a fiberglass forward fuselage and a 3/32” thick rolled basa tail boom.” (image: Bob Dodgson)

Most of my flights were disasters because in order to save weight, I had ignored the recommended CG position. After all, how can making a glider heavier make it fly better? My flights off a slope were a terminal series of ever-expanding oscillations that ended only when the glider’s nose was laid to rest six inches into the hillside. After all, I was a loner and knew no one to turn to for help. Finally, in desperation I decided to put a handful of rocks in the nose to move the c.g. closer to the point shown on the plans. Once again, I fearfully heaved the battered little plane off the slope, and to my total amazement, it flew straight out over the Issaquah Valley as if it were on rails. Not long after my initial amazement began to subside, it was renewed when I discovered that the radio link between the glider and me was missing. While I was standing there helplessly watching my dreams and aspirations quietly glide off into the sunset, the little plane slowly turned in a giant arc, came back, and landed on the slope.

“Hijacker II which Bob kitted for a time.” (image: Craig Christensen)

Needless to say, soon I became frustrated with the rubber band escapement system and after much work, I convinced Sandy that I needed (and it wouldn’t cost much) a pulser conversion on my transmitter and a galloping ghost rudder/elevator servo for the plane. With this system, the rudder is always flopping back and forth and the elevator is always flopping up and down. For up elevator effect, the pulse is speeded up and the elevator spends more time up than down. For down elevator, the reverse is true. Rudder control is achieved by the ‘on’ pulse being either longer or shorter than the ‘off’ pulse. If it is longer, the rudder spends more time on one side than on the other. If it is shorter, the rudder spends more time on the other side. This galloping ghost system allowed me to achieve my first sustained controlled slope flights. The year was about 1968.

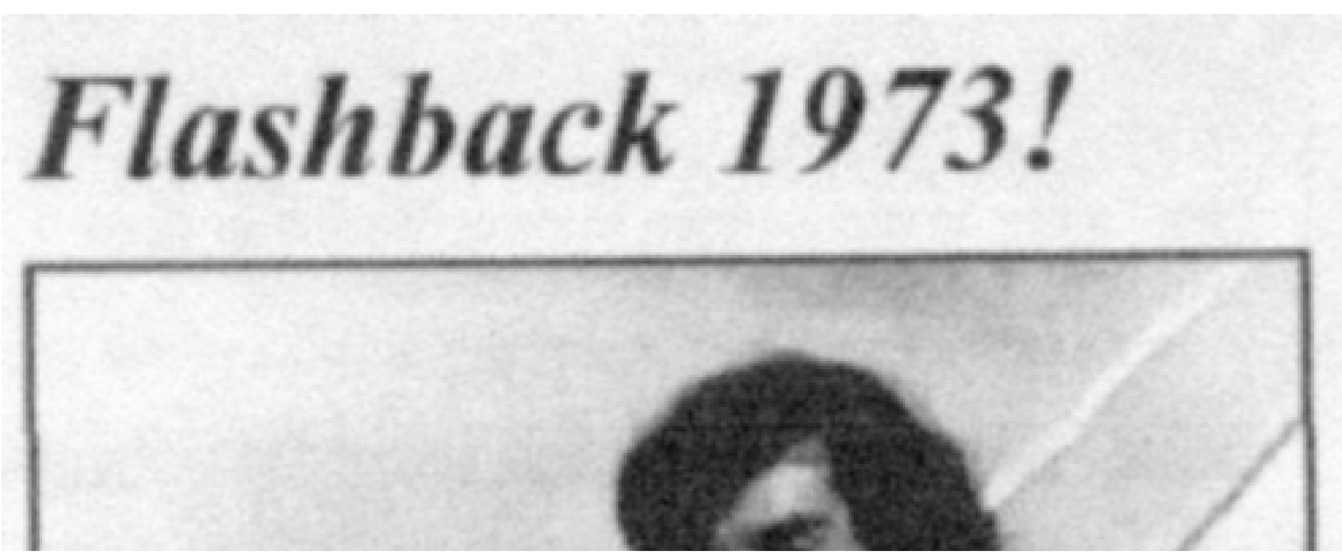
"Mid-1980s." (image: Mike Hansow)

It wasn't long before I wanted a new glider and so I designed and scratch built a ship of about the two-meter size with standard box fuselage and constant cord wings with dihedral, utilizing the same wing construction that the Weihe 50 had used. The plane flew great. I had heard about a group of Seattle flyers who flew gliders off Badger Mountain by Wenatchee, Washington one weekend a year, and I went over to showcase my newfound skills. It was no fair. These people all had digital radios, and the speed capabilities of some of the planes took my breath away. The well-publicized designer Harley Michaelis was there with his Tri-belle and breathtaking Misqueet. Ralph Brooks was there with his huge, gorgeous scale-like Nelson KA6. Ralph White, who later bought the Flight Glass Company, was flying his Phoebus. The Graupner Fokas, Claus, and other imported ships and many original designs were flown.

“Me and my Maestro III in my parents backyard in Vancouver, BC in 1975. Sadly I rekitted that magnificent aircraft just days later.” (image: Terence C. Gannon)

This was heaven to me, but I had never before flown off such a colossal slope into such winds. It was all that my little, quivering, slow glider could do to stand still into the wind. The amount of down elevator available was very small. Finally, I made it out away from the cliff and into a giant thermal. Wow! I was right up there with the big digital birds. Everyone was amazed at seeing this pulsating aberration doing so well. More than one person remarked as they watched the tail surfaces vigorously flapping: “Look, even his glider stutters.”

My enthusiasm was enormous in this moment of triumph, but so was my fear. How was I going to get the ship down? I was holding full down elevator just to get it to move forward. Finally, I put full down and full turn into the plane and it started a spiral descent, slowly at first and then gradually steepening. As the speed increased, the pulsing tail surfaces began to make the entire fuselage oscillate like the body of a powerful fish running at full speed. Then came the ego-shattering snap as the combined effort of all the forces caused a wing panel to give way and brought an abrupt and untimely end to my brief moment of glory.




"Russ Young was the first flyer to place nationally with a Dodgson Designs kit. It was the TODI in 1973." (image: Bob Dodgson)

It wasn't long until I ordered a digital Control-Air four-channel radio kit from World Engines with a single stick transmitter configuration. To complement the new radio, I needed the greatest glider in the world, and I couldn't afford the $35 for a Phoebus or Foka kit. Besides, I wanted more scale-like controls in the model than the simple rudder-elevator controls offered in stock kits. I designed a four-channel glider with a rounded and shaped balsa fuselage covered by fiberglass. It had a high-aspect ratio, 100-inch wing with the Eppler 387 airfoil. The plane had flapperons, coupled rudder and ailerons and elevator. My first flights were very short, ending in an underground probing mission. The difference in control between the slow, gentle galloping ghost system and the quick, precise response of the digital system was more than I could handle. I was too proud to let any of the more experienced Seattle flyers help me. I didn't even know what the problem was. I thought the plane was just uncontrollable. After many crashes and after moving the c.g. very far forward, I finally got a handle on the plane. It flew just great and I was king of the slope. I never did experiment with moving the c.g. back where it belonged, after I learned to fly the plane. Flaperons were achieved in this plane with a sliding servo.

The next year when I went to Wenatchee, I had a plane to be proud of. By this time, I was growing restless as an architectural draftsman and I had lost my zeal for taking the state boards to obtain my own architect's license. I found I was spending every spare moment on the job designing a new glider or working out some new control linkage, etc. My heart was with my hobby.



"Apparently I had a phase of church window sailplanes. I lost the Megan at one hour and fifty minutes into my two-hour thermal for Level 5 of LSF. It was about 800 ft up and a cloud rolled in underneath it and I never saw it again." (image: Randy White)

*This article was originally published in the April 1983 Northwest Soaring Society Newsletter edited by Dean Rea. Bob updated and submitted it to the AMA History Project in 2002. RCSD would like to thank both Bob and the AMA History Project for permitting the use of the AMAHP document as a source for this series of articles in RCSD. In particular, we would like to thank Jackie Shalberg, Archivist and Historian for the National Model Aviation Museum, for the assistance in making these arrangements. — Ed.*

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The Carbon Electric 200E on an evening flight in some imagined future.

# PSS Candidate | Carbon Electric 200E

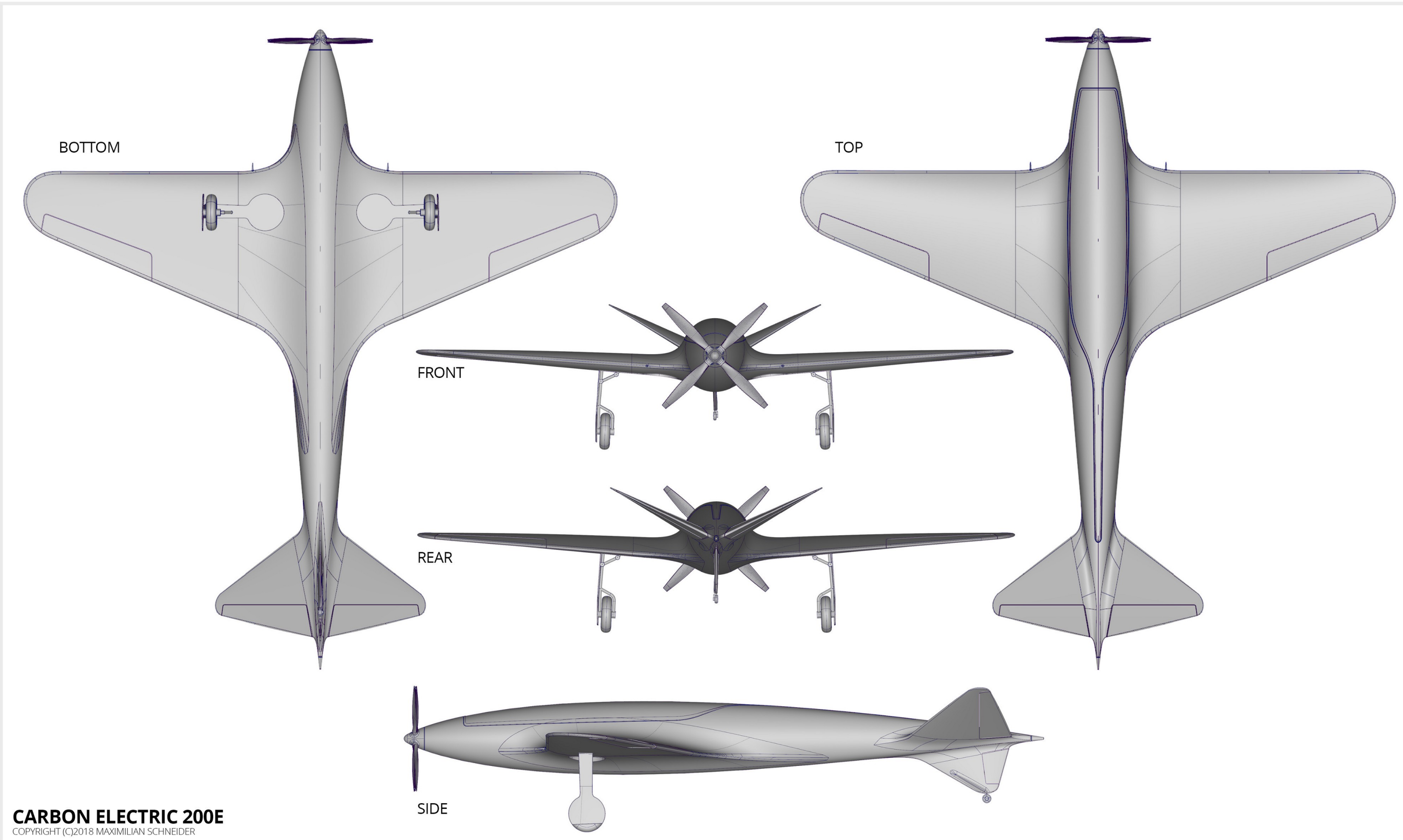
A 21st century update of Ettore Bugatti and Louis de Monge's classic Bugatti 100P.

Max Schneider Follow
May 14 · 4 min read

Since I was a kid I was always fascinated by airplanes and flying. To this day getting my private pilot's license is on top of my list waiting to be crossed off — but can't find quite the time for it right at the moment.

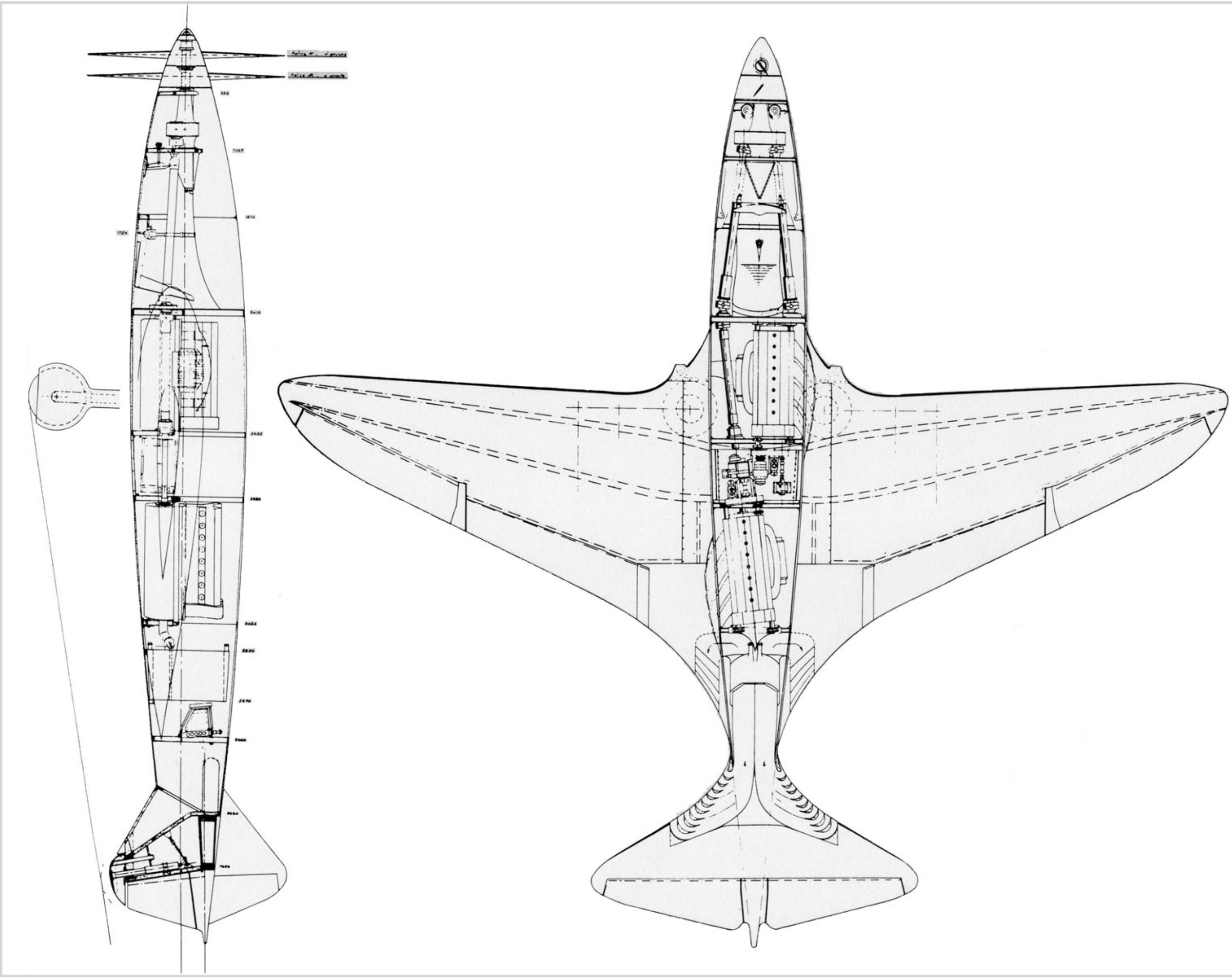
As a professional car designer, the Bugatti 100P quickly caught my attention with its gorgeous design and unique history. It is my all time favorite air plane and this project, the Carbon Electric 200E is my way of paying homage to Ettore Bugatti and Louis de Monge. However, I didn't want to just copy it, but add a unique twist and incorporate own ideas into what could be a modern successor of the original 100P which was never flown.

## Meet the Carbon Electric 200E




The Carbon Electric 200E.

The Carbon Electric 200E concept is a full carbon monocoque two seater with a powerful electric motor for ultra premium recreational flying. It is longer and differently proportioned compared to the Bugatti — I wanted to rebalance it's appearance and emphasize it's unique empennage configuration. Special details like the fully integrated taillight and light stripe on top, an integrated and aerodynamic tail wheel, a fully seamless and rivetless appearance thanks to carbon fibre and only one propeller to simplify technology distinguish the Carbon Electric 200E from its grandfather as much as the differently shaped and angled main wings.

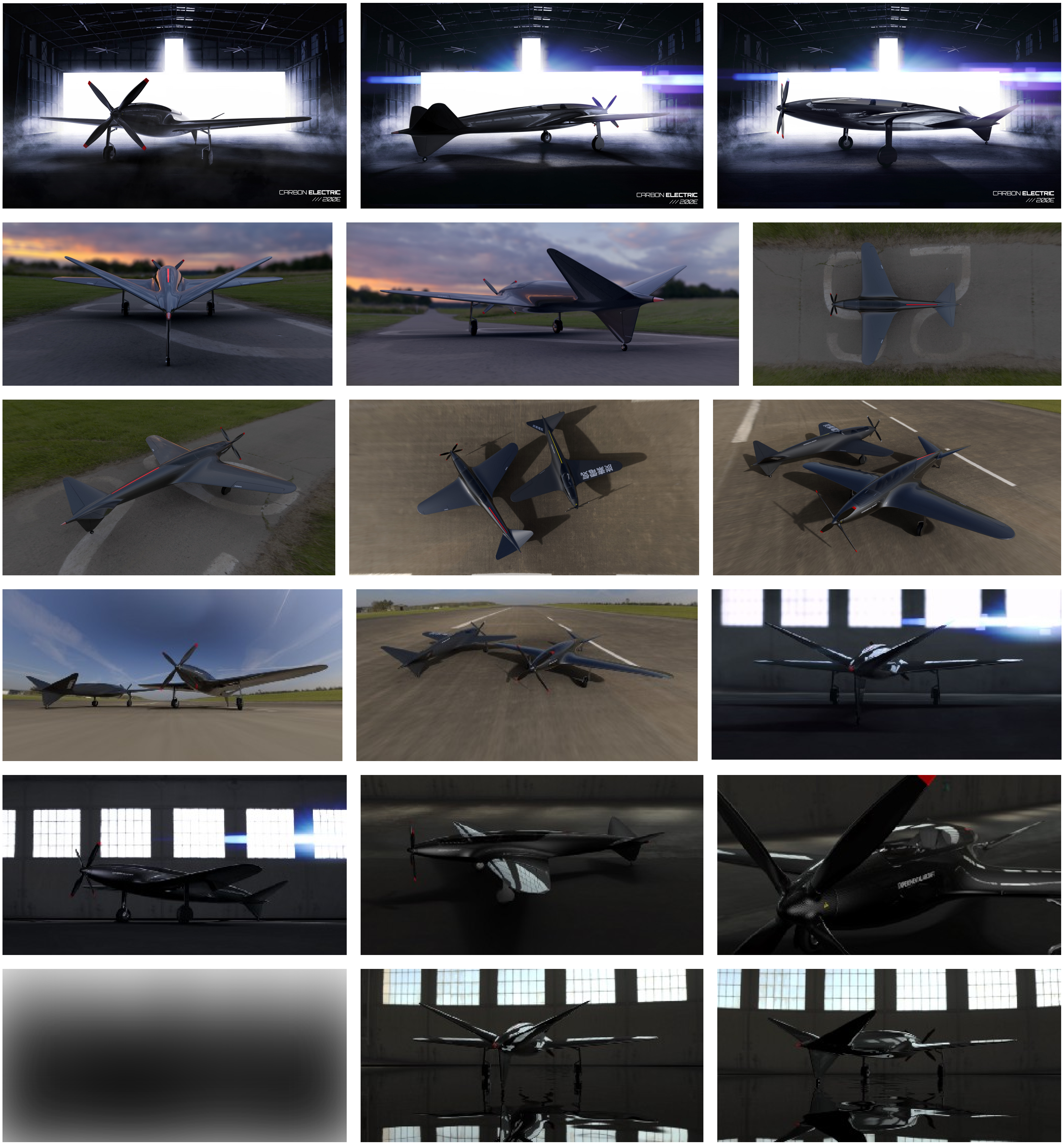


The configuration of the original Bugatti 100P (drawings: Louis de Monge)

The longer aircraft fuselage makes room for two people, because I genuinely believe the joy of flying should be shared. However, for seekers of maximum performance I additionally created a one seater with shorter fuselage (the 100E) coming closer to the original 100P.

In the RC world I started with cars but got super excited once I saw videos of FPV drones, which got me into drone racing. I then expanded my interest into FPV wings but lately haven't had much time to fly here in Tokyo.

Therefore, I was pleased to be approached by RCSD to write a brief article about the 200E as a potential subject for power scale soaring (PSS). I was not even aware such a thing existed! But I am excited about the possibility of having a reader (or readers!) create an actual flying example of the 200E as a glider. I dare not dream that might even lead to a full-size version at some point in the admittedly distant future.




To get the creative juices flowing, here are various renderings of the Carbon Electric 200E. You can make any of these images larger simply by clicking on them. To view them in the highest resolution, right-click and save them to your local storage and then view them with any image viewer.

Fun fact: my interest in RC sailplanes might be encoded into my DNA. My father was a professional hang glider pilot in the 1970s and 1980s and I found it super interesting!

You can find me on Instagram where I will post more aircraft designs in the future. I wish you all luck in the development of a 200E PSS. If you have any questions, please write a response to this article below. While my work as a Senior Automotive Exterior Designer keeps me very busy, I will do my best to answer your questions when I can.

Thanks very much for reading and the very best of luck with your projects.



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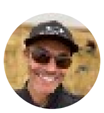
The moment of truth — The Buzz about to be launched into the gentle spring breeze for the first time.

# RC Soaring Diaries

## Feelin' the Buzz: Test flying the Buzz VTPR from Slopecorn.



Michael Berends Follow
May 19 · 6 min read

*Many RCSD readers will already be familiar with* RC Soaring Diaries *and the force of nature behind it, Michael Berends.* Diaries *is a popular fixture on the RC soaring scene so you can imagine our delight when Michael agreed not only to extend the franchise into RCSD, but also write up some additional, exclusive material to enrichen the readers experience when watching his videos. We look forward to Michael's ongoing contributions in the future. — Ed.*

After being involved in RC soaring for close to 40 years, I'm always amazed that there are new planes and flying styles that constantly give us 'Glider Guiders' new challenges. The *Buzz* from Slopecorn gives exactly that!

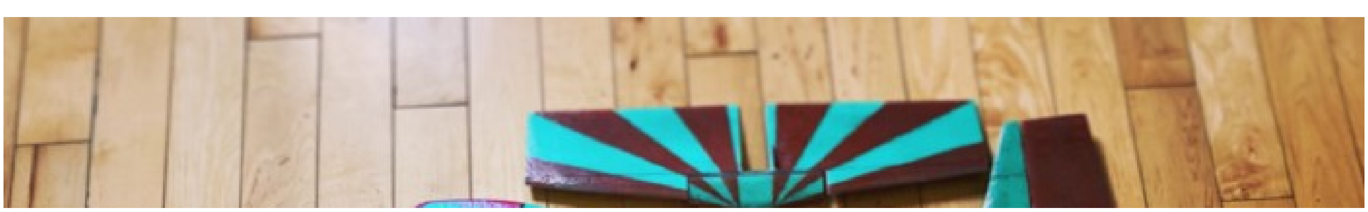
I remember first hearing about VTPR (Voltige Trés Prés du Relief) around seven years ago and was absolutely fascinated with it. VTPR, in general, is low level slope aerobatics done within close proximity. Something that's right up my alley as I love flying close and low and it's guiding me closer to something that I've envisioned since I was really young learning how to slope soar. I've always wanted to do genuinely interact with my plane on the slope and this type of flying is the closest thing that I've seen to it.

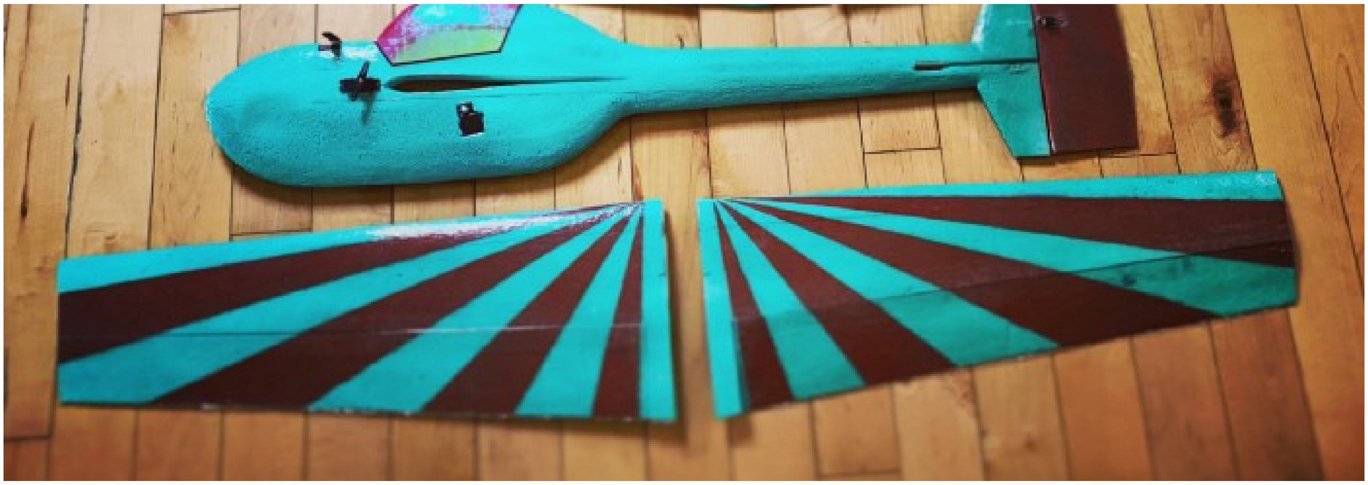
My initial plunge into this style of flying was done with a Dream-Flight *Ahi* and although it's a great flying plane and served me well for a few years, I wanted something with better performance. This is where the *Buzz* came in.

Because of my involvement in so many other facets of RC soaring, the pursuit of a better VTPR plane was placed on the back burner till I saw that Justin Gafford from *Slopecorn* was putting a new batch together recently and knew that this was the plane I needed to take my flying to the next level. I seized the opportunity and reached out to him where he notified me that he could build one for me in the current batch he was building. This started lots of great conversations with Justin where I pleasantly found out that he is quite the character!

> I was bewildered when he told me to set up the CG (Center of Gravity)at 55% behind the Leading Edge and to set my control throw Exponential at 90%…

It was great too see the progress as Justin sent me pictures at various stages. As far as color schemes went, I let him have free reign on that in which he chose a *groovy retro look* with seafoam green and a red sunburst that I instantly thought was awesome!





The Buzz freshly out of it's shipping box. All pieces arrived in great condition after their journey from California to Calgary, Canada.

Justin offers a few versions of this glider in various forms of completion and I opted to get a complete plane with servos installed to expedite the building time. Arriving in a stout cardboard box, all the components made their journey unscathed. The EPP foam (*Expanded Polypropylene*) components were painted and covered with laminating film. All servos came installed and a small accessory pack along with some laminating film came in the package to complete the assembly.

The pre-cut hatches were sized just right for the battery and receiver I chose to use in this very unique bird. I went with a flat 4 cell pack of Eneloop NiMH (nickel-metal hydride) batteries because of the safe chemistry used in them. The 4.8v output works great with inexpensive servos also with no need for any voltage regulation such as those needed with lithium batteries. Pretty much all of my slope ships carry NiMH batteries as the last thing I want to be concerned about is a lithium battery catching fire on the edge of a remote hill somewhere in a crash. Unfortunately we are losing flying sites all the time and I see no point in taking any extra risks.

The assembly was pretty straight forward and required me to join the wing halves, reinforce it with the some of the extra laminating film and glue it into place with a nice bead of hot glue. The stabilizer was glued in the same way. Once that was completed all that was needed was to install the rudder control horn and the pull-pull control lines along with making the aileron pushrods with the provided components. once everything was completed there was some more reinforcements made in the nose area with laminating film and all was done. An easy laid back assembly that took me a few hours one night to accomplish.

Setting up all the control throws and balancing this plane was highly entertaining and had some fun and questionable instructions from Justin. I was bewildered when he told me to set up the **CG (*center of gravity*) at 55%** behind the leading edge and to set my control throw **exponential at 90%**! Along with this he stated that *"If you don't activate elevator to aileron/flap mixing, this plane will fly like a paper plate".* The ailerons both drop down when the elevator goes up and they deflect up with the input of down elevator.

Pull-pull servo configuration and the resulting extreme deflections of the tail surfaces.

With some hesitation I heeded his advise and set the tail surfaces up for approximately 80 degree deflection along with 90% expo. Also programmed the elevator/flap coupling. It balanced at the recommended 55% mark with no weight needed to accomplish this.

Finishing this at the end of the unpredictable winter weather here in Canada, I needed to patiently wait for a few weeks for favorable conditions. Not my strong suit but that's what happens when you're involved in weather dependent pursuits. The day finally came and I zipped out to a hill close to my home after work. Gave everything a final check and tossed the *Buzz* into the light and variable, slightly cross, winds. You can see the results in the accompanying video below.

It flew straight out of my hands and I didn't find it twitchy at all with such a rearward CG and gigantic control throws. Much to my surprise, Justin's recommendations were bang on!

The conditions were less than optimal, but I certainly had a chance to see how it flies. Some of the initial observations were that it flew with far more authority than I expected it and went exactly where it was pointed, inverted flight needed no down elevator to maintain altitude and the rolls were nice and axial. It was a fun game playing with the energy management of the glider to learn how to do flips and extreme maneuvers. You can come to a grinding halt when you fully deflect the tail surfaces for too long, or without enough energy. *You can see an example of this at the end of the video.*

Since the video was posted I've had a chance to get more time on the *Buzz* and can tell you that it does some amazing things. Continuous flips, sustained knife edge, wingtip scraping rolls and elegant spins. One of my favorite ways to fly is to put in some earbuds, play some music and "dance in the sky". The **Buzz** definitely allows me to do that! Looking forward to seeing what else this agile little ship will do!

I highly recommend giving VTPR flying a try. A nice change of pace from the norm, a great way to improve your skills and it's always rewarding seeing what type of new maneuvers you can do!


The maiden flight of the Buzz from the RC Soaring Diaries channel on YouTube.

Thanks for reading, and watching, and we will see you next time!

*All photos and video are by the author. Read the **next article** in this issue, return to the **previous article** or go to the **table of contents**. Downloadable PDFS: just this article or this entire issue.*


**Photo 1:** The RC Throwmeter mounted on the wing.

# Make Your Own Bluetooth RC Throwmeter

A new level of precision for setting up control surface throws.

Pierre RONDEL Follow
May 14 · 8 min read

***Note**: While Medium only permits one author of record to be listed, it's important to note that this article is a collaboration between Yannick Selles, Vitaliy Ryumshyn, Alois Hahn and Pierre Rondel, who share the author credit equally.*

## Introduction

The purpose of this article is to propose that you 'build' your own Bluetooth Throwmeter at a very reasonable cost. This RC Throwmeter, in addition to measuring angles and travels, it possesses nice features such as measuring Max UP and DOWN Travels/Angles, or set an visual alarm to a certain position (UP or/and DOWN). In addition the mobile app supports two devices simultaneously which is very convenient.

It doesn't require any soldering or cabling. You just need to have access to a 3D printer! The original idea came after finding by chance on aliExpress an all-in-one 6 Axis Bluetooth Digital Angle Accelerometer Module.


**Photo 2:** The prototype in yellow and the final device on the left.

Initially, one of us bought two examples of the 'naked' board, then bought a 1S LiPo, a micro switch, and designed the case and the clips. Later we discovered the same component was available with a case, battery, switch, charging plug and a charging cable for about four euros more. It saves lots of soldering and cabling, so the final version we propose hereafter is based on this model.

## The Measurement Component


**Photo 3:** The Wit-Motion component in its package.

The component is the BWT61CL from Wit-Motion, a six axis Bluetooth attitude angle sensor with battery incorporated. You can buy it on AliExpress or Amazon US / EU and it costs between 24 and 35 Euros with free shipping. It is based on the JY61 sensor, has Bluetooth or serial connectivity, integrates a dynamic Kalman filter algorithm, an internal voltage stabilizing circuit module, voltage 3.3v~5v. The only drawback is that the Bluetooth BLE is only compatible with Android. We apologize, in advance, to all iOS users! The battery has a 150mA capacity which provides plenty of operating time. Components are now provided with an USB-C plug instead of the load balancer type plug it had initially.

**Photo 4:** Comparison between the old and new version of the component, now with an USB-C socket.

## Characteristics

- **Voltage**: 3.3V-5V
- **Current**: <40mA
- **Size** : 51.3mm x 36mm X 15mm
- **Weight** : 16gr
- **Dimension**: Accelerated speed -3d Angular speed -3d Magnetic field-3d Angle-3d
- **Air pressure**: 1d
- **Range**: Accelerated speed -±16g Angular speed -±2000°/s Angle — -±180°
- **Stability**: Accelerated speed -0.01g Angular speed -0.05°/s
- **Attitude measurement stability**: 0.05°
- **Output content**: Time, Accelerated speed, Angular speed, Angel.
- **Output frequency**： 100Hz
- **Date interface**: Serial TTL level, Bitrate 115200 (default and can't be changed)
- **Bluetooth transmission distance** : >10m
- **Supported OS**: Android
- **Battery Life**: 2 to 3 hours (full charge)
- **Documentation**: Gyroscope Bluetooth Version BWT61CL (2.3MB PDF)

## Let's Start Building Your RC Throwmeter

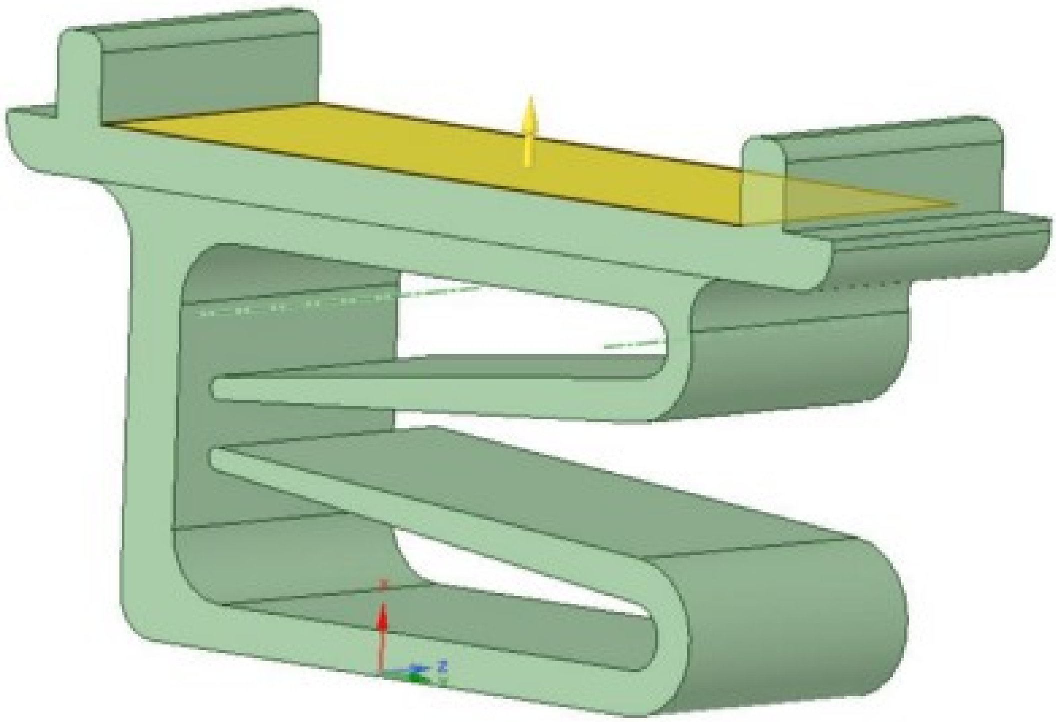


**Photo 5:** Design of the removable clip.

As stated in the introduction, the work is limited to the 3D printing of the clip that fixes the device to the trailing edge of the glider. It has been designed on DesignSpark, and we are providing the .rsdoc original file (**original file .rsdoc**) in addition to the STL file. If you want to do your own modifications, you can easily to with the **STL file here.**

The clip is removable, so the device, its clips and the charging cable can be carried/stored in a small plastic box.

**Photo 6:** Once the clip removed, the RC Throwmeter can be stored in a small plastic box.

Just print the part, in PLA, PETG or ABS, 100% infill. The dimension is optimized for F3x plane wings and tail planes. To protect the surface of the control surface and avoid the clips sliding or shifting, we add a piece of rubber (a small piece of bicycle inner tube) on the clips surfaces, with double-sided tape.

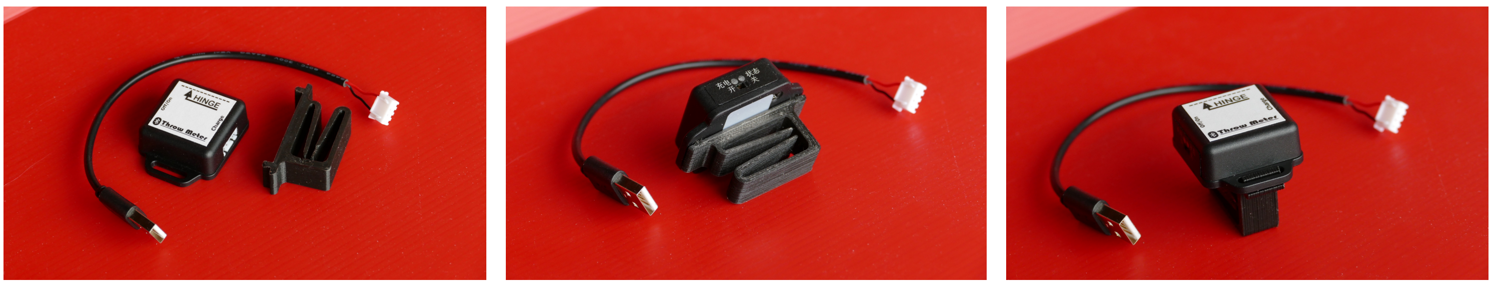



**Photo 7 to 9 :** Different views of the RC Throwmeter and its clip.

Print the sticker using the .pdf provided (**PDF file for the sticker)**. Prior to applying it, don't forget to remove the other sticker. Protect the printed paper with transparent tape at the top, and double-sided tape on the other side, and position it on the top of the case, respecting the correct orientation (`Charge`, `On/Off`). This will give you the orientation when using pointing where is the hinge.

## The Mobile App

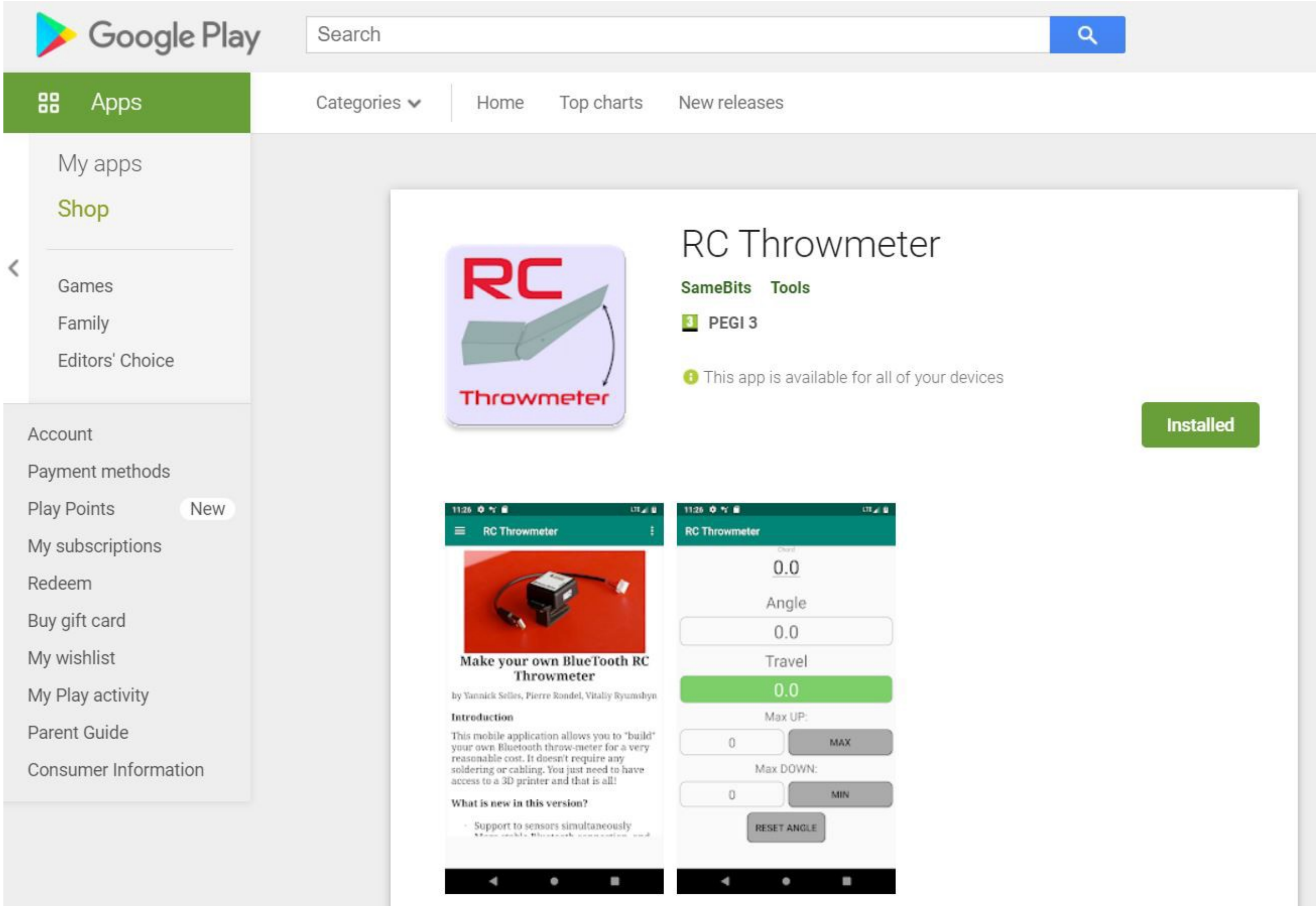



**Photo 10:** The mobile application can be found only on Google Play — sorry iOS users!

The Android app has been initially developed by Yannick who implemented all the framework and pages, and also the angle/travel calculation. Then Vitaliy added the support of a second Bluetooth connection, and more recently Alois integrated the full calibration commands and made some other improvements.

The app is divided into several screens, the `Start` screen giving access to the top left menu, the `Sensor BT` screen to bind the app with the Throwmeter, and finally the `RC Throwmeter` screen where everything happens once binding is complete.

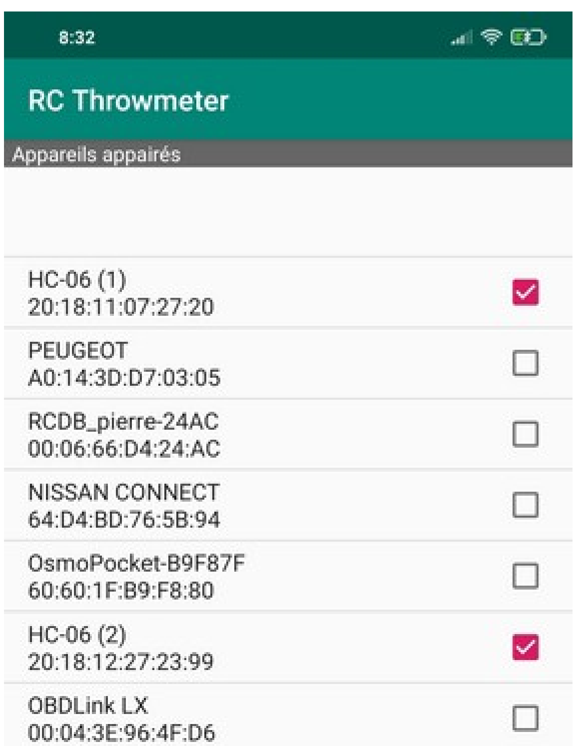
## Features of version 1.4

- Support two sensors simultaneously
- Calibration support, no need for manufacturer's app
- Bluetooth status bar
- More stable Bluetooth connection, and re-connection when exiting of standby/sleeping mode

- Clearer separation between max travel feature and limit setting with alarm feature
- Localization
- German language support
- Sensor option to chose more robust X/Y only calculation
- Compacter screen layout for small displays
- Reminder to power off sensor when app is exited

## Using Your RC Throwmeter(s)

- **Charging the battery:** Connect the cable provided to the balancer plug. On newer versions just connect the USB cable. The red LED is ON during the charge and switches to OFF once charged.
- **Switching on your Throwmeter(s):** Move the sliding switch from right to left. The blue LED blink which indicates that the device is waiting for the binding.
- **Binding your Android smartphone for the first time:** On your smartphone navigate to the `parameter/Bluetooth` menu and scan for new devices. The BWT61CL will show as HC-06. When asked, enter the code `1234`. The sensor is now bound and you are ready to open the app.



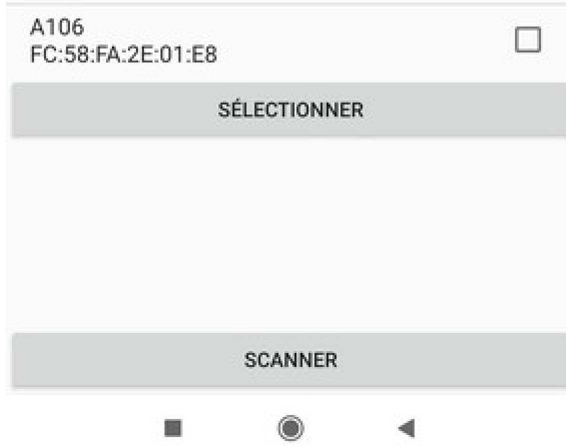



**Photo 11:** The binding page of the app where you select which device(s) you want to connect to.

- **Binding with the app:** Select the menu on the top left, then open `BT Sensors` and select one (or two) HC-06 sensors or click on `Scan` if the device doesn't appear. Once selected you can return on the start page. Open the menu on the top left and select `RC Throwmeter`.
- **Calibration:** If the device is providing inconsistent or weird measurements, it probably needs a full calibration. Level the sensor(s) horizontally and do not move in. To activate Calibration use a **long press** of the `Reset/Calib` button, confirm dialog and wait until calibration completes.
- **Reset Angle:** The device is supposed to do a calibration at startup. It is recommended to do it with the device installed on a horizontal surface. Once done, you can clip the device on the leading edge of control surface you want to measure. When your control surface is at its neutral position, proceed to a new `Reset` in order for the device to know its spacial position and be ready to measure the angle.

**Photo 12:** The clip is perfect for F3X planes. CAD files are provided so you can modify it if needed.

- **Travel setup** Measure the chord of your control surface and click on the chord field at the top of the screen to enter the value. There is no unit, so it can be either mm or inches. Travel will be shown in the same unit.
- **Max UP and Max DOWN** This is a very useful feature that allows you to quickly measure the maximum up and down travels of a control surface. Use `Reset` to clear the `Max UP/DOWN` values for a new measurement.

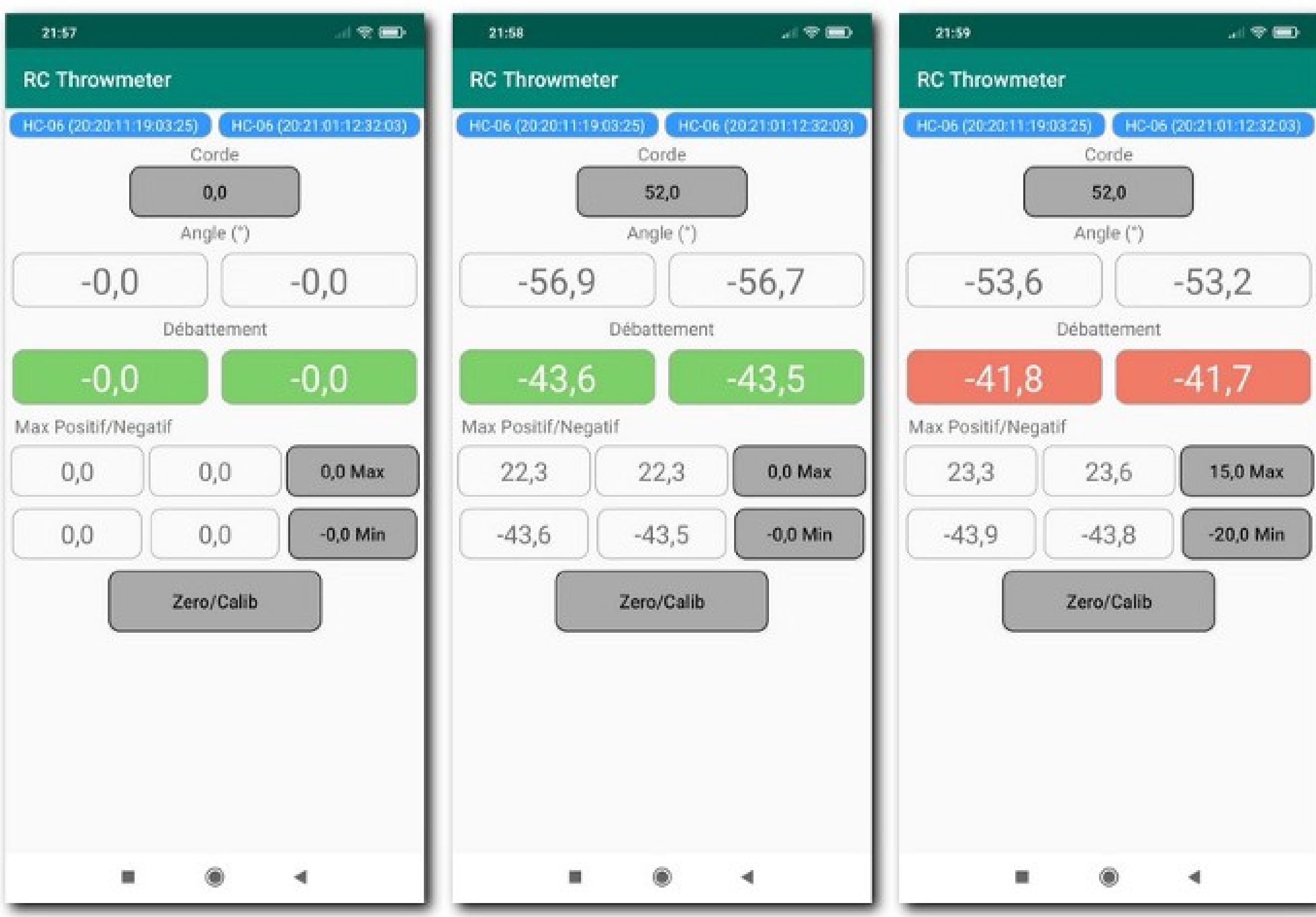



**Photo 13:** The measurement screen in action: measure, min/max and limits.

- **Set Max UP and Max DOWN Thresholds** If your objective is to do settings, not to measure, you can enter a `Max Positive Travel` and a `Min Negative Travel` separately. This instructs the app to display an alarm (in red instead of green) when the travel value exceeds a threshold, either above the `Max Positive Travel` or below the `Min Negative Travel`.


**Photo 14:** The clip is holding perfectly.

- **Sensor Options** The app computes its spatial position upon the rotation measurements of the Wit-Motion sensor. The most precise method uses all three axes X,Y and Z. It turned out, that the Wit-Motion sensor can lose the correct Z value when moved fast and irregularly. This may add significant error to the measured angle, specifically around zero. The user has to use `Reset` if this occurs.

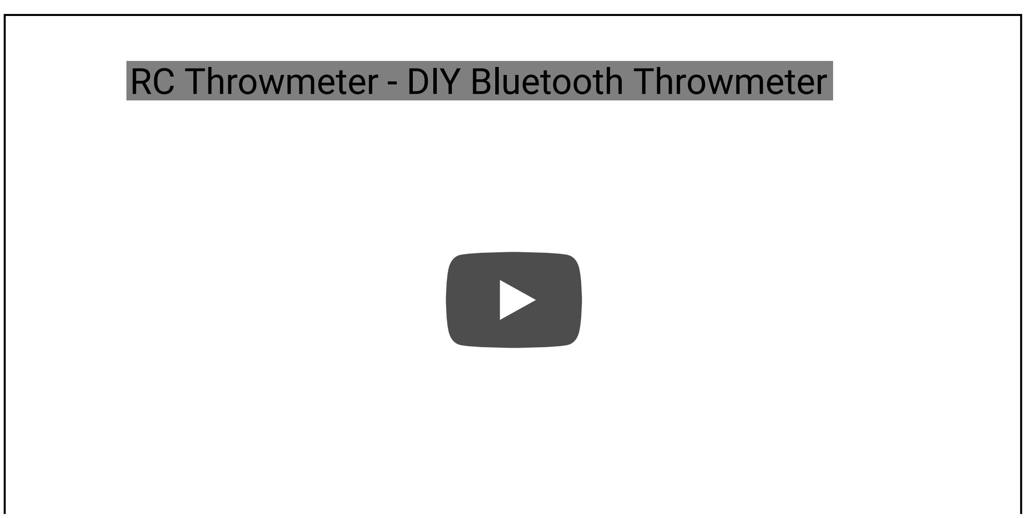
As an alternative, the app may ignore the vertical Z axis. This method is much more robust, but might add some absolute measurement error. In a real life context this can be accepted for the comfort of robustness, thus it is the default setting.

Sensor setting options are provided to allow the user to choose the preferred mode.


**Photo 15:** A configuration menu allow you to deactivate the Z axis.

## Video

Better than any written explanation, hereafter is a very instructive and comprehensive video made by Alois:



Video 16: A great video from Alois to explain everything in a comprehensive way.

## Calibration with the Manufacturer App

Alternatively, instead of using the `Calibrate` button as described above, the calibration can be done with the manufacturer's app as well which can be downloaded **here**. To do a full calibration, once selected the correct chipset model WT601, click on `SET` (top left) and then `Acceleration Calibration`. Once calibrated the app can be closed and the user can run the RC Throwmeter application.

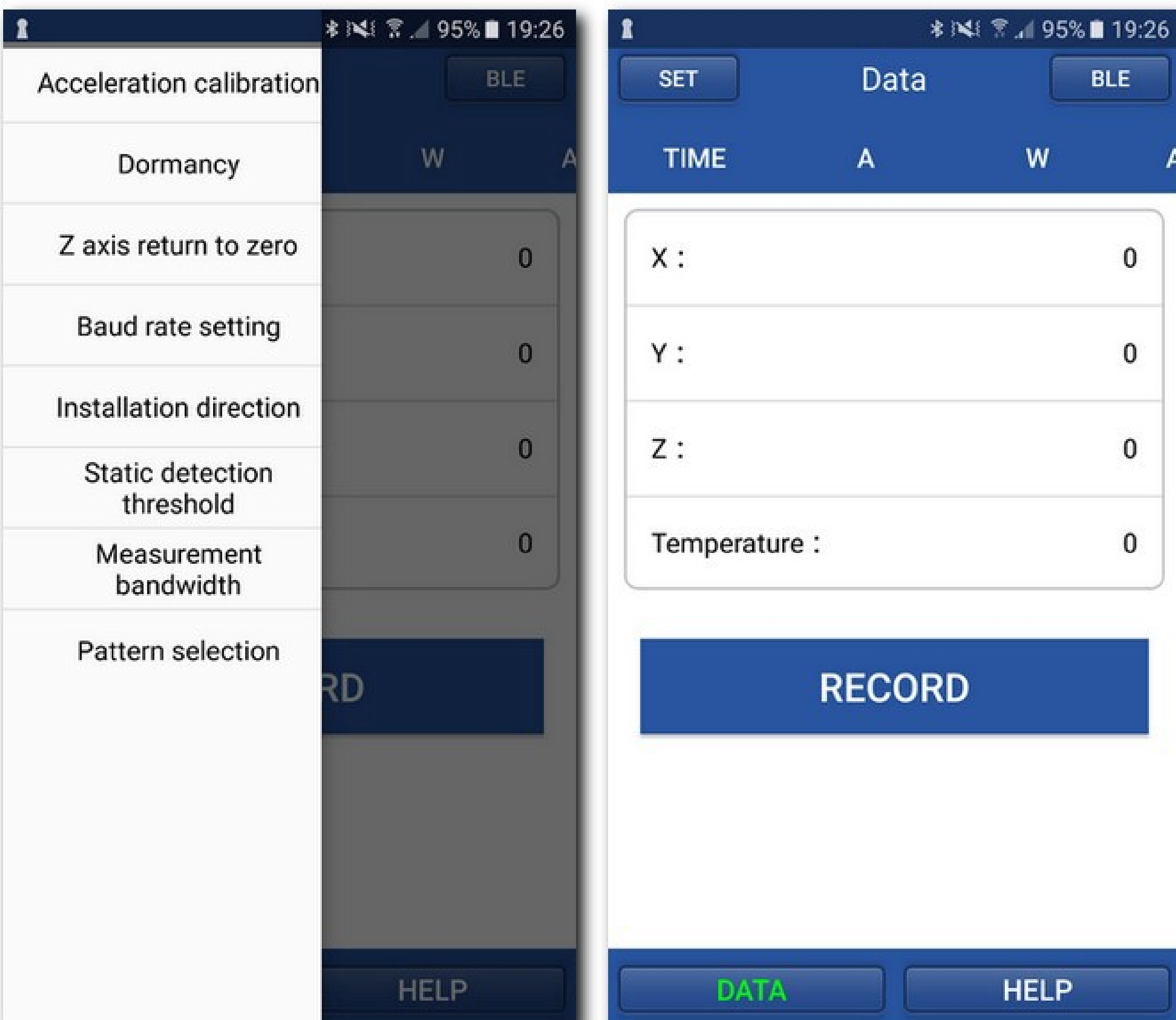


**Photo 17:** The manufacturer's app can also be used for the initial calibration**.**

## The Final Word

We sincerely hope you will enjoy this Bluetooth RC Throwmeter! Please remember that all this work has been done freely as a contribution to the soaring community. There is probably some imperfections or possible improvements (write a response below!) which will come in the future, but believe us: if you try it, you will certainly adopt it and will never go back!



*All videos and images are by the authors. Read the* ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents****. Downloadable PDFS: just this article or this entire issue.*

Bluetooth Throw Meter DIY Android

# Center Finder

When it's time to stake out some middle ground.

Tom Broeski Follow
May 19 · 3 min read

I was trying to find the exact center of the root rib on an Aquila XL so I could replace the tiny 1/4" rods with a decent 1/2" carbon joiner. Trying to get the measurement just right with just a rule, wasn't that easy. I had a Robart center finder that has really helped me find centerlines for hinges and such. The only problem is that it is too small for a lot of my needs.

**Photos 1 and 2**: The Robart Hinge Point Drill Jig which I simply refer to as their center finder because that's what it actually does.

Soooo…I made a quick and simple center marking gauge large enough to fit the thicker ribs on many of my planes.

## Materials

- (2) 1/4 inch by 3/8 inch by 3 inch block (you can vary the sizes however you want)
- (1) 5/8 inch by 3 inch block (the longer this block the thicker the thing you want to find the center of can be)
- (2) Machine screws ( I used 8–32 stainless because that's what I have handy)
- (2) Nuts
- (2) 'O' rings (optional)
- (1) Scribe insert (optional)

**Photos 3 and 4**: The basic parts, and the assembled center finder.

- Cut out the blanks and mark for the holes.
- Drill the appropriate end holes in the three blocks. I counter sunk for the screw heads, but it is not necessary.
- Assemble the unit (I chose to use knurled nuts and "O" rings to make it work like I wanted).

**Photos 5 and 6**: This is the trick to finding the exact center.

- This is a critical step to get the exact center. Take and push the blocks together and scribe a line on the main block. Flip the outer bocks the other direction and scribe again. This gives you an "X" right in the center of the block.

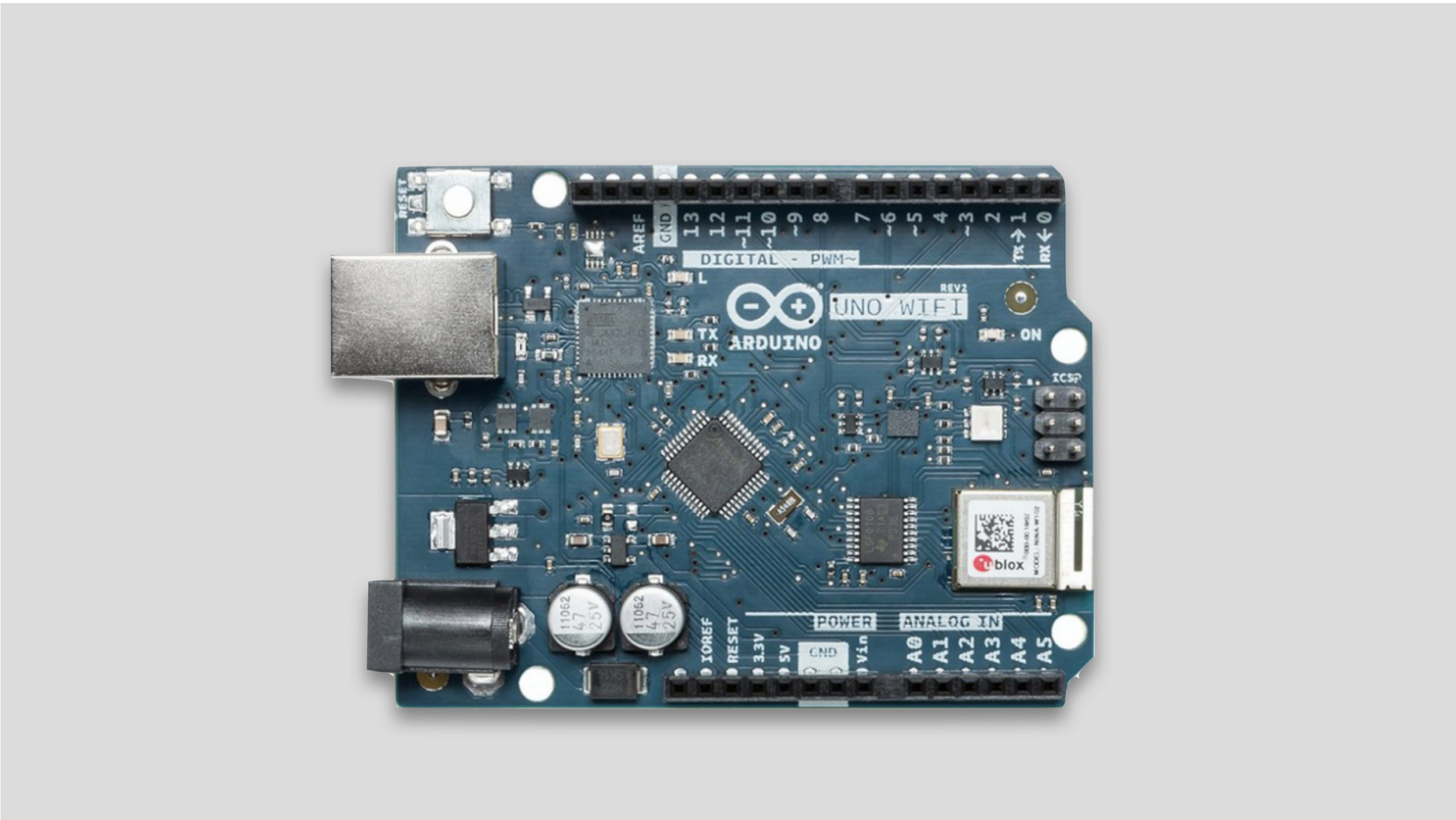
**Photos 7 and 8**: The finished center finder both with the marking pin on the left and, alternatively, a pencil on the right.

- Drill the center hole. I chose to use a center scribe insert, since I had several in my tool chest, but you can drill a small hole for a pin or a larger one for a pencil.

Thanks for reading. Please let me know what you think or if you have any questions, feel free to write a response below.



*All photos by the author. Read the* ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents****. Downloadable PDFS: just this article or this entire issue.*




The Arduino Uno WiFi rev 2. (image: Arduino.cc)

# Use of Arduinos in Model Aircraft

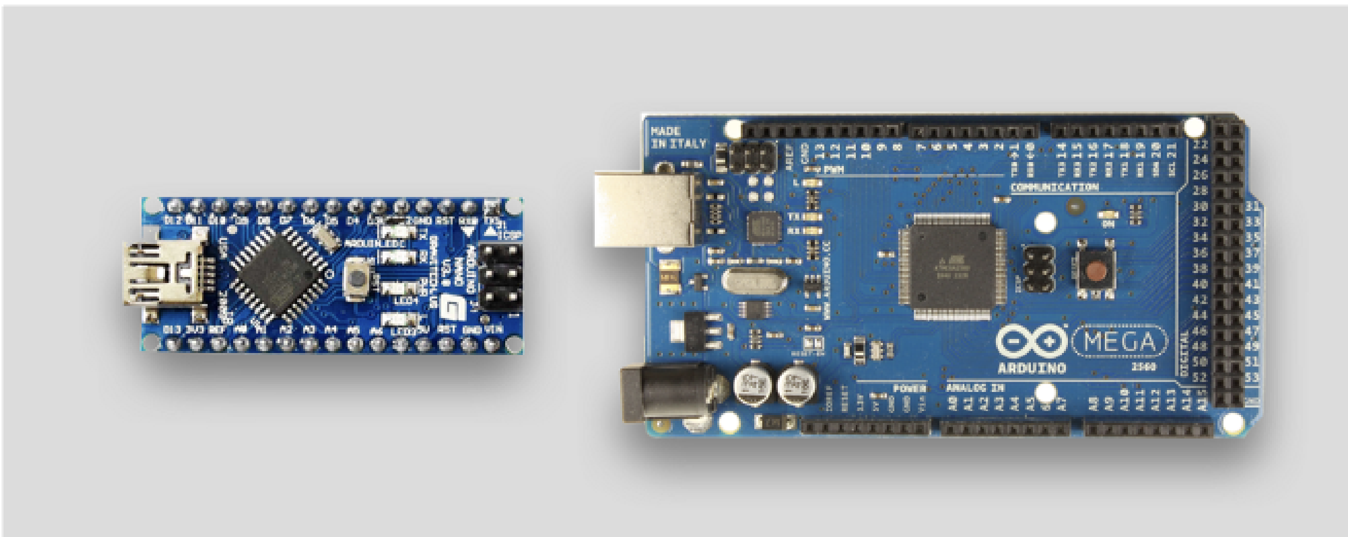
## Add a little computing power to your next project.

Peter Scott Follow

May 14 · 5 min read

What is an Arduino? It is a small, very cheap computer board intended for reading sensors and controlling things, for example using motors and servos. It was designed by Arduino.cc in Italy to get people to use computers in a more creative way, including what we now call Internet of Things (IoT). There are many different boards ranging in size from the Nano (18 x 45 mm and 7g) to the Mega (53 x102 mm and 37g). They differ mostly in the number of inputs and outputs. All are programmed using free software running on a personal computer, which can be running Linux, Windows or Mac, the simplest being on one running Linux, such as Ubuntu. There are smaller boards of differing shapes but they are not ready to use. They are intended to be built into devices. You can power the board from the receiver supply using the red and black wires in a servo lead.

The whole project is Open Source, which means that the software is free and users share their programs and designs online. Don't worry if you have never written program code. There is a huge range of ready written code for just about any job you might want to do. You soon learn how to adapt the code if you really need to. It's all part of the fun.




The smallest Arduino (Nano) on the left and the largest (Mega) on the right. Images are not to scale relative to each other. (images: Arduino.cc)

## How Does It Work?

An Arduino has several inputs of two types. Inputs are pins onto which you can put voltages:

- Digital voltages, from a switch or other device, which have one of two values (0 and 1), for example 0V and 5V.
- Analogue voltages from sensors detecting such things as light, sound, temperature, pressure, potentiometer voltages etc. These can have any value between say 0V and 5V. The Arduino digitises them, which means it measures them and gives the value a binary number, for example between 0 for 0V and 1023 for 5V. In binary these are 0000000000 and 1111111111. Ten **B**inary dig**IT**s (bits) are used so this is called 'ten-bit resolution'. Remember, there are 10 types of people. Those who understand binary and those who don't.

It also has several output pins from which signals may be sent:

- Digital outputs give 1 and 0 in the form of a voltage, for example 0 or 5V. These could be used for switching lights, relays and so on.
- Pulse width modulation outputs allow you to create varying signals. For example an on-off voltage could be used to drive a motor at different speeds, or a lamp at different brightnesses, by varying how long the signal is on rather than off (mark-space ratio). You could make sounds by sending varying signals to a loudspeaker. You can create the same servo signals that our receivers produce.

You either use standard code or write your own on your computer. You then send it to the Arduino through a lead. The chunks of code are called sketches. The software you need on your computer can be downloaded free of charge from the Arduino site.

## How Might We Use One in a Model Aircraft?

Several ideas spring immediately to mind:

- An Arduino can create the pulse width modulation signals that vary from 1 to 2 milliseconds in length, to operate our servos. They can drive low power servos directly but might need an additional board to boost the current for larger ones. If you have a scale model with complicated undercarriage doors and mechanisms, you could build a sequencer that drives the door servos and retracts at a chosen speed and in the order you want. The Arduino would read a start signal from a switched receiver channel and then go into its retract sequences.
- You could operate landing lights and steady or flashing navigation lights. You could even power up some high intensity LEDs if the model thermals too high to see clearly.
- Along the lines of a free flight dethermaliser you could automatically raise airbrakes at a pre-determined height, read from a GPS or variometer telemetry sensor.
- For rubber powered free flight models you could build an electric winder that would program and count the turns on a stepper motor. Yes, I have one of these in the design stage.

- Free flight F1A/A2 gliders are released at speed from a 50m towline and follow a vertical S-shaped path of half a loop and half a bunt. They can gain up to another 50m in this way. The Arduino could control the elevator servo to do this without breaking the competition rules.

## How to Get Started

You can buy a board, a power supply, a USB lead and a set of components for about £35 ($45), for example on eBay. You never know, you might get hooked on these control systems and start building all kinds of clever things. It is probably best to start with the middle-sized Uno. Cheaper compatibles are usually fine and should have the same mounting holes as the original Arduino ones. You will also need connecting (jumper) leads that push on to the pins or into sockets, so you need both male and female. They are sometimes called DuPont wires. A breadboard is also useful for plugging up circuits as you experiment. Here are some typical prices as of 2020.

| | |
|---|---|
| Uno (Compatible) Board | £5.00 |
| 5V power supply | £5.00 |
| USB lead | £2.00 |
| Sensor kit (37 devices) | £12.00 |
| Stepper Motor | £4.00 |
| Connecting Wires | £4.00 |
| Breadboard | £3.00 |

The sensor kit will include a huge range of input devices, to sense such things as light, infrared, sound, temperature, wetness, proximity, tilt, joystick movement, vibration, time, rotation and magnetism and will have some output LEDs and sounders. You can use the small 9g servos that cost around £2 or low power stepper motors.

There are plenty of books to get you started. It will be obvious which are for beginners. You will be amazed how quickly you pick it up. It is best to start no later than early afternoon or you will look up from your bench and find it is 4 am.

*The author has no connection, financial or otherwise, with the makers or distributors of the items mentioned in the article. Read the* ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents****. Downloadable PDFS: just this article or this entire issue.*


# 1/3 スケール三田式 3 型改 1 製作記

マルチパートシリーズの第2部。

Norimichi Kawakami Follow

May 12 · 28 min read

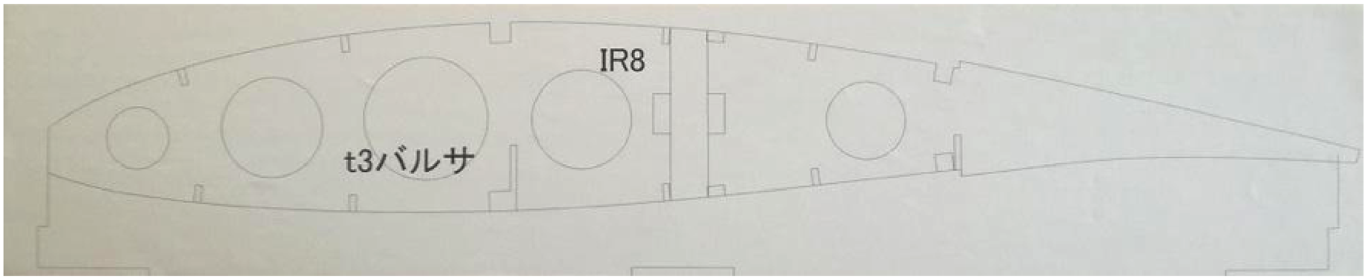
*If you prefer you can read the English translation of this article, which was provided by the author. この記事に進む前に、このシリーズの最初の部分を読むことをお勧めします。*

**製作その 2 中央翼リブ組み立て**

*リブ切出しと組立治具製作*

スポイラー製作に続いて中央翼本体の製作に取り掛かりました。翼の製作方法には各自流儀があるようですが、私の流儀を説明します。

まず、リブを切出すために図面を原寸大で印刷します。この時、下の画像のようにリブと共にリブ下面に接し高さ30mm程度の組立治具となる部分も一緒に作図して印刷します。



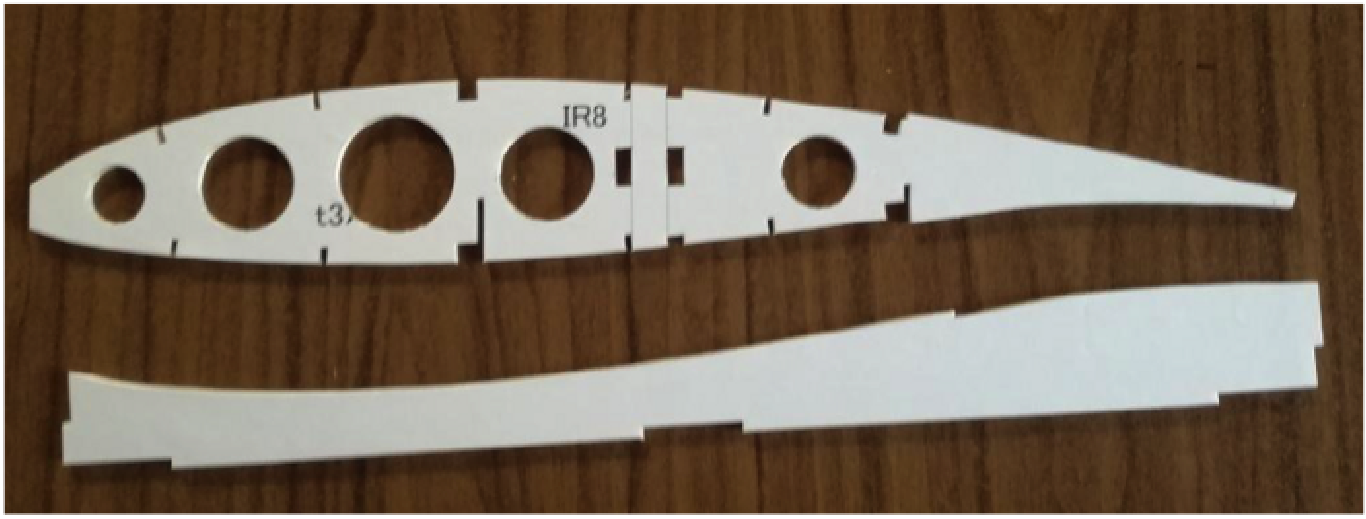

画像6 リブと組立治具部品図の印刷

この印刷されたものを3Mのスプレー式剥がせる糊でリブ用バルサ板に貼り付け、OLFAの30度薄型カッターで線に沿って切出します。

画像7 3M製スプレー式剥がせる糊とOLFA製30度薄型カッター

図面は0.09〜0.13mmの極細い線で印刷していますので、これに沿って慎重に切出せば殆どレーザーカッター並みの精度で切出せます。

これが切出し後のリブと組立治具の構成部品です。




画像8 切り出されたリブと組立治具構成部品

リブと組立治具構成部品の切出しと共に、治具前後枠と下部補強部品も切出しておきます。すべての部品の切出しが終わったらまず治具組み立てから開始します。中央翼は2mの長さになるので、製作中の取り回しやすさを考えて左右2つに分けて別々に作り、最後に結合することにしました。

中央翼の図面を原寸大で印刷したものを平板の上に敷き、その上に直接治具部品を図面のリブ位置に配置していきます。これを治具の前後枠で支えてから瞬間接着剤で接着します。枠と治具部品には互いに噛み合う切り込みが設けてあり、簡単且つ正確に組み立てられます。図面は接着するときに垂れた瞬間接着剤で治具にくっつきますが気にしません。このようにして中央翼の組立治具が下の写真のように出来上がりました。

画像9 組みあがった中央翼組立治具

中央翼の組立

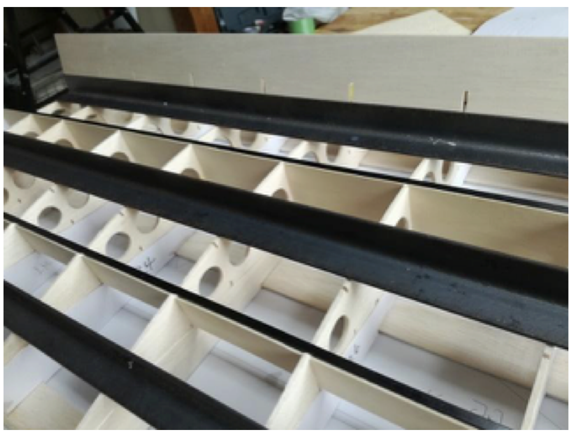
リブ切出しと組立治具が完了したのでいよいよ中央翼本体の組立です。次の写真が片翼分のリブです。まだ型紙が貼りつけられたままです。

画像10 切り出された中央翼片翼分のリブ

尚、リブは基本的に3mm厚バルサで作りましたが、左右両端の後縁までプランクされる部分は2mm厚バルサとしました。また一番内側のリブには1.6㎜厚のシナベニアを、一番外側の外翼と接するリブには2mmのハードバルサを保護板として貼り付けることは前に説明した通りです。

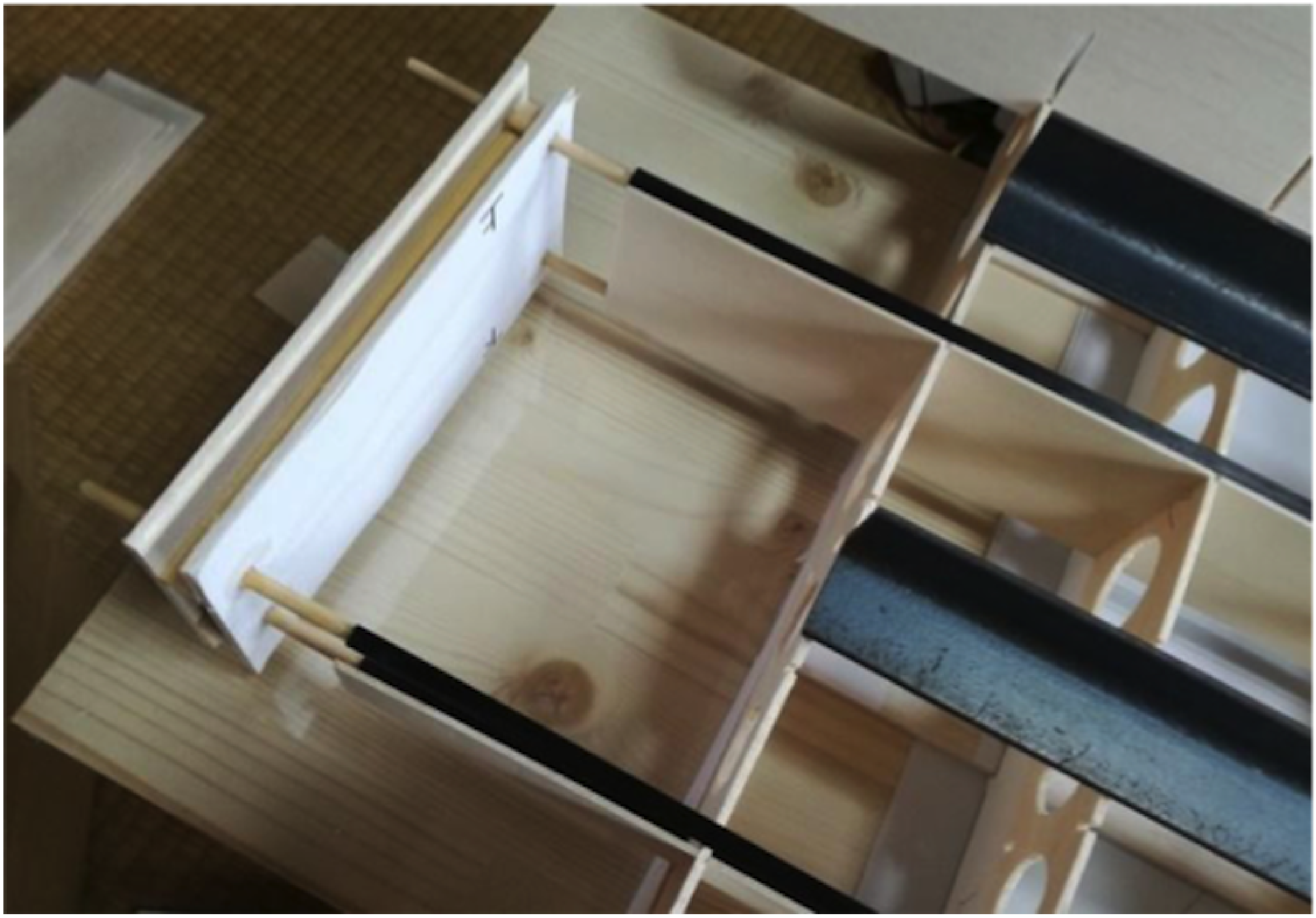
型紙は当初貼りつけたままでも良いかと思ったのですが、剥がしてその重さを計測してみて驚きました。優にリブ数枚分の重さがあります。考えてみると型紙用に購入したA3コピー紙はずっしりと重量がありました。紙は重いです。

これを組立治具の所要の場所にセットして、カーボン角パイプの桁フランジと1.6㎜厚シナベニアから切出した桁ウエブを組み合わせていきます。この状態でスポイラーと、外翼と結合するためのカンザシ受けとなるアルミチューブも組み込んでおきます。組合せ完了後重量のあるスチール製のL型棒を2～3本上に置いて重しとし、リブをキッチリと治具に合わせます。治具とリブは元々一枚のバルサから切り離して製作したものなのでピッタリと合います。



画像11 中央翼の組立

左側の写真でリブ前縁側に立っているバルサの板はリブを正確に垂直に立てるために噛ました治具です。尚、左右の翼を後程結合するために桁位置を正確に揃えておく必要がありますので、下の画像のような簡単な位置決め治具を噛ませておきました。



画像12 桁位置決め治具

この状態で低粘度瞬間接着剤を結合部に垂らし、カンザシ受けのアルミチューブはたっぷりのエポキシ樹脂で周辺の桁ウエブに接着します。画像13は接着完了後の中央翼リブ組み立てです。赤く着色されたものがスポイラーで、カンザシ受けのアルミチューブも見えます。

画像13 接着完了後の中央翼リブ組み立て

組立治具のお蔭で正確なリブ組み立てが簡単に製作できました。治具はこの後のプランク作業にも威力を発揮します。尚、この状態で重量を測定したところ左翼が355ｇ、右翼が344ｇで合計して約700ｇでした。左右の重量差が若干大きいのが気にいらないところです。尚、この後のプランク作業では大量のバルサ粉が出ますので、涼しくなってからにしようと中央翼の製作は一旦中断しました。

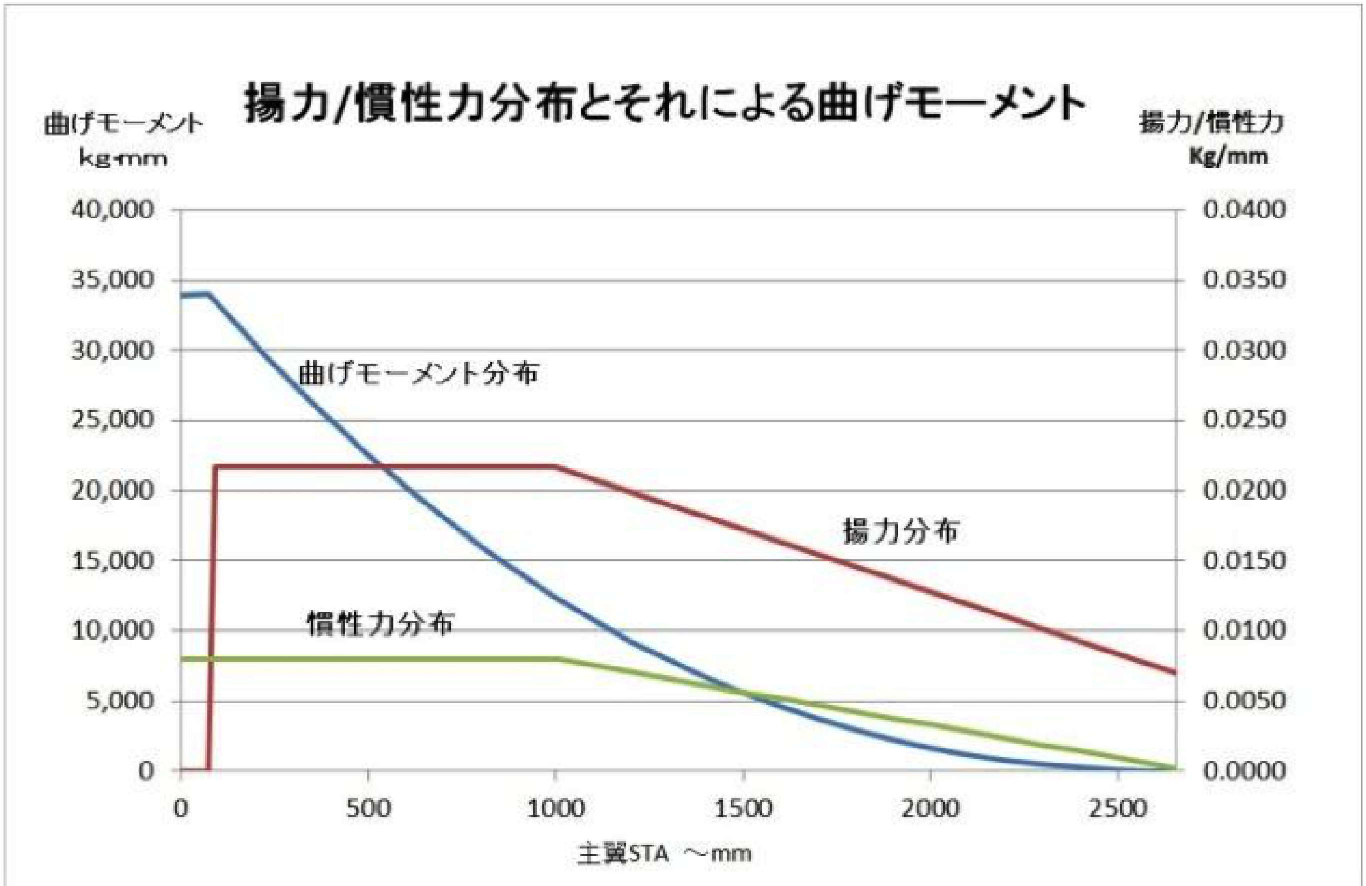
## 主翼の強度計算

今回は大型機で重量も重いので主翼の強度計算をしておきました。

*設計荷重*

航空機の強度計算は機体の制限荷重倍数（許される最大G）に、安全余裕として安全率1.5を乗じた終局荷重倍数で発生する荷重（設計荷重）に対して、壊れないことを確認する作業です。設計を開始した時点では三田式3型改1実機の制限荷重倍数が見つけられなかったので、アクロバット飛行をする固定翼A類に適用される制限荷重倍数6.0を採用しました。これに安全率1.5を乗じると終局荷重倍数は9.0となりますが、更に余裕をとって10として設計荷重を算出して強度検討することにしました。

最大全備重量8.7Kgの機体に10Gをかけるということは、主翼に87Kgの揚力がかかることを意味します。主翼には質量がありますから揚力と反対向きに10G分の慣性力が働きます。揚力と慣性力の差分が主翼を上に曲げるモーメントになります。この関係をEXCELの表計算で計算した結果が下の図です。



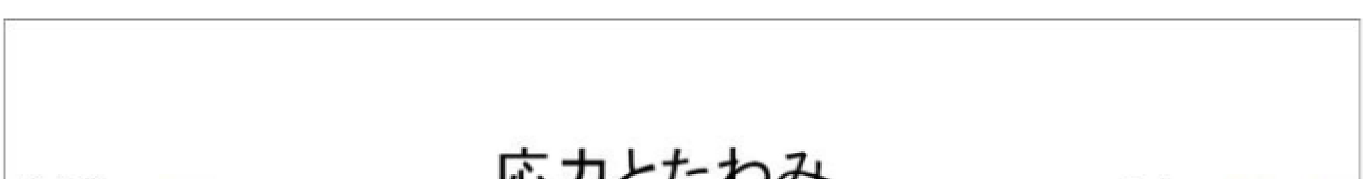

グラフ4 主翼の設計荷重

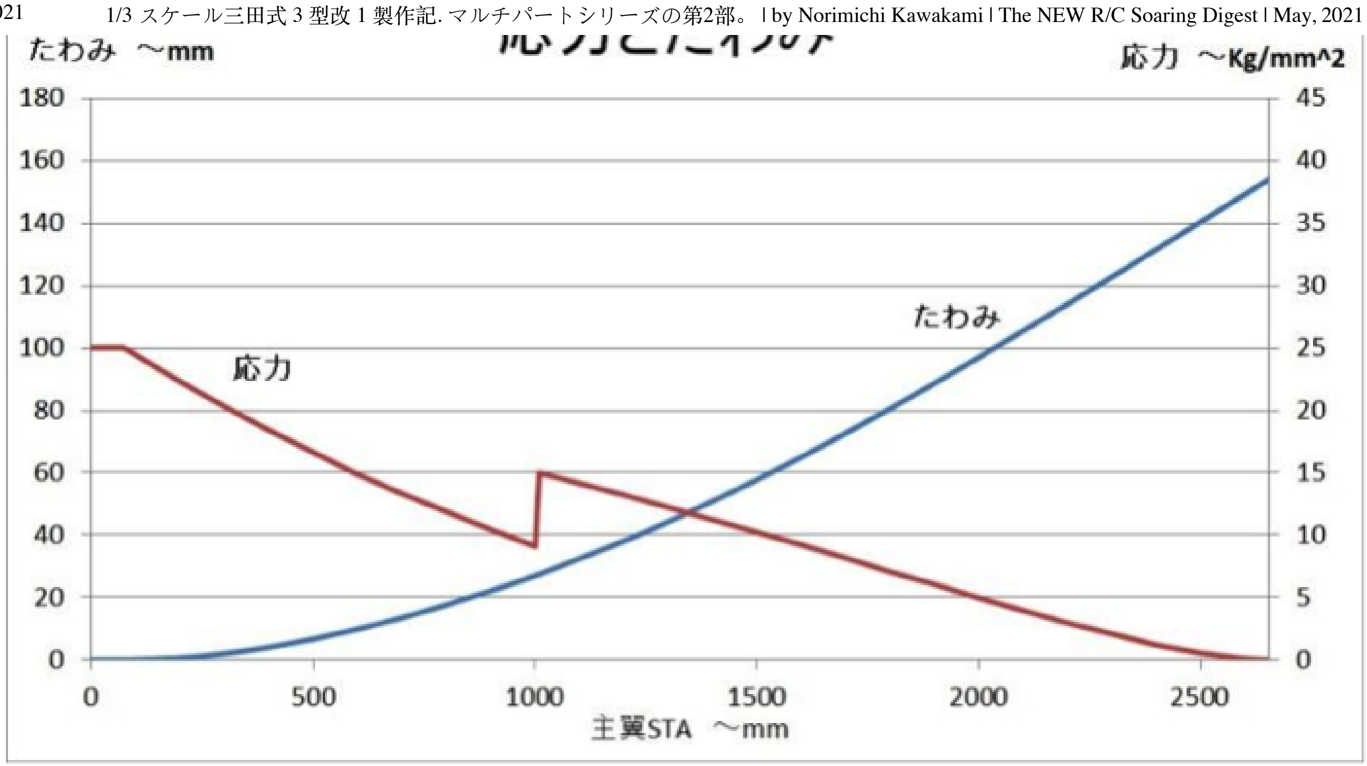
これは片翼についてグラフ化したもので、主翼STA＝0が胴体中央線、主翼STA=2655が翼端です。揚力、慣性力共にSTA＝1000より外では外側に行くほど減っていますが、この範囲がテーパーした外翼です。揚力がSTA＝100付近より内側でゼロになっているのは胴体内にあるためです。

曲げモーメントは翼端でゼロで翼根に向かって徐々に増加します。STA100付近で増加が止まり一定になるのはこの位置で翼が胴体に結合されているからです。曲げモーメントの最大値はこの翼胴結合部で、その値は約34,000Kg・mm＝34Kg・mです。

*強度検討*

この曲げモーメントによって翼は上向きにたわみ、桁に応力が発生します。モーメント荷重による桁のたわみと応力は材料力学の梁理論で求められます。詳しい説明は省略しますが、これをEXCELの表計算にして計算しました。結果を下図に示します






グラフ5 設計荷重による主翼の応力とたわみ

たわみは翼端に行くほど大きくなって、翼端では154㎜程度と予想されます。応力はモーメントの大きい翼根が最大で翼端に向かうに従って減少しますが、STA1000付近で再度増加します。これはここからが外翼で桁フランジが細くなるためです。最大応力は25Kg/mm2程度であることが判ります。この応力はカーボン角パイプのフランジに発生しますが、カーボンの許容応力は70Kg/mm2程度ですので、十分な強度があることが判ります。

尚、中央翼と外翼は外径20Φ、内径16Φのカーボンパイプ製のカンザシで繋がれています。STA1000はこのカンザシだけでモーメントを伝えますがそれによってカンザシに発生する応力は26.8Kg/mm2と計算され、十分余裕があることが確認できました。

後日実機の制限荷重倍数が5であることを元東海大学グライダー部教官の方から教えて頂きました。また完成重量は約10Kgに増えてしまいました。この条件での設計荷重は10×5×1.5＝75Kgですので、上に述べた87Kgの設計荷重は安全側であることが確認できました。

## 動力システムの選定

グライダーに動力システムの選定とは似合わないことですが、私の所属するラジコンクラブの飛行場は平地にあり、私はグライダー用ウインチを所有していないの

で、保有するRCグライダーには全てモーターと折り畳み式プロペラを装着して自力離陸できるようにしています。1/3模型も他機と同じくモーターと折りペラを搭載する予定で、そのためにはモーター、動力用バッテリー（LiPo)、モーターコントローラー（アンプ）からなる動力システムを選定しておく必要があります。

*モーターの選定*

まずモーターの大きさを決める必要があります。このクラスのグライダーでは重量1Kg当たり約130Wのモーターが必要とのうろ覚えの知識から、最大重量8.7Kgの本機では約1,100～1,200Wクラスがが妥当と踏みました。

このクラスのモーターとそれに伴うLiPo、アンプの組合せを調査して一覧にしたのが下表です。

動力システムの候補

| | | | | |
|---|---|---|---|---|
| 候補モーター | | OS OMA-5020-490 | FSD FC5065-6T | E-MAX GT4030/06 |
| KV値 | rpm/V | 490 | 430 | 420 |
| 通常電流 | A | 50 | 60 | |
| 最大電流 | A | 90 | 70 | 60 |
| 重量 | g | 350 | 361 | 380 |
| 価格 | ¥ | 14,900 | 7,236 | 6,483 |
| 候補LiPo | | KYOPOM 5,100mAh | KYOPOM 5,100mAh | KYOPOM 5,100mAh |
| セル数 | | 5 | 5 | 5 |
| 容量 | mAh | 5,100 | 5,100 | 5,100 |
| 重量 | g | 600 | 600 | 600 |
| 価格 | ¥ | 0 | 0 | 0 |
| 候補AMP | | Hobbywing Flyfun 100A | sunrise Model 80A | sunrise Model 80A |
| 負荷電流 | A | 100 | 80 | 80 |
| 重量 | g | 76 | 65 | 65 |
| 価格 | ¥ | 6804 | 4,495 | 4,495 |
| 合計重量 | g | 1,026 | 1,026 | 1,045 |
| 合計価格 | ¥ | 21,704 | 11,731 | 10,978 |

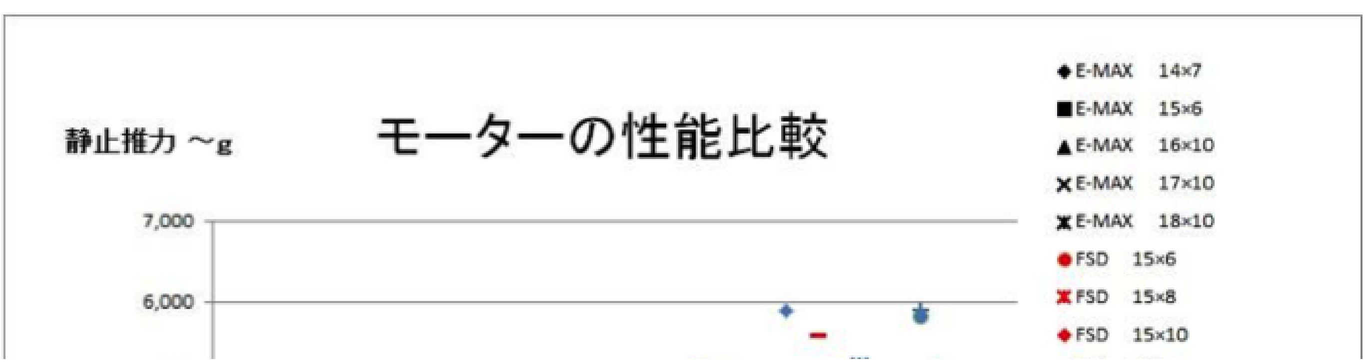
表1 候補モーターとそれに見合うLiPoとAMP

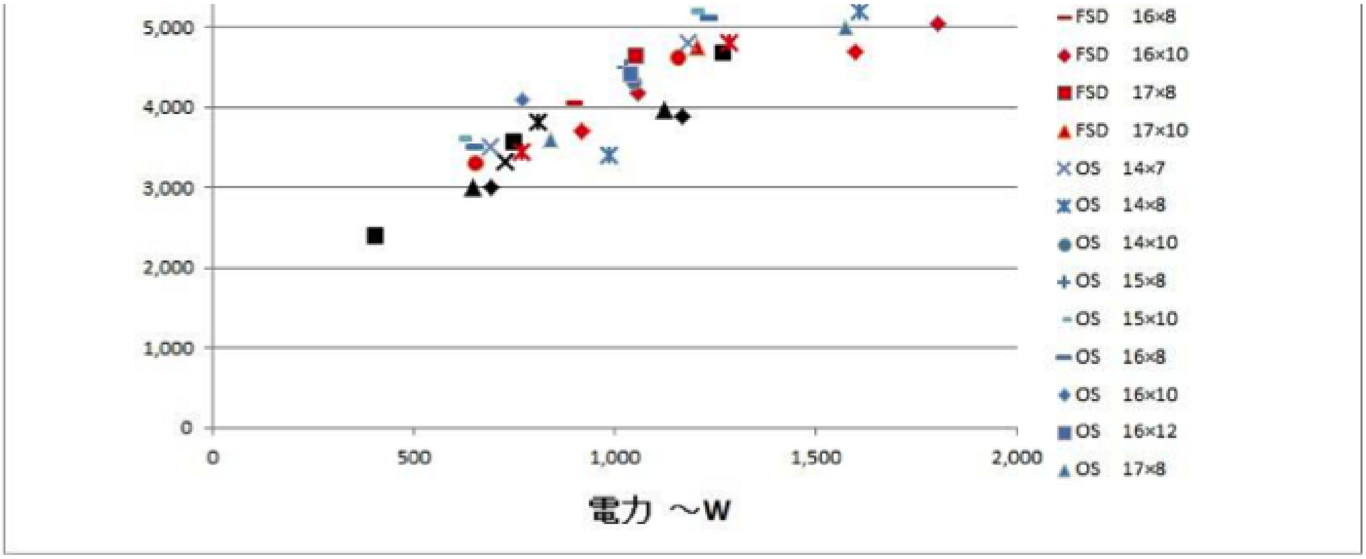
OS、FSD、E-MAXの3ブランドのモーターでおよそKV値が420～490、重量が350～380ｇです。

- OSモーターは小生もこれよりひとクラス小さいものを複数使用しています。、品質も性能も良く満足しています。特にOSモーターは他社モーターより若干KV値を高めに設定してあり、重量の割にパワーがありますので、重量の厳しい小型グライダーには打って付けですが価格が高いのが難点です。
- FSDモーターはReasonableな価格で問題ない性能を発揮するモーターで、私も一回り小さいモーターを、1/5三田式3型改1や1/5ミニモアに使用しています。
- E-MAXモーターは一番安価なモーターですが作りもしっかりして問題ありません。これと同じモーターを私の自慢のスケール機であるCurtiss Jennyに使用しています


画像14 E-MAX GT4030/06モーターを搭載した私のCurtiss Jenny

3つのモーターの性能比較グラフを公表データを用いて作成したのが下図です。OSモーターのデータはOSのHPから、FSDとE-MAXモーターのデーターはKKHOBBYのHPから借用しました。






グラフ6 候補モーターの性能比較

横軸が消費パワー（W)で縦軸が静止推力です。搭載するプロペラによって多少の違いがありますが、性能にそれほどの違いは認められません。ただ、適切なパワー領域に若干の違いがあるようで、E-MAXモーターが略1,000W前後、FSDモーターが略1,100～1,200W前後、OSモーターが1,200～1,400W前後が妥当な使用範囲のように思われます。

*動力用LiPoバッテリー*

全てのモーターの許容電流が50～90Aあるので、1,100～1,200Wを賄うには5セルのLiPoで間に合います。5セルのLiPoの公称電圧は18.5Vですが、満充電すると20Vを超え、通常使う範囲でも20V近くありますから、60A流せば1,200Wが得られます。必要なバッテリー容量は次のように求めました。

モーターを全出力60Aで1分間も回せば相当の高度が稼げます。そのあとはモーター回転を止めてグライダーとして楽しみます。サーマルをゲットできれば最早動力は必要ありません。サーマルが弱く高度を落としてきたならば再度モーターランを行って高度を回復します。このようなモーターランを3回もやれば恐らく10分以上の飛行になり、操縦も疲れてきますので着陸させることになります。つまり、60Aの電流を1分間流すことを3回繰り返すだけの容量（60A×1/60h×3＝3Ah＝3,000mAh)を持ったLiPoがあれば良いことになります。LiPoは通常、容量の50～70%の消費に抑えて使用することがベストですので、4,300～6,000mAhの容量を持ったバッテリーが適当ということになります。

小生にとって幸いなことに、先に写真を載せたCurtiss Jennyのバッテリーが正に5,100mAhの5セルLiPoで、ピッタリと合います。このバッテリーは他に利用する事も無く稼働率の低いものでしたが、これで新たにバッテリーを購入しなくて済みます。

アンプ

OSモーターは最大電流が90Aなので100Aクラスのアンプが必要ですが、FSDとE-MAXモーターは最大電流が70A以下なので80Aクラスのアンプで足ります。アンプは容量が大きくなると高価になりますから、サンデーフライヤーにとってはこれも重要なポイントです。Sunriseのアンプは小生の1/5三田式にも採用しているもので、価格の割にしっかりしているアンプです。

結論

以上の検討から、モーターとしてパワー範囲の妥当性、価格、類似品の使用経験等を考慮してFSD FC5065–6Tを採用することにしました。LiPoは手持ちのKYOPOM 5セル5,100mAhを、アンプはSunriseの80Aのもの（実はこれも手持ちが有りました）を採用することに決定してモーターを購入しました。

尚、プロペラとしては上のモーター性能比較グラフから16乃至17×8が良さそうと見込みました。

***失敗その4*** 後で説明しますが、実はこの決定は検討不足で、モーター/アンプ/LiPoを買い替える羽目になりました。余り深く考えずに重量1kg当たり130Wと見込んだことが失敗でした。手痛い出費となりました。

### ***ペイロード重量***

以上のパワーシステムは目標重量で検討したペイロードに含まれます。ペイロードには他に受信機やその電源も含まれますので、ここでそれらを含んだ全重量を推定しておきました。

ペイロード重量の推定

| | |
|---|---|
| モーター | 361 g |
| LiPo | 600 g |
| アンプ | 65 g |

| | | |
|---|---|---|
| 折りペラ＆ハブ | 50 g | |
| 受信機 | 10 g | |
| 受信機用電源 | 155 g | (2,500mAh NiNH電池) |
| 同上用S/W | 11 g | |
| ハーネス | 100 g | |
| 合計 | 1,352 g | |

ペイロード重量として目標に置いた重量は1,800gでしたので約450ｇ軽く済みそうです。しかし重心位置合わせるために錘を積む必要があるかもしれませんので、次に重心計算を行いました。

**重心計算と重量重心管理**

動力システム検討で予定していたペイロード重量より軽量で収まることが判明しましたが、それで重心が合うものか不明です。そこで重心位置を検討します。併せて以後の設計製作が進むにつれて随時チェックする必要がある重量重心の管理方法を決めました。

*目標重心位置*

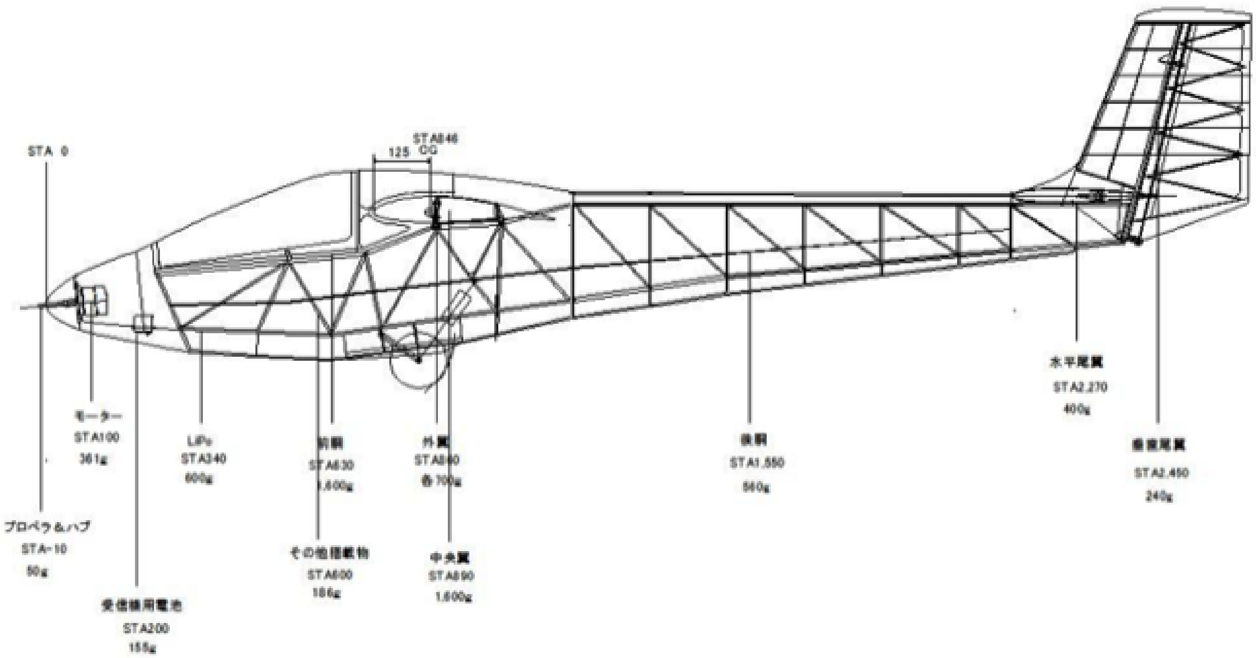
この時点では実機の許容重心範囲が判りませんでした。そこで1/3三田式3型改1の目標とする重心位置はサーマル工房製の1/5模型で実績のある重心位置と同じにしました。1/5模型の重心位置は主翼前縁から75㎜後方にありますので、1/3模型では75×5/3＝125㎜後方となります。これは、機首から測ってSTA846㎜の位置です。

*第0次重量重心検討*

機体構成品毎の目標重量を元に重心位置の計算をしました。但し、目標重量では縦に長い胴体を尾翼も含めて一つに纏めていましたが、重心計算ではこれをもう少し分解する必要があります。胴体を主翼後縁直後の細くなるところで分断して前胴と後胴に別けます。更に、後胴は後胴そのもの、垂直尾翼、水平尾翼に3分しました。後胴そのものと垂直、水平尾翼の図面からそれらの重量を略算してみると、

| | |
|---|---|
| 後胴本体 | 560 g |
| 垂直尾翼 | 240 g |
| 水平尾翼 | 400 g |

程度と見積もれましたので、前胴は胴体全体の目標重量である2,800ｇからこれらを差し引いて、1,600ｇを目標としました。これらの目標重量と、動力システムの選定で検討したペイロード重量の位置を図にしたものが図面6です。




図面6 各部の重量とその位置

この図を元に、各部の重量がが作るモーメントを計算したのが表2です。

| 0次重量重心 | 2018/5/15 | | 実積率 | 0 | % |
|---|---|---|---|---|---|
| | 重量 | STA | モーメント | 実績重量 | 残作業予想重量 |
| 左外翼 | 700 | 860 | 602,000 | 0 | |
| 右外翼 | 700 | 860 | 602,000 | 0 | |
| 中央翼 | 1,600 | 890 | 1,424,000 | 0 | |
| 前胴 | 1,600 | 630 | 1,008,000 | 0 | |
| 後胴 | 560 | 1,550 | 868,000 | 0 | |
| 垂直尾翼 | 240 | 2,450 | 588,000 | 0 | |
| 水平尾翼 | 400 | 2,270 | 908,000 | 0 | |
| モーター | 361 | 100 | 36,100 | 0 | |
| プロペラ&ハブ | 50 | -10 | -500 | 0 | |
| 受信機用電池 | 155 | 200 | 31,000 | 0 | |
| LiPo | 600 | 340 | 204,000 | 0 | |
| その他搭載物 | 186 | 600 | 111,600 | 0 | |
| 合計 | **7,152** | **892** | 6,382,200 | 0 | |
| 目標重心位置 | | **846** | | | |

| | | | | | |
|---|---|---|---|---|---|
| 追加Weight | 483 | 160 | 77342.974 | | |
| ノーマル飛行状態 | **7,635** | 846 | 6,459,543 | | |

表2 第0次重量重心計算表

重心合わせに何も錘を積まないと重量は7,152ｇで収まりますが、重心位置は892㎜と目標の846㎜より46㎜も後方になってしまうことが予想されます。これは1/5模型から想定されたモーターや受信機用電源より軽いもので済むことが理由です。このままでは飛行できませんので、機首のモーター直後のSTA160に錘を積むことにすると483ｇを積んで重心が合うことが判ります。結局ノーマル飛行状態の重量は7,635ｇとなり、目標の7,600ｇを35ｇ超過してしまいそうです。

折角ペイロード重量が目標値より軽いもので済むのに、重心が合わないために余計な錘を積んで、全体で目標重量を超過してしまうという理不尽な状況が予想されます。これの打開策は最後方にある垂直、水平尾翼の軽量化が最も効果的であることは自明です。尚、上の重量重心計算に用いた重量は全て目標とした重量であって、実際に実測された重量ではありません。その意味で実績率0%としてあり、精度もそれなりのものに過ぎません。これが第0次重量重心計算と称している理由です。製作を進めるに従って各部の実際の重量が実測できますので、それを用いて随時この表を改定します。

*第一次重量重心計算*

中央翼リブ組立が完成しています。その状態で重量を計測したら実測重量が700ｇで、残作業の予想重量は860ｇでした。このデータを用いて早速重量重心計算表を改定し第一次重量重心計算としたのが表3です。

合計重量は7,112ｇと予想され、そのうち700ｇは実測されましたから実績率は9.84%です。この状態でも尾翼はまだ第0次計算と変わっていませんから、重心位置に大きな変化は無く、錘は481ｇが必要です。ノーマル飛行状態の全備重量は7,593ｇと予想され、かろうじて目標内に収まりそうです。

| 1次重量重心 | 2018/5/27 | | 実積率 | 9.84 % | |
|---|---|---|---|---|---|
| | 重量 | STA | モーメント | 実績重量 | 残作業予想重量 |
| 左外翼 | 700 | 860 | 602,000 | 0 | |
| 右外翼 | 700 | 860 | 602,000 | 0 | |
| 中央翼 | **1,560** | 890 | 1,388,400 | 700 | 860 |
| 前胴 | 1,600 | 630 | 1,008,000 | 0 | |

| | | | | | |
|---|---|---|---|---|---|
| 前胴 | 1,600 | 630 | 1,008,000 | 0 | |
| 後胴 | 560 | 1,550 | 868,000 | 0 | |
| 垂直尾翼 | 240 | 2,450 | 588,000 | 0 | |
| 水平尾翼 | 400 | 2,270 | 908,000 | 0 | |
| モーター | 361 | 100 | 36,100 | 0 | |
| プロペラ＆ハブ | 50 | -10 | -500 | 0 | |
| 受信機用電池 | 155 | 200 | 31,000 | 0 | |
| LiPo | 600 | 340 | 204,000 | 0 | |
| その他搭載物 | 186 | 600 | 111,600 | 0 | |
| 合計 | **7,112** | **892** | 6,346,600 | 700 | |
| 目標重心位置 | | **846** | | | |
| 追加Weight | 481 | 160 | 76932.478 | | |
| ノーマル飛行状態 | **7,593** | 846 | 6,423,532 | | |

表3 第一次重量重心計算表

*重量管理図*

下の図は第0次と第一次の重量重心計算の結果得られた重量と実績率をグラフ化したものです。


グラフ7 重量管理図

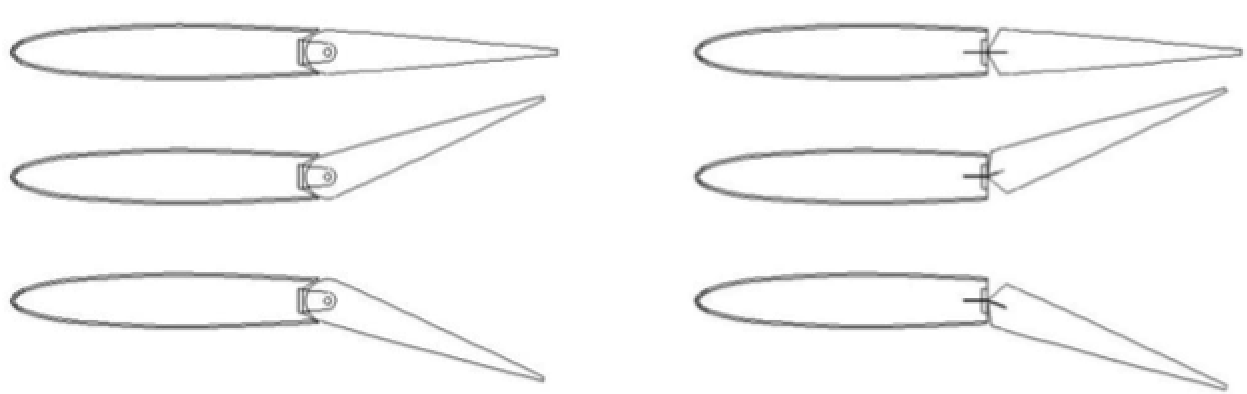
製作が進むにつれて、第2次、第3次・・・・・と重量重心計算を改定していくに従ってこの図も右に伸びていきます。この図を見ながら、常に目標重量を超えないように注意して以後の設計、製作を進めました。実績率は右肩上がりになりますが、

それに従って、重量に変化を与える設計変更の自由度が減りますので、当初から注意深く対処する必要があります。

### 製作その3 垂直尾翼

中央翼リブ組み立てに続いて垂直尾翼の製作に着手しました。これには理由があります。今回の大型グライダーの製作に当たってはエルロン、ラダー、エレベータの動翼の前縁を実機のように半円のRを持たせて主翼や垂直、水平安定板に取り付ける（図面7 左側）ことを目論んでいます。通常のラジコン機の動翼の前縁はV字型に尖らせて布ヒンジや棒ヒンジで取り付けられています（図面7 右側）。私がこれまで製作した全ての機体がそのような形式でした。小型のラジコン機ではこれで十分ですが、実機の1/3にもなる今回の機体では、この形式では取付け部のギャップも大きくなり、空力性能に悪影響を及ぼすことが懸念されますし、なにより見栄えが悪くいかにも模型染みてしまいます。又実機のエルロンは所謂フリーズ形式で上げ舵時に前縁が翼下面から飛び出します。それに似せたエルロンとするには従来のラジコン式動翼取り付け方法では無理です。

そこで実機同様に動翼の前縁にRを持たせ、それに覆い被さるように前方から外板を伸ばします。こうすることで取付け部のギャップを最小にして空気の流れもスムーズになります。これにはヒンジにも一工夫必要です。



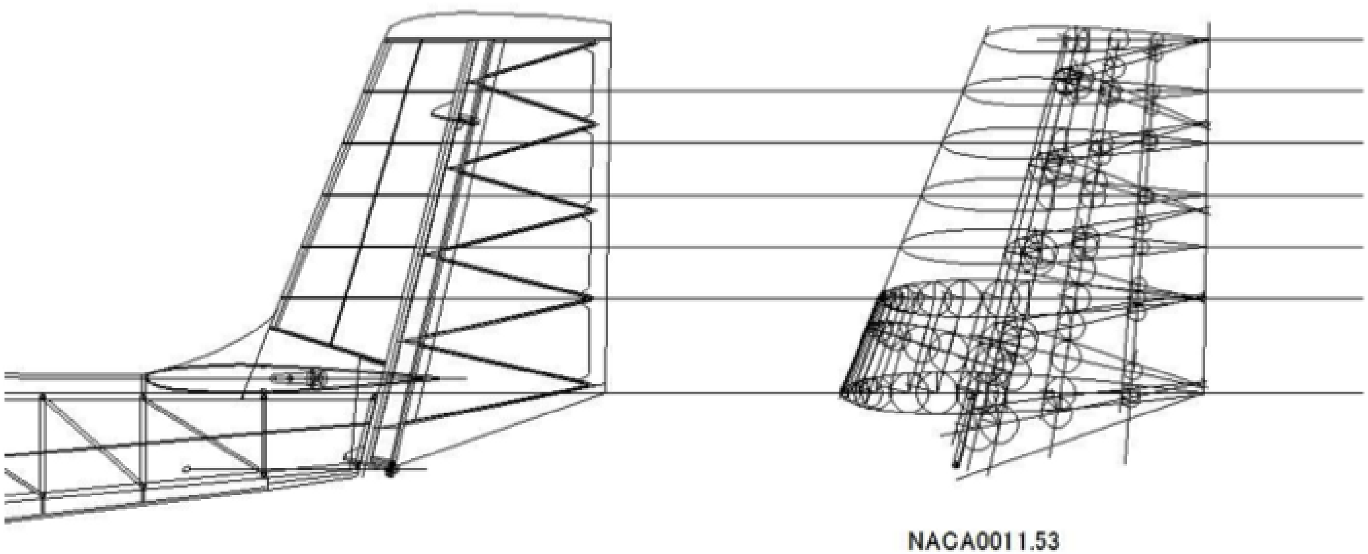
図面7 実機の動翼装着法（左）と通常のラジコン模型の動翼取り付け方（右）

私にとって初めての動翼取付形式となるので、まず動翼が1枚の垂直尾翼で製作経験を積んでそのノウハウを動翼が２枚の主翼や水平尾翼の製作に反映しようと考えた

訳です。

*垂直尾翼の構造*

下図が垂直尾翼の構造図です。




図面8 垂直尾翼の構造図

翼型は胴体側面と垂直尾翼がスムーズに繋がるようにしたところ、11.53%翼厚の対象翼が最適と判明したのでNACA0011.53としました。

この図面を作図する過程で面倒なことが生じました。三田式３型改1の動翼は全て布張りでプランクされていません。そのため捩じり剛性を確保する目的で動翼のリブは全て斜めに取りついています。翼型は当然気流方向に定義されていますから、動翼のリブ形状はそれから作図で求めなければなりません。3次元CADが使えれば簡単に求めることができますが、私のCADは2次元ですので昔の製図版での設計を思い出してラダーのリブ形状を作図で求めました。それが右側の図です。尚、ラダーのリブは３mm板厚としました。問題のラダー前縁はラダー前桁に半円形のリブを数か所立てて、それを１㎜厚のバルサでプランクする方式にしました。

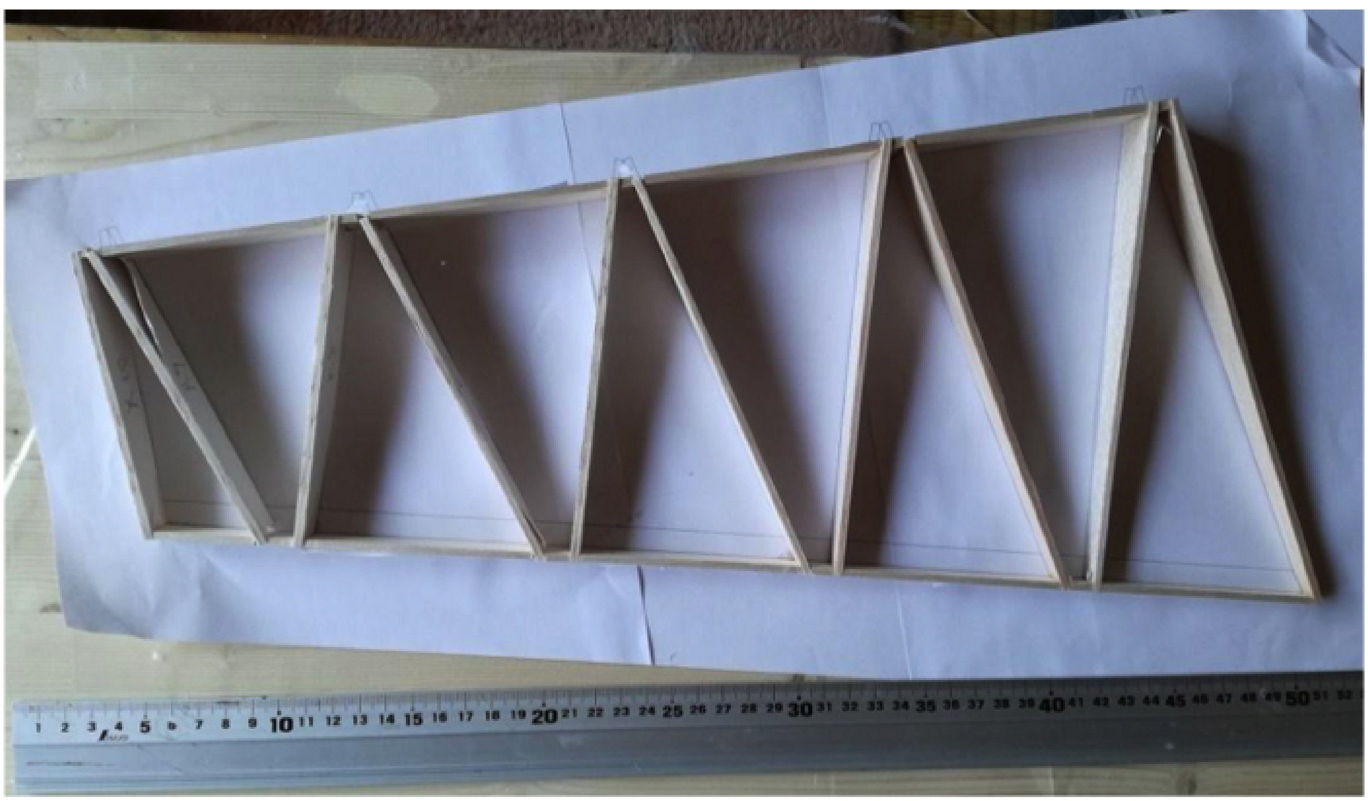
垂直安定板はフルプランクです。下部は水平尾翼取り付けのために大きくカットされており、一番下のリブはやはり斜め方向に配置されます。10㎜厚の厚い桁が最後部にあって、これで胴体後部に２本のボルトで取り付けられます。取付け部には補

強のため硬板を埋め込みます。プランクのペコ対策として1×5㎜のヒノキ棒のストリンガーを最大翼厚付近に斜めに走らせました。実機ではもう少し後方に垂直に走っているようです。尚、垂直安定板のリブは2mm厚のバルサ、プランクは1.5㎜厚バルサとします。

ラダーヒンジは実機同様上下２か所に設け、ラダーは取外し自由とするヒンジ方式にしました。上側のヒンジは安定板から伸びたカーボン板ステーの先端に4Φの短い竹ひごを上向きに装着して回転軸とし、ラダー側に取り付けた穴あきアクリル板で竹ひごの軸を受けます。下側のヒンジはラダー下面から4Φのボルトを挿しこんで、安定板から伸びた穴あきカーボン板のステーを貫通してラダー本体にねじ止めする方式です。この部分にはカーボン製のラダーホーンも取り付けられます。

*ラダーの組立治具製作*

中央翼と同じようにラダーのリブと同時にその組立治具の部品も切出しました。それを組立てたのが下の図です。



画像15 ラダー組立治具

*ラダー部品*

切出しを終えたラダー部品です（画像16）。


画像16 切り出しを終えたラダー部品

ラダーのリブ組立

組立中のラダーのリブ組立です（画像17）。重いスチール製のL型バーで組立治具にしっかりと押さえつけています。

画像17 ラダーのリブ組み立て作業

*リブ組立が完了したラダー*

リブ組立が完了しました（画像18）。治具のお蔭でリブ表面のコンターもきれいに揃っています。

画像18 完成したラダーリブ組み立て

*垂直安定板の製作*

ラダーと同様の手順を踏んで垂直安定板を組み立てました（画像19）。組立治具（左）と垂直安定板部品（右）です。

画像19 垂直安定板の組立治具と部品

一番下のリブが斜めに走るので組立治具のリブ受けは他と角度が異なっています。部品もリブをしっかりと桁に取り付けるために、突合せではなく桁材に穴を設けてリブを挿し込む構造にしています。

前縁材との組み合わせは通常の突合せ方式です。

画像20はリブ組立が完了した垂直安定板です。組立治具の効果絶大で、正確な組立が非常に簡単に完了しました。

画像20 垂直安定板のリブ組み立て

この後ヒンジ軸を桁に取り付けた後に1.5㎜バルサでプランクしました。プランク完了後にラダーを取り付けて垂直尾翼組立としたものがこれ（画像21）です。

画像21 完成した垂直尾翼組立

肝心のラダー前縁のR形状部は写真を撮り忘れてしまいました。半円形のリブを桁に垂直に立てて1㎜バルサで半円にプランクしましたが、リブ間隔が広すぎた上に1㎜プランク材が薄すぎた為に綺麗な半円柱の前縁とならず、多少の歪みが生じてしまいました。このため、凹みの大きいところは当てパッチを貼って整形するという始末でしたが、幸いカバーリング後は目立たなくなりました。

安定板の桁より後方に張り出したプランク部も精度に若干反省点があります。この部分は単に桁にバルサ板を縦張りで貼りつけてラダー前縁にかぶさるように張り出したのですが、長手方向に若干うねりを生じてしまいました。

この経験から以後のエレベータとエルロン製作では次のようにすべきとの教訓が得られました。

***教訓2***

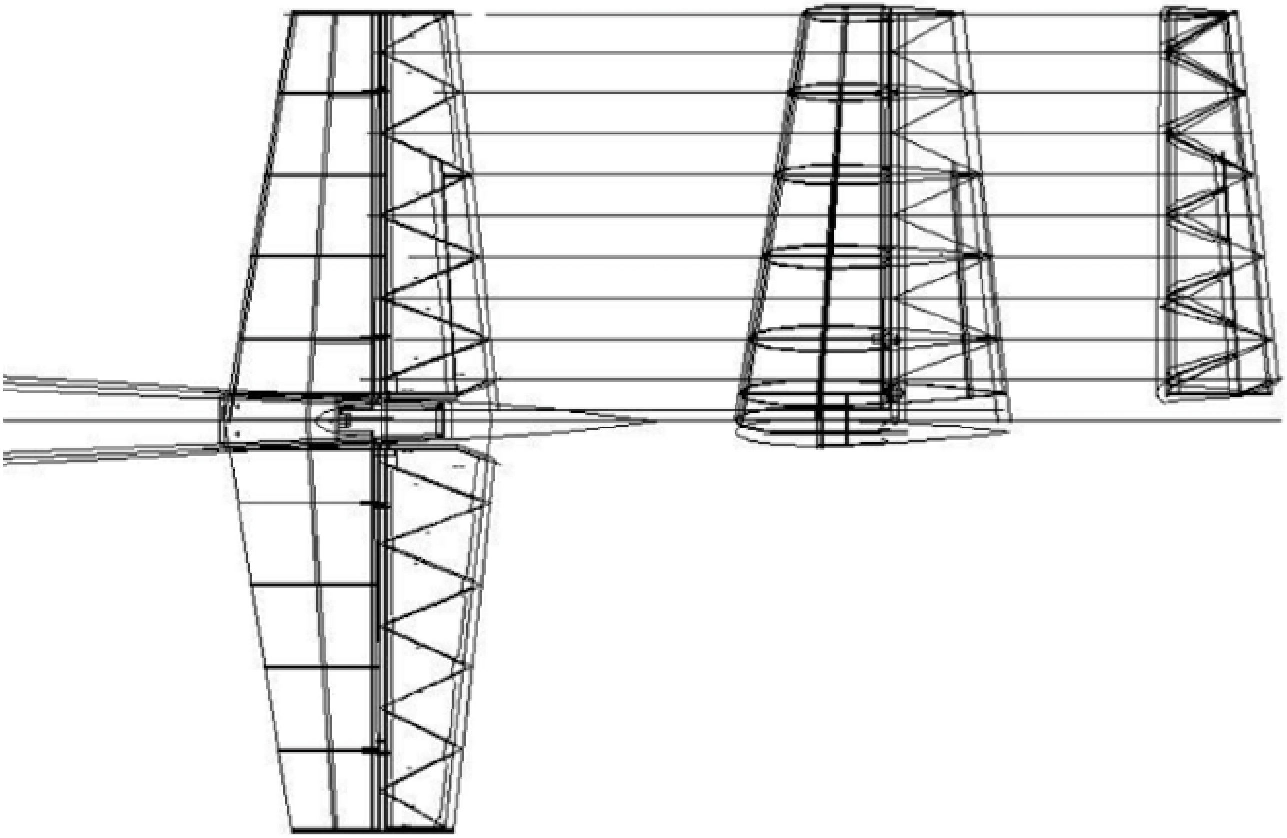
1. 前縁R部のプランク材はもう少し厚いものとするか、リブ数を増やして間隔を詰める。
2. 前縁半径が小さい場合は半円状プランクが困難と思われるので、多少の重量増加を覚悟してムク材を貼りつけて整形する方式がベターであろう。

3. 前縁R部に覆い被さる張出プランクの位置決め精度と強度を確保するために、リブ後部を三角形 状にして桁材後方まで張り出し、張出プランクを支える方式にする。（水平安定板の項参照

**製作その４ 水平尾翼**

*水平尾翼の概要*

これが作成した水平尾翼の図面です。



図面9 水平尾翼の構造図面

スパンは996㎜、約1mもあります。実機の翼型情報は不明ですが、10％翼厚のNACA0010とすると胴体上面との接続がスムースになることが判り、それを採用することにしました。エレベータのリブが±45度方向に片翼で10枚もありますので、その翼型設計が結構面倒でした。

右側のエレベータの内側にはかなり大きなトリムタブが付きます。トリムタブは人力操縦での操舵力をトリムするものなのでサーボ駆動のラジコン機には不要です

が、スケール感を出すために実機同様に作ることにしました。但し作動は不要なのでヒンジを固めにして手で動かせば動く程度にします。

エレベータ前縁は半円形状です。エレベータがテーパーしているのでその半径は外側に行くほど小さくなります。この部分の構造はラダーの教訓を反映して、厚板を整形することにします。

ヒンジは左右エレベータに各2か所設け、エレベータを外側から差し込む方式にしました。左右のエレベータを結ぶ軸をねじで取り付ける構造にしてエレベータを取り外し可能に設計しました。エレベータの作動はその軸の中央に取り付けたホーンが水平安定板の中に伸びて、胴体側から立ち上がるリンクに接続されます。そのために水平安定板の中央付近は後側に切欠きが設けられています。実機ではホーンの先端にはカウンターウエイトが取り付けられてフラッターを防いでいます。1/3模型でもウエイトを取り付けられるようにしておきました。

水平安定板は後縁が桁ですが、前述の通り中央付近が切りかかれますので最大翼厚位置に2×5のヒノキのフランジ、2mm厚バルサのウエブで細いI型桁を設けました。実機では切欠き部分から垂直に桁を通していますが、本機では細い桁で曲げ剛性を確保するために、最大翼厚部に通しましたので後退角を持ちます。尚、水平安定板は1.5ｔのバルサで全面プランクしますので捩じり剛性は十分確保できます。

*エレベータの製作*

これがエレベータ組立治具の上に置いたエレベータ部品です。

画像22 組立治具上に配置したエレベータ部品

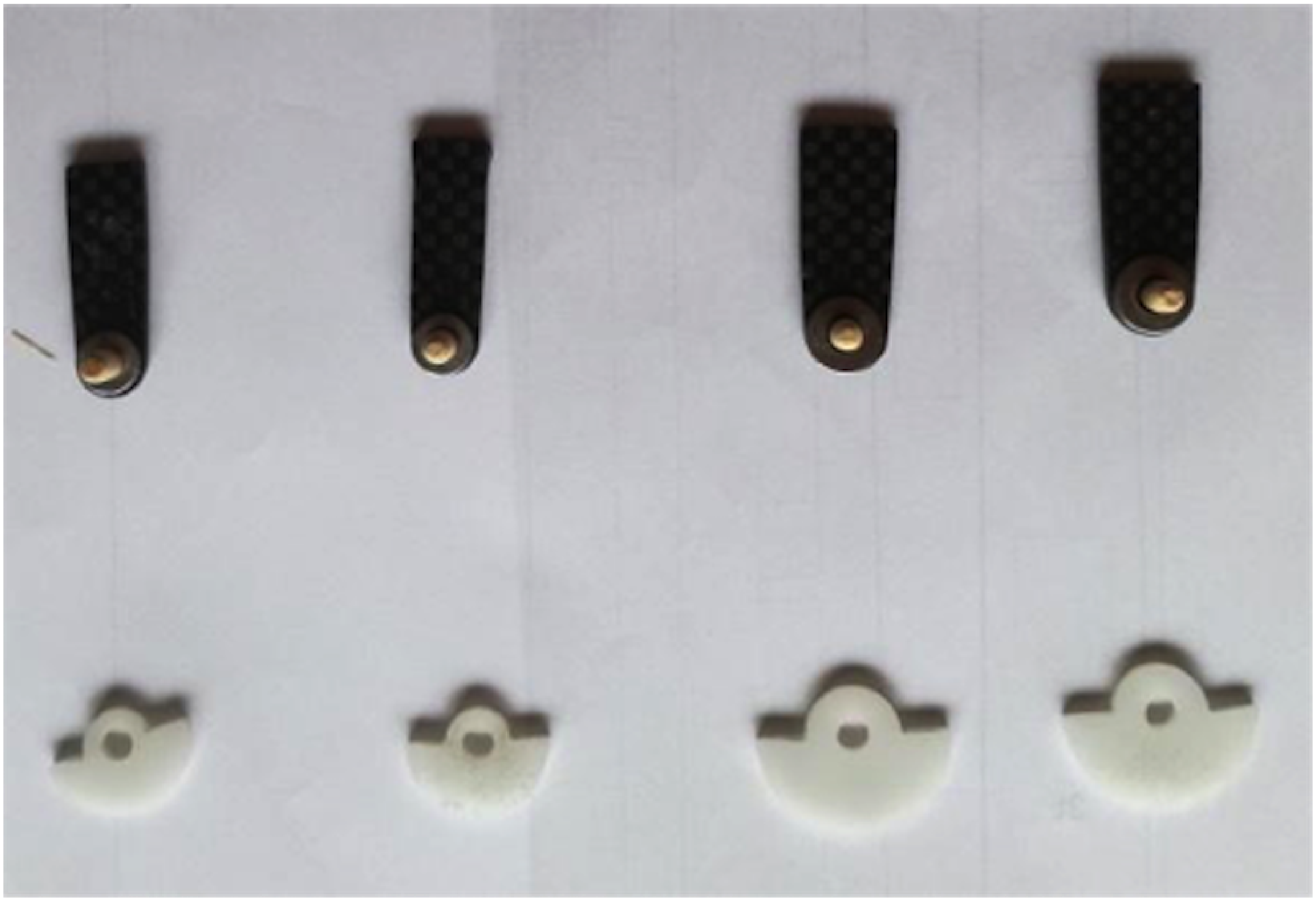
これは左側エレベータです。まだ切り出し用の型紙が貼りつけられたままです。桁の型紙に誤ってラダー前縁スパーと記されているのはご愛嬌です。スパーに沢山の四角い穴が開き、リブにも出張りがあるのにご注目ください。リブの出張り部がスパーの穴に嵌め込まれて、組立精度と剛性確保に貢献します。小さいリブにも穴が開けてあるのは、太陽に照らされエレベータ内の空気が膨張して、カバーリングフィルムが膨らむことを避けるための通気口です。

これが組立が完了したエレベータです。前縁のRも割と綺麗に出来上がりました。

画像23 組立が完了した左エレベータ

*エレベータヒンジの製作*

エレベータ用ヒンジがこれです。上側は水平安定板に取り付く部品で2mm厚のカーボン板と4mmΦの竹ひごで作りました。エレベータ側には2mmアクリル板で作った写真下側のヒンジ受けを取り付けます。



画像24 エレベータヒンジ

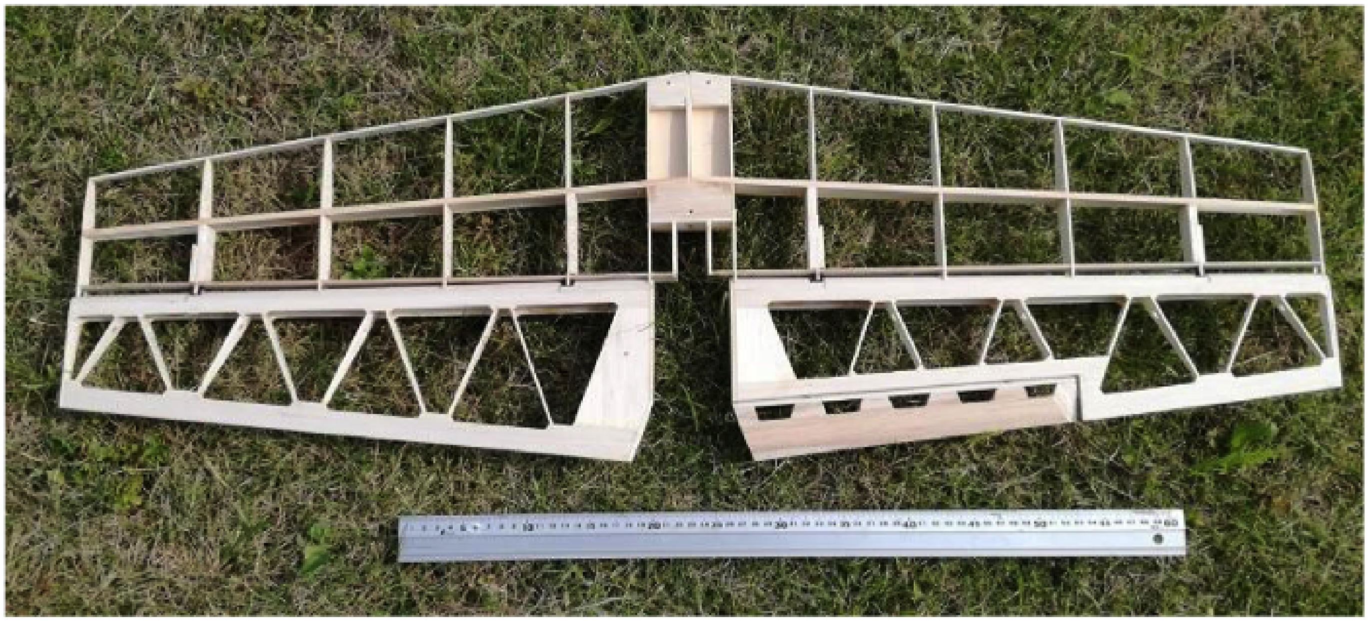
*水平安定板のリブ組み立て*

同様にして水平安定板のリブ組み立てを製作しました。

画像25 完成した水平安定板のリブ組み立て

ヒンジが取り付けられています。リブ後縁が三角形状にカットされて桁より後方に伸びていることに注目ください。これが今回の改善点です。これにエレベータ前縁に覆いかぶさる外板を貼って前縁Rとの距離精度を確保するための構造です。垂直安定板ではこれを設けずに桁に貼った外板を後方に張り出しただけであった為にその精度と剛性がイマイチでした。その教訓を活かした設計にしたものです。

エレベータと安定板を組み合わせた水平尾翼リブ組み立て写真が画像26です。大きな水平尾翼の大略がわかります。



画像26 水平尾翼リブ組み立て完成

*水平尾翼の組立完了*

水平安定板のプランク用に1.5㎜厚のバルサ板を購入しました。バルサ板は通常幅80㎜～95㎜にカットされて販売されていますので、本機のような大型機では幅が足りません。複数板を貼り合わせたプランク材を製作してからリブに沿って慎重に貼りました。プランク後前縁を平らに整形してから5mm厚の前縁材を貼って丸く前縁形状に整形しました。完成した水平尾翼が画像27です。

画像27 完成した水平尾翼木地

水平安定板中央付近に3つの穴があいていますが、ここに3mmボルトを通して胴体に固定します。左右のエレベータはカーボンロッドとカーボン板で製作した連結ロッドで連結されています。この写真では判りにくいので、その部分を撮影したのが画像28です。

画像28 エレベータ連結部

軸両端の丸板をエレベータの最内端リブに貼った保護リブ（シナベニア製）にネジ止めして連結します。軸の中央にはホーンが付いています。その中央付近にピボットを設けて、胴体側から上がってくるリンクに連結されます。ホーンはピボットより前方に伸びており、そこにフラッター防止及び操舵力軽減用の錘が付きますが、この写真では未だ何も付いていません。

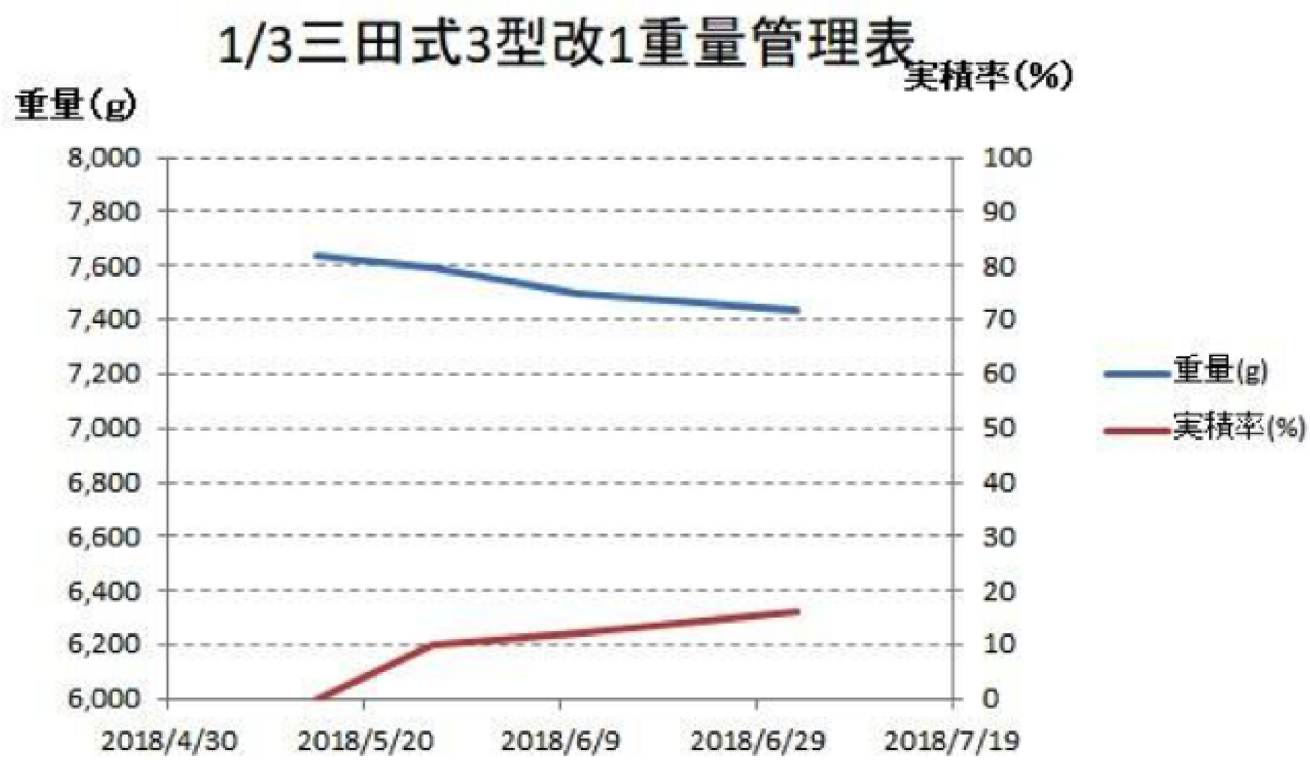
以上で水平尾翼の木地組立が完成しました。この状態で重量を測定したところ268ｇでした。今後の残作業はカバーリングと塗装で約70ｇです。余裕をみて錘の重量40ｇも確保して置くと、残作業重量は110ｇで、完成重量は378ｇと予想され、予定の400ｇ内で仕上がりました。

### *第三次重量重心計算*

この段階で、重量重心を見直して第三次重量重心計算をした結果が下表とグラフです。これ以前にも垂直尾翼木地完成時に第二次重量重心計算を行っていますが、その説明は省略します。

| 3次重量重心 | 2018/7/3 | | 実積率 | 16.00 % | |
|---|---|---|---|---|---|
| | 重量 | STA | モーメント | 実績重量 | 残作業予想重量 |
| 左外翼 | 700 | 860 | 602,000 | 0 | |
| 右外翼 | 700 | 860 | 602,000 | 0 | |
| 中央翼 | **1,560** | 890 | 1,388,400 | 700 | 860 |
| 前胴 | 1,600 | 630 | 1,008,000 | 0 | |
| 後胴 | 560 | 1,550 | 868,000 | 0 | |
| 垂直尾翼 | **212** | 2,450 | 519,400 | 162 | 50 |
| 水平尾翼 | **378** | 2,270 | 858,060 | 268 | 110 |
| モーター | 361 | 100 | 36,100 | 0 | |
| プロペラ＆ハブ | 50 | -10 | -500 | 0 | |
| 受信機用電池 | 155 | 200 | 31,000 | 0 | |
| LiPo | 600 | 340 | 204,000 | 0 | |
| その他搭載物 | 186 | 600 | 111,600 | 0 | |
| 合計 | **7,062** | **882** | 6,228,060 | **1,130** | |
| 目標重心位置 | | **846** | | | |
| 追加Weight | 370 | 160 | 59,151 | | |
| ノーマル飛行状態 | **7,432** | 846 | 6,287,211 | | |

表4 第三次重量重心計算



グラフ8 第三次重量重心図表

実績重量が1,130ｇ、実績率が16%に上がりました。胴体後部に搭載する水平尾翼の重量が予定より軽く仕上がったので重心合わせの錘が減り、ノーマル飛行状態の重量は7,432ｇと計画の7,600ｇより168ｇ軽くなりそうです。どうやら予測に使ったバルサの重量より実際の重量が軽く済んでいることが主な理由のようです。バルサは同じ板厚でも固さによって重量がばらつくので、計画段階では手元にあった数種類のバルサの重量を測定して安全の為一番重い値を用いています。今後もバルサ部分の軽量化が期待できそうです。



***次の記事を読む*** | ***前の記事を読む*** | ***目次*** **|** *この記事のPDFをダウンロードしてください。 |この号全体のPDFをダウンロードしてください。*

A vintage 3.75M Multiplex DG-300 built in 1989 catches the last wintery rays of sunlight at Mount Salève in France. (image: Speedamigo Modellflugfilm)

# The Trailing Edge

Wrapping up our fifth issue as we head into June.

The NEW RC Soaring Digest Staff Follow
May 14 · 3 min read

Okay, we admit it. We comb through hundreds (maybe thousands, by now?) of pictures to try and find just the right ones to feature in cover photo and *The Trailing Edge*. Every time we think we've seen them all, along comes one which not only takes our breath away but sometimes leaves us puzzled as to exactly how it was taken. Thankfully, 'Speedamigo' explains:

"*The picture was shot about two years ago. I live in Geneva, Switzerland and our nearest slope is just cross the border in France on Mount Salève. Every year in November/December we get this particular weather where the city is under a dense low cloud layer and the slope — which is 1000m above the city — is out in the sun. If the wind blows from southwest, it's time to go flying above the clouds. The DG-300 has a FX-60–126 Wortmann airfoil and as I like to say 'flys by itself' — so no problem to shoot a photo of your own glider!*"

Not an issue goes by that we don't add at least one more place to go when we start travelling again. Thanks so much for letting us feature your work Speedamigo, and we truly hope we get to fly together soon.

On behalf of ourselves and all of our readers, heartfelt thanks all the contributors to this month's issue. We know readers will show their appreciation with a few *Claps* or by writing *Responses* to articles they enjoyed or have comments or questions for the author. Also, please consider contributing a story of your own — the June deadline is **2021–06–13**. From our perspective, that feels like tomorrow but it's actually plenty of time to get your magnum opus ready.


**All proceeds from the sale of this product directly support the operating costs of the NEW R/C Soaring Digest.**

You'll forgive us if we hawk a little merch to help keep the lights and heat on — it's how RCSD continues to come to you entirely free. Here's the April edition of the *RCSD Cover Photo T-Shirt*. It features Pierre Rondel launching his *Shinto* at the Col des Faïsses in the French Alps. Or you can get the January, February and March editions if you prefer.

Also, we're still putting together our *Corporate Sponsorships* program. But don't wait for us. If you feel RCSD might help you better market your products and services to the RC soaring community, please do not hesitate to get in touch.

If you don't want to miss the June issue when it comes out, please subscribe to our mailing list. Also, follow us on Facebook, Instagram and Twitter for even more complementary content.

So how did we do? Let us know your thoughts. Thank you all so much for reading and until next time…fair winds and blue skies!



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