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.*

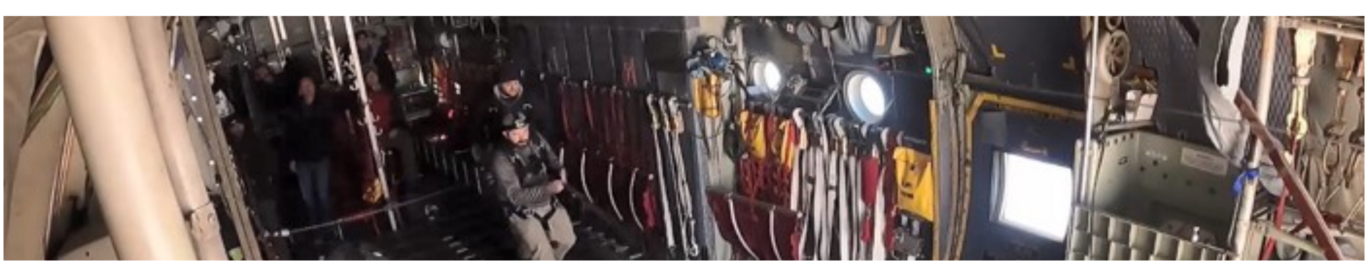
The view aft from the host C-130 'Hercules' as the Silent Arrow starts on its glide to the target.

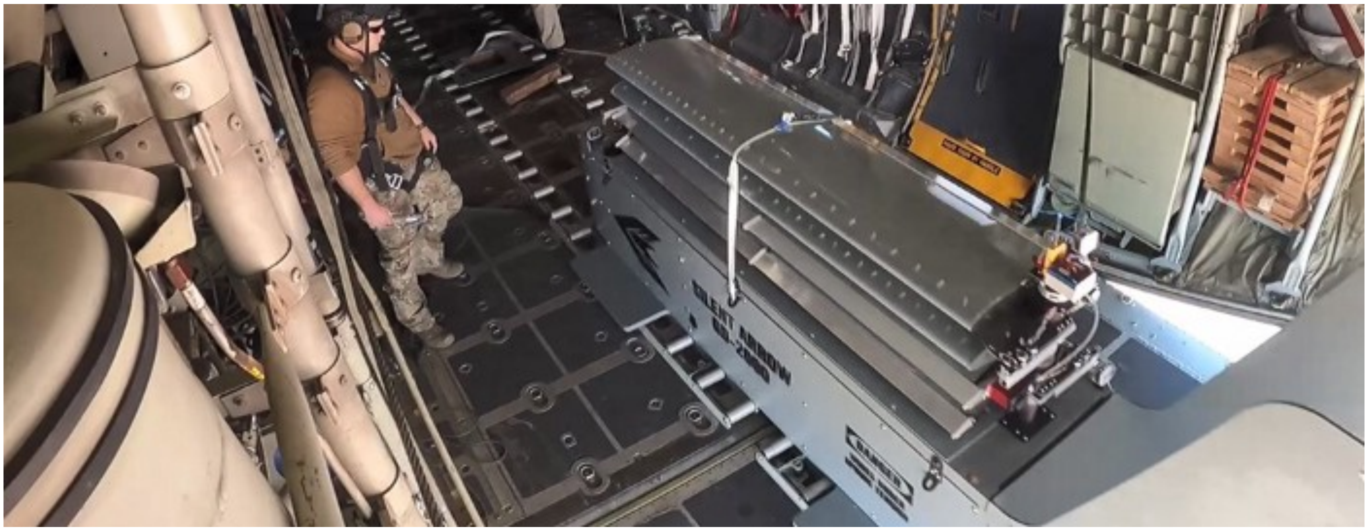
Silent Arrow Passes Next Phase of Testing

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.

All images and video are ©2021 Yates Electrospace, all rights reserved, used here with permission. 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/dm² 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.

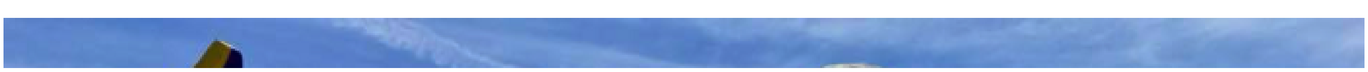


Photo 5: John Phillips is looking happy — he's just got fastest time at one of the Eurotour events. (image: [tbd])

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.

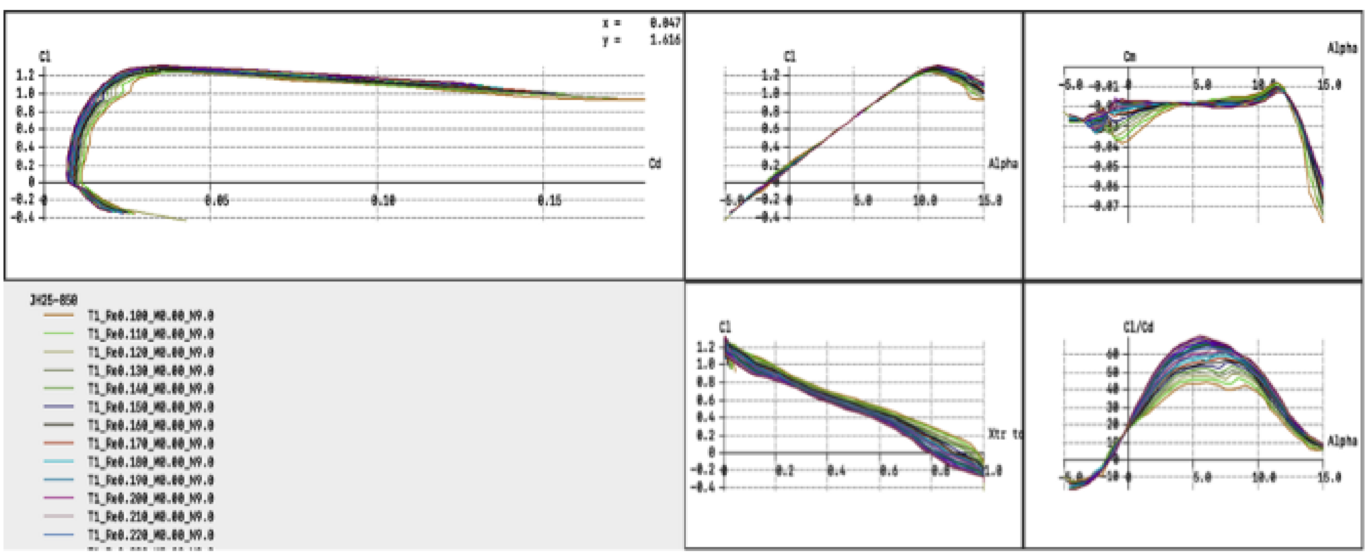


Figure 7: JH25 curves — this is a good all-round section especially designed for racing.

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.

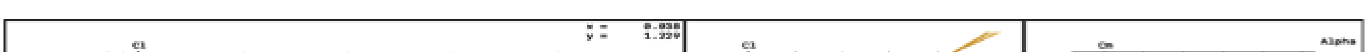
On just one pass, observing his model's behavior, what passes through the controlling pilot's mind could be:

- 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.



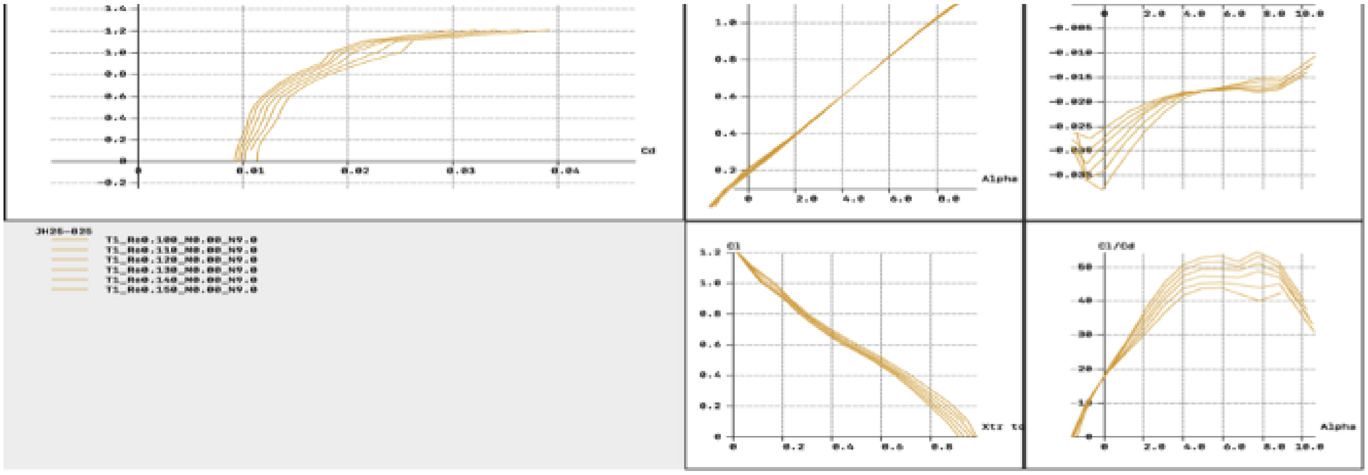


Figure 8: JH25 Curves.

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

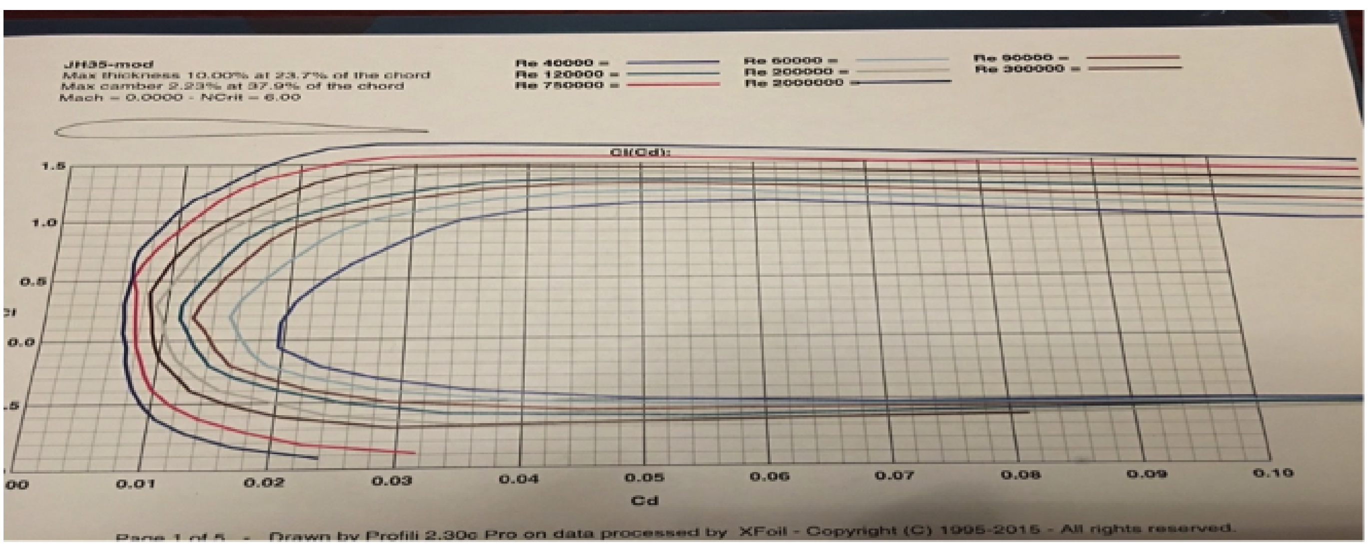


Photo 9: More of an Alpine soaring section, this is the JH35.

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.

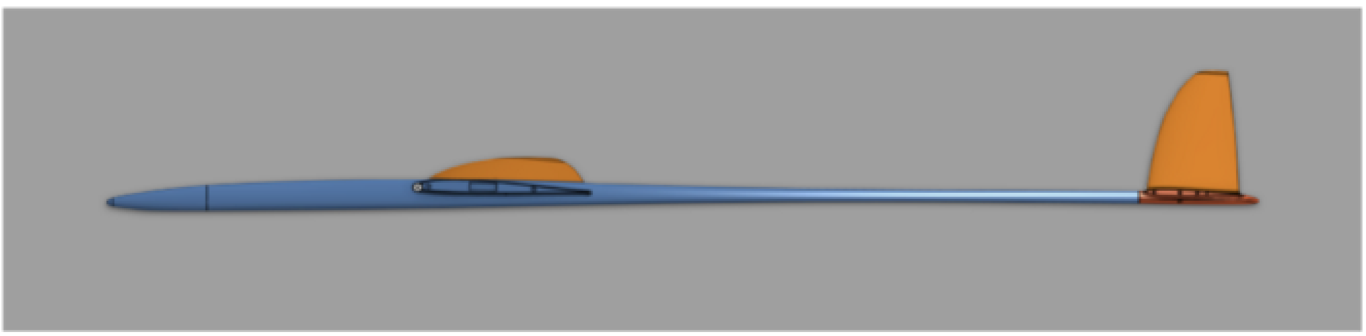
> Takeaway: Thinner aerofoils do not necessarily have less drag, and may actually lessen control response.

> 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

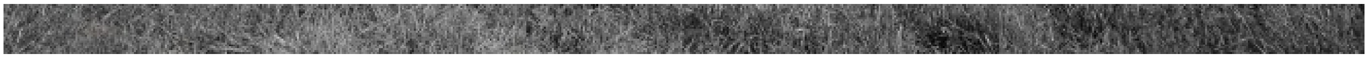


Photo 3: The Wasabi standing on my preferred fence.

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/dm^2 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!

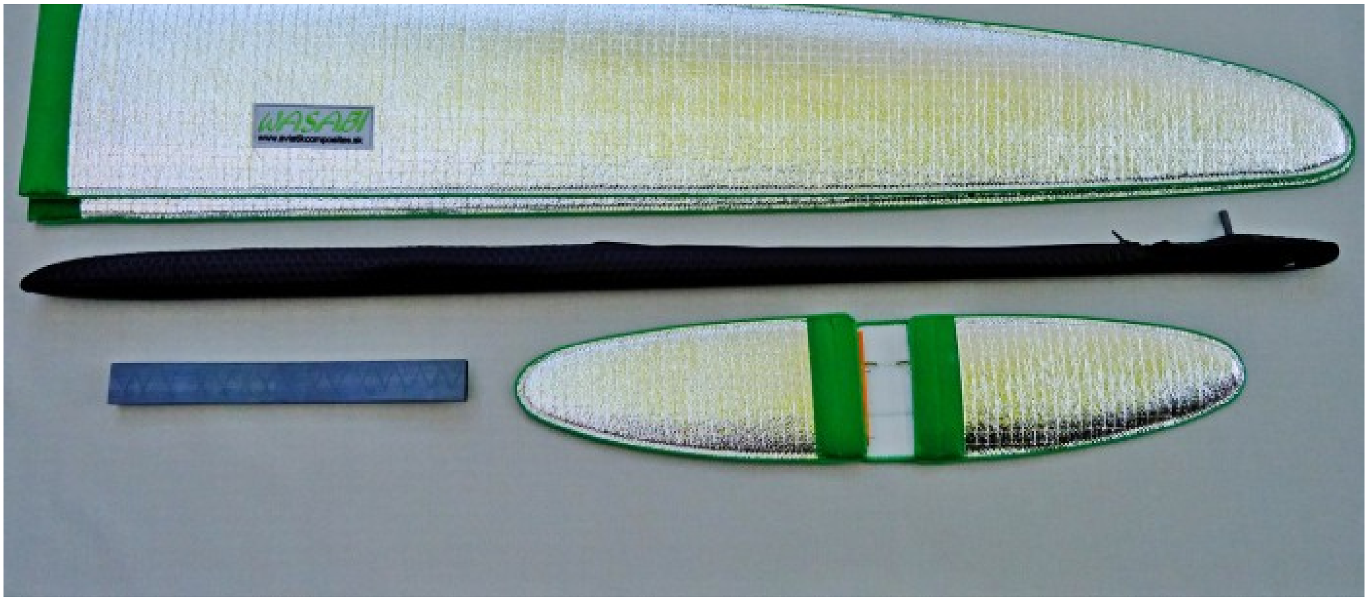


Photo 6: The Wasabi arrives with wing and tail bags. Fuselage bag is an option.

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.

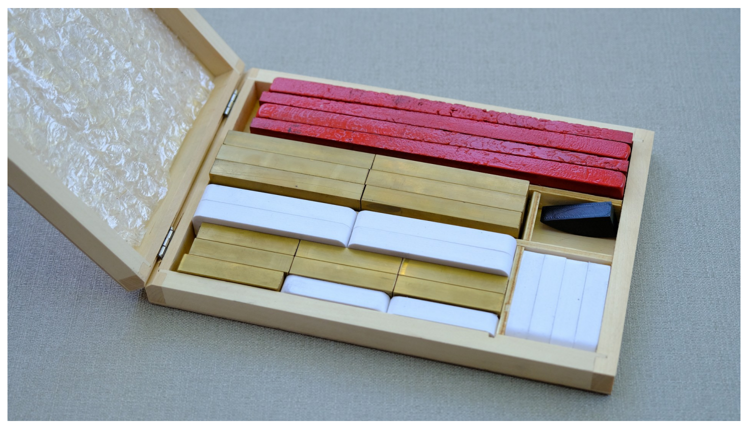
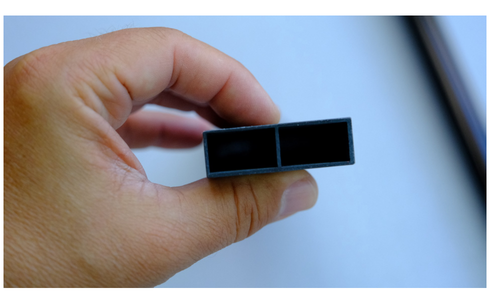
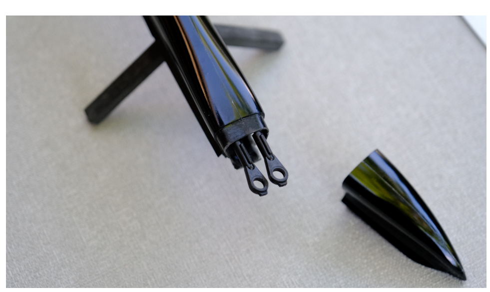
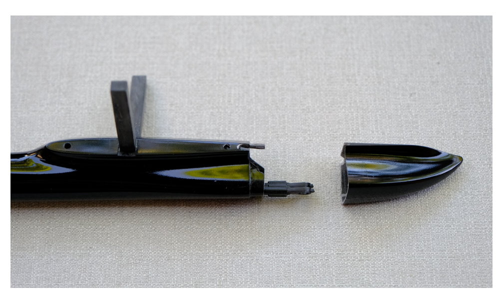



Photo 8 & 9: The ballast tube is already installed, and the servo tray is complete with M2 screw brass inserts / Ballast is provided except the joiner ballast with is an option.

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

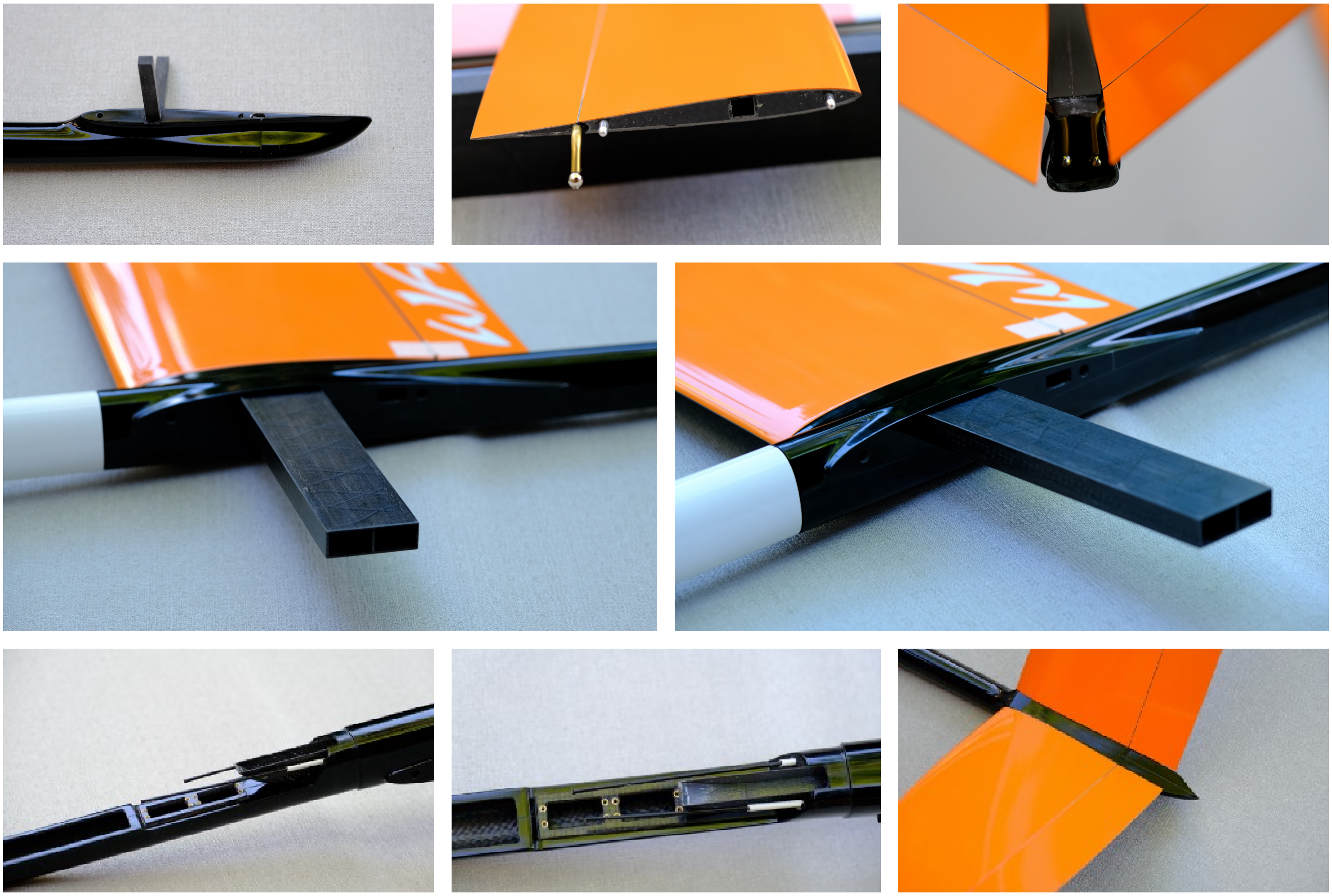


Photo 10 to 20: Some more pictures of the kit. Fit and finish is excellent like the tail adjustment and rear cap.

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.

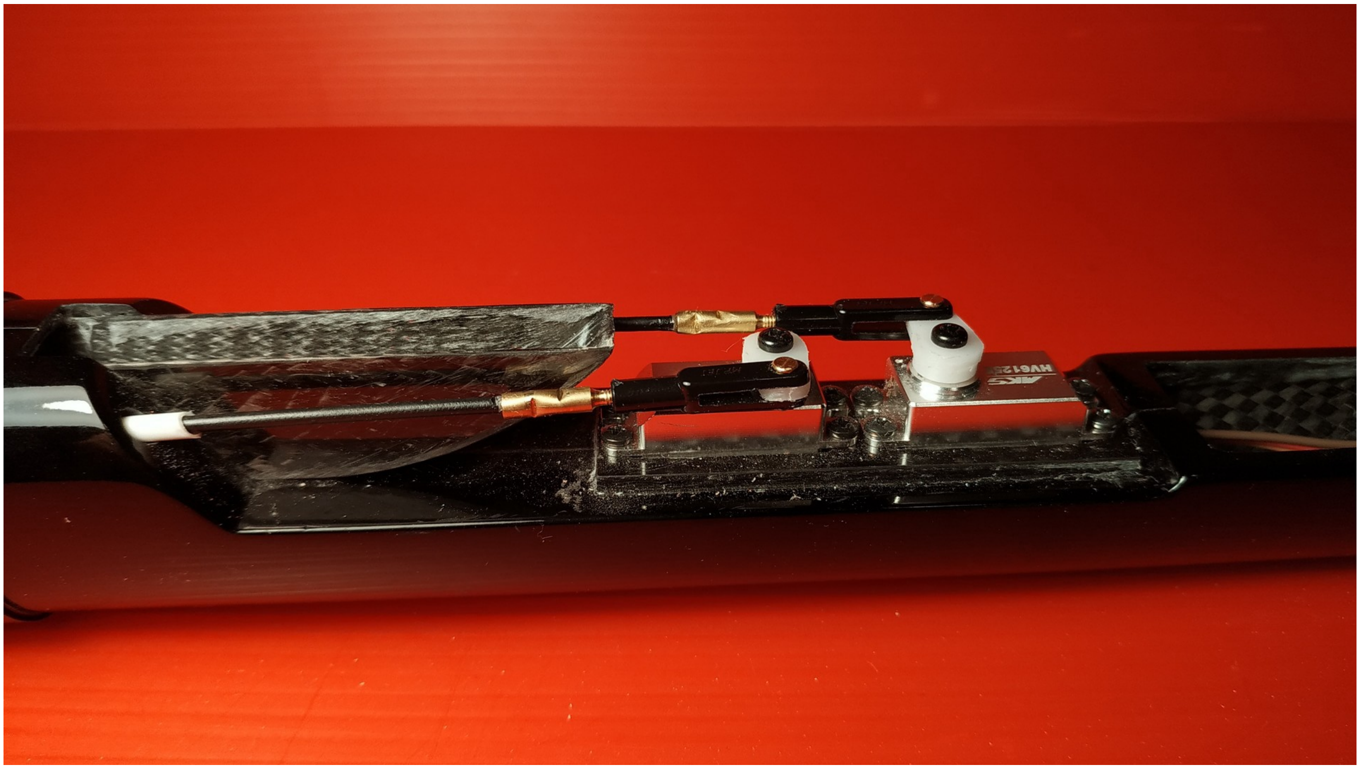


Photo 21: The space for the radio equipment is limited because of the ballast tube.

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.

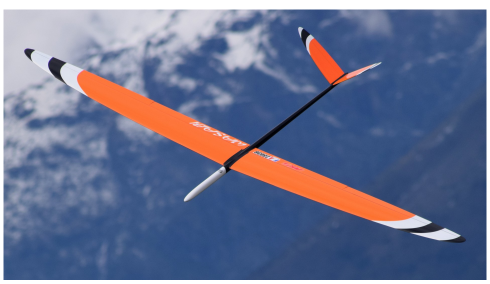
Video 25: The maiden flight!

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.







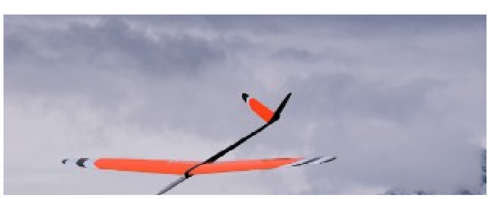
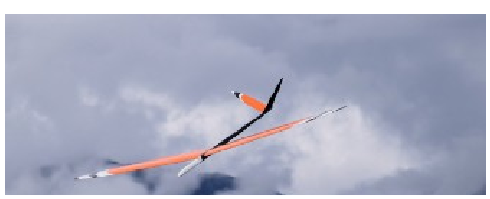
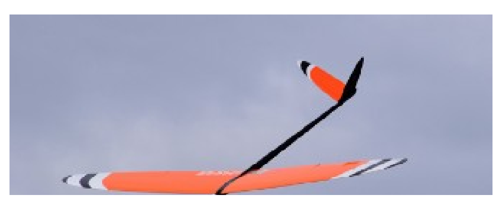
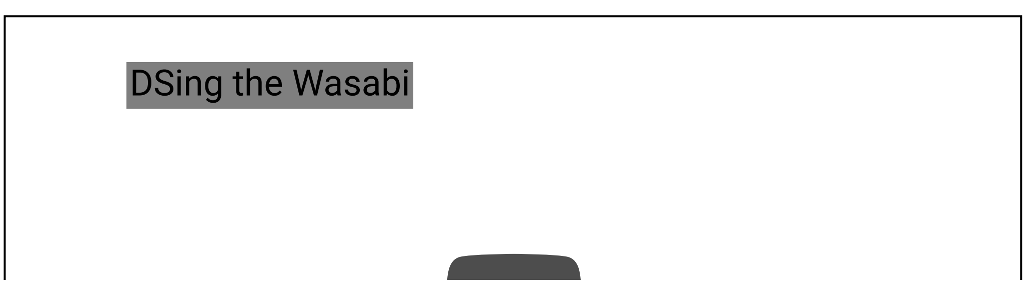
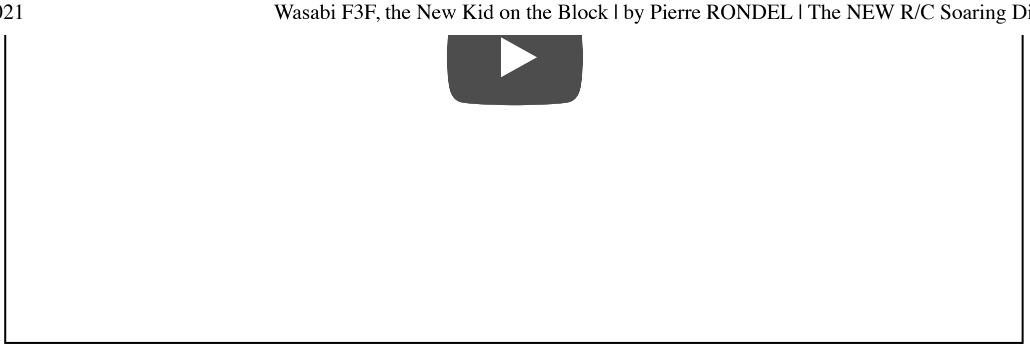





Photo 26 to 43: The Wasabi in flight: a very competitive F3F plane but also very pleasing for sport flying.

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:

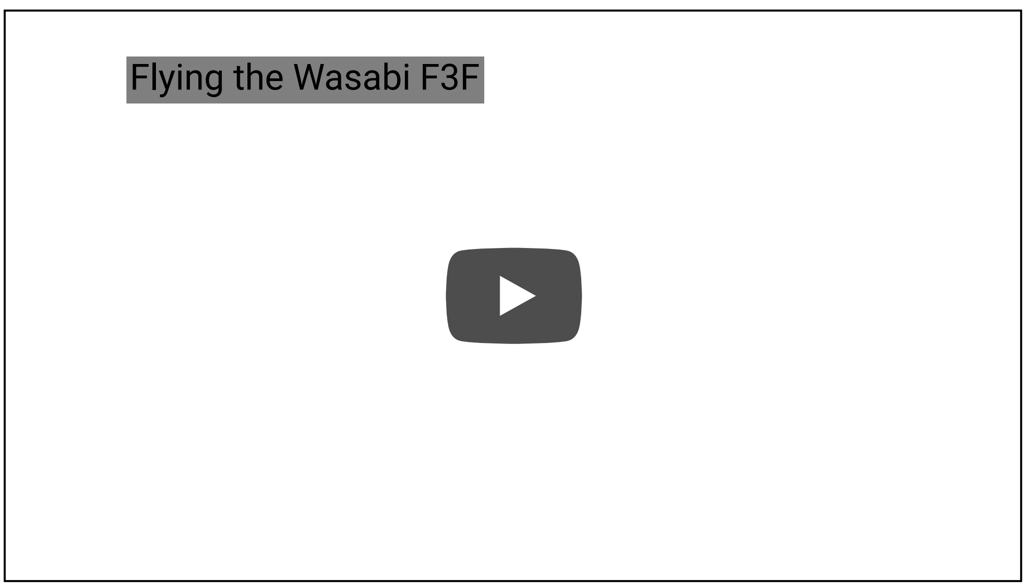




Video 44: DSing the Wasabi.

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!

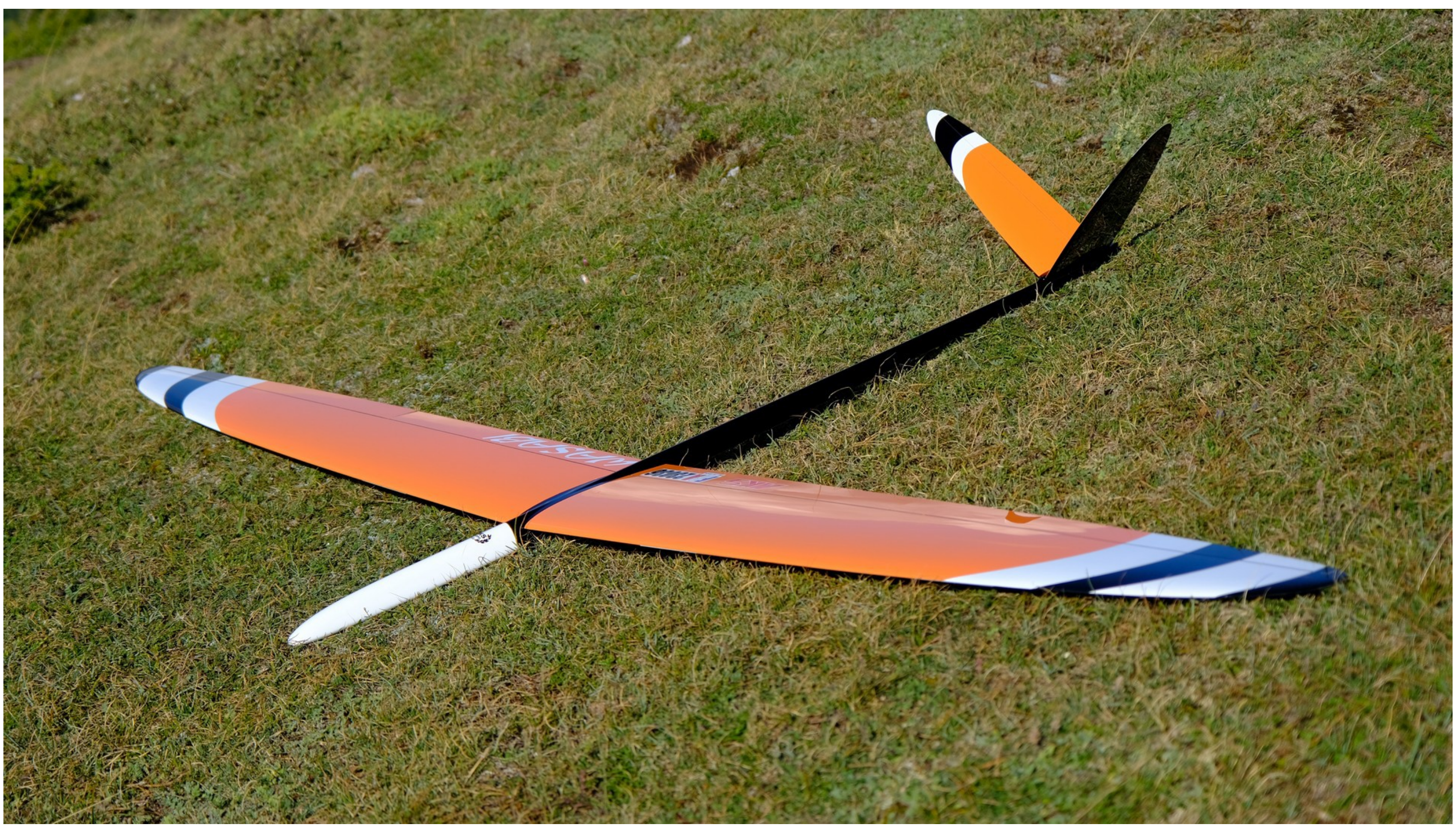


Photo 46: Top notch quality and excellent flying performance!

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

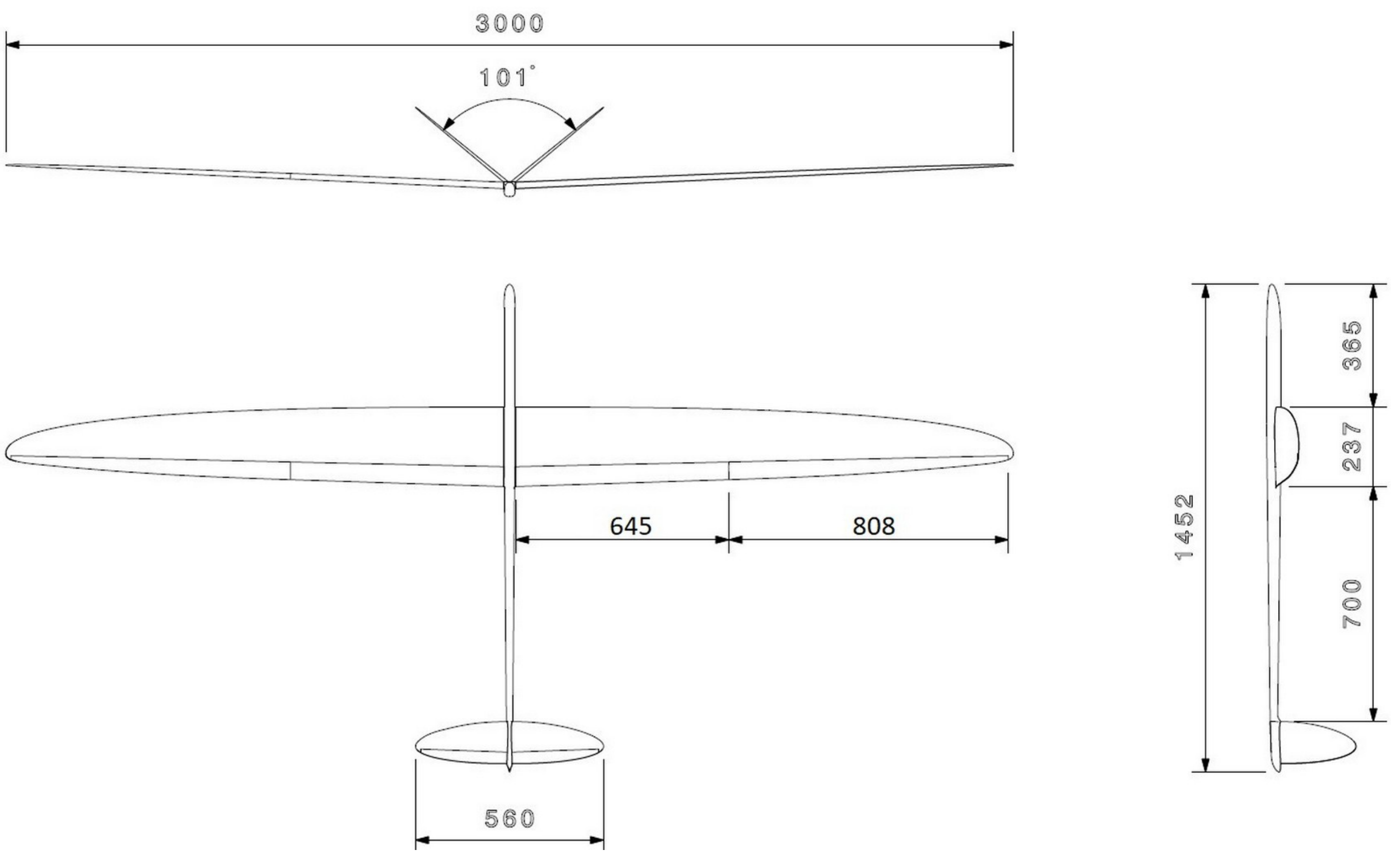


Photo 46: 3 views (source: Aviatik Composites)

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****.*
Downloadable PDFS: just this article or this entire issue.

F3f Slope Soaring Review All Composite

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.

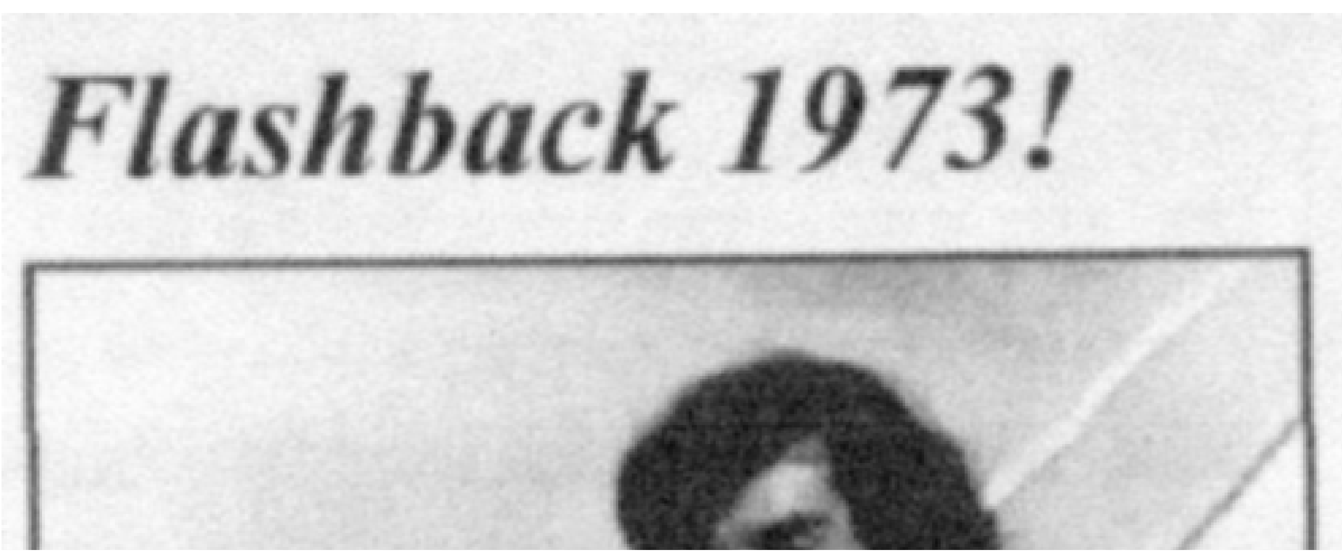
“Mid-1980s.” (image: Mike Hansow)

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

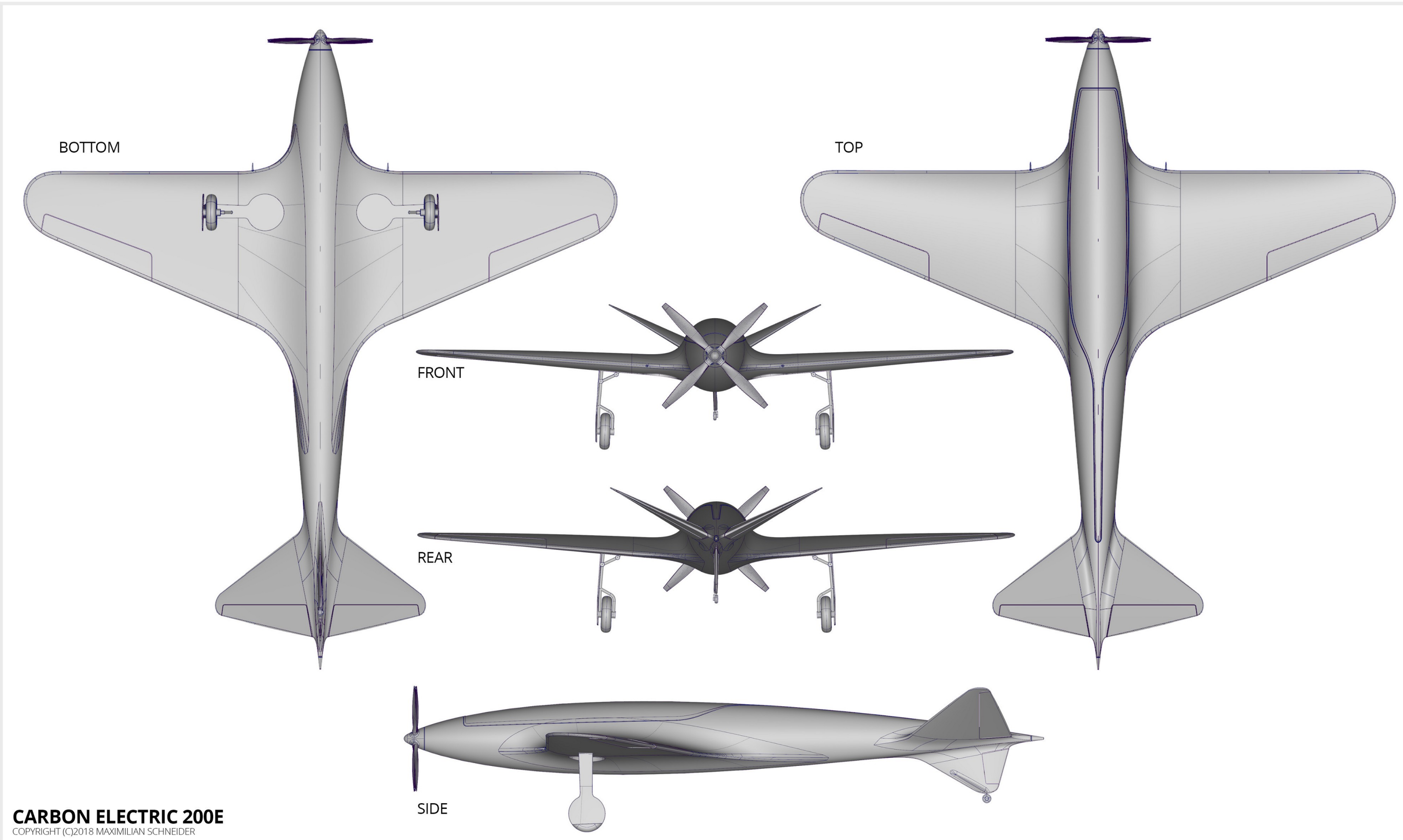
A 21st century update of Ettore Bugatti and Louis de Monge's classic Bugatti 100P.

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.

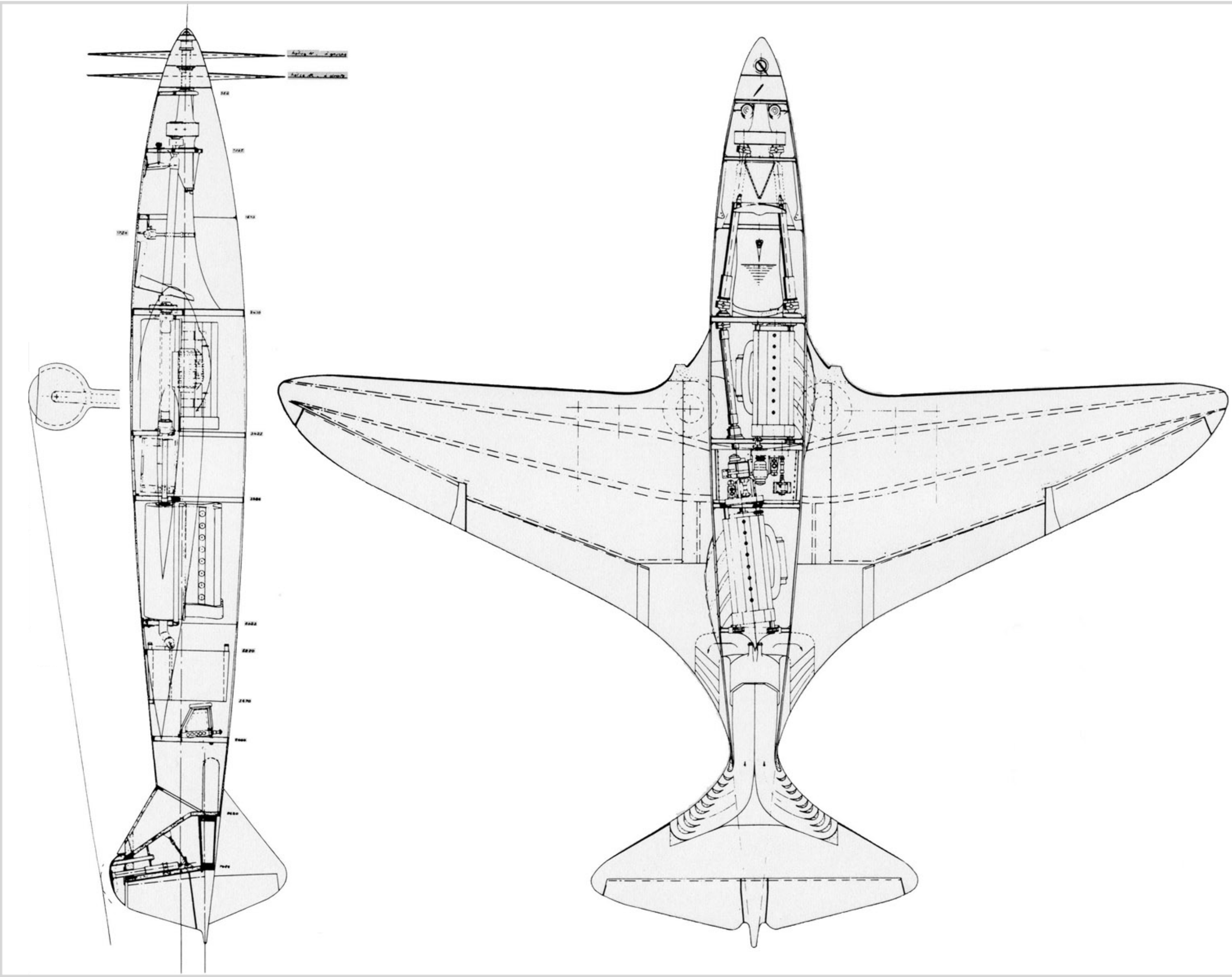
As a professional car designer, the Bugatti 100P quickly caught my attention with its gorgeous design and unique history. It is my all time favorite air plane and this project, the Carbon Electric 200E is my way of paying homage to Ettore Bugatti and Louis de Monge. However, I didn't want to just copy 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.

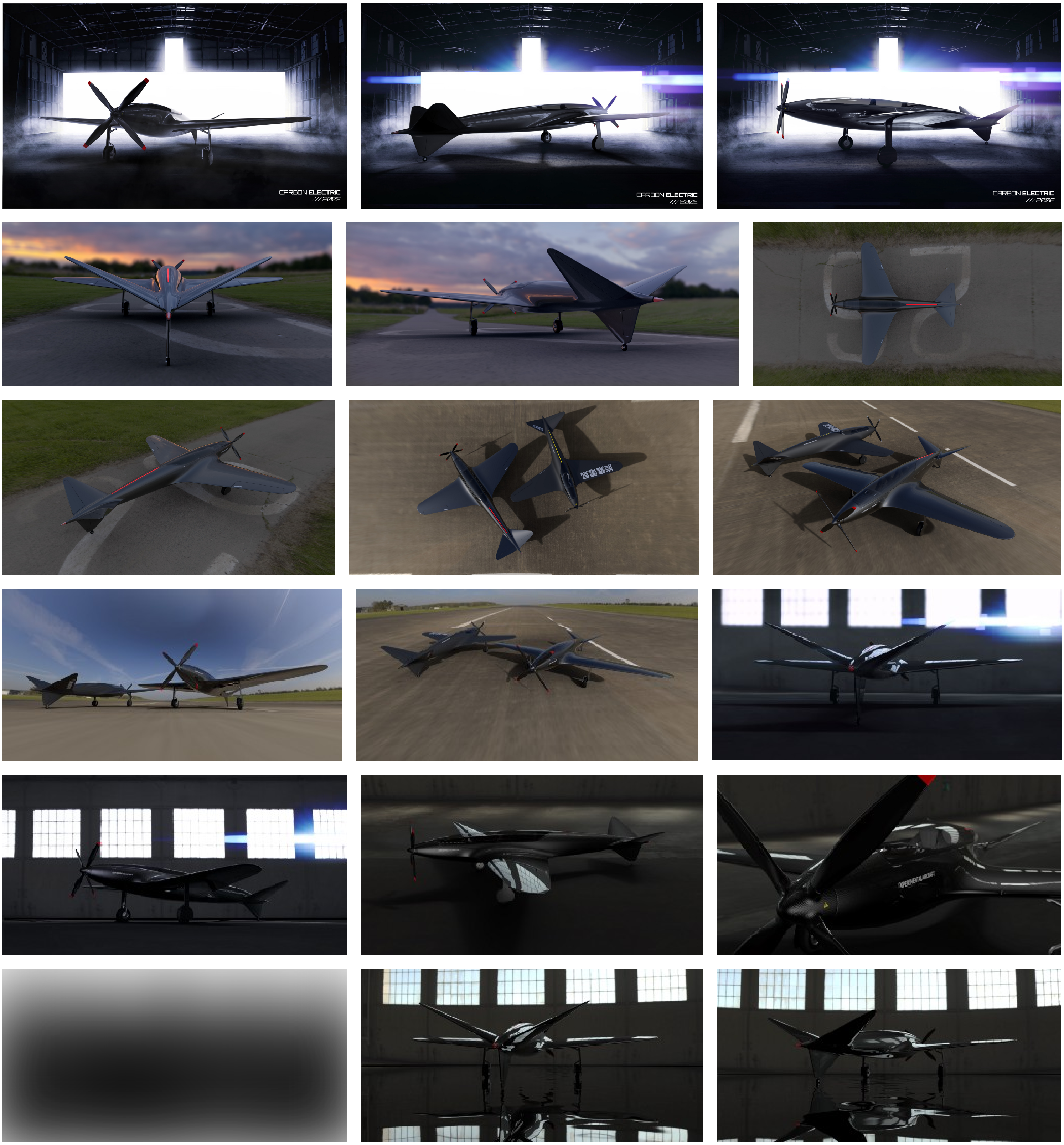


The configuration of the original Bugatti 100P (drawings: Louis de Monge)

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.

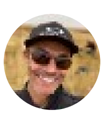
Thanks very much for reading and the very best of luck with your projects.

*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 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!

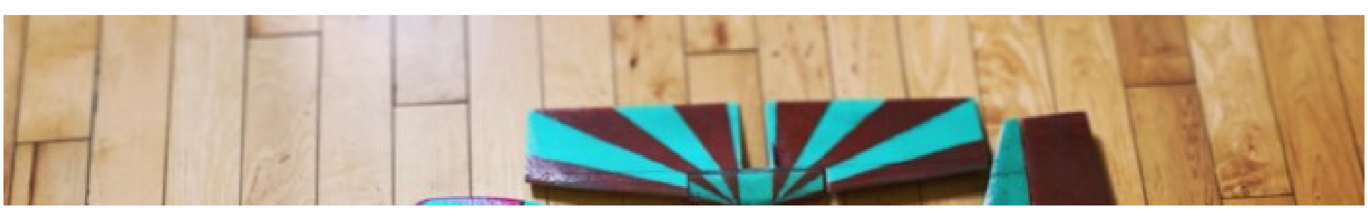
I remember first hearing about VTPR (Voltige Trés Prés du Relief) around seven years ago and was absolutely fascinated with it. VTPR, in general, is low level slope aerobatics done within close proximity. Something that's right up my alley as I love flying close and low and it's guiding me closer to 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.

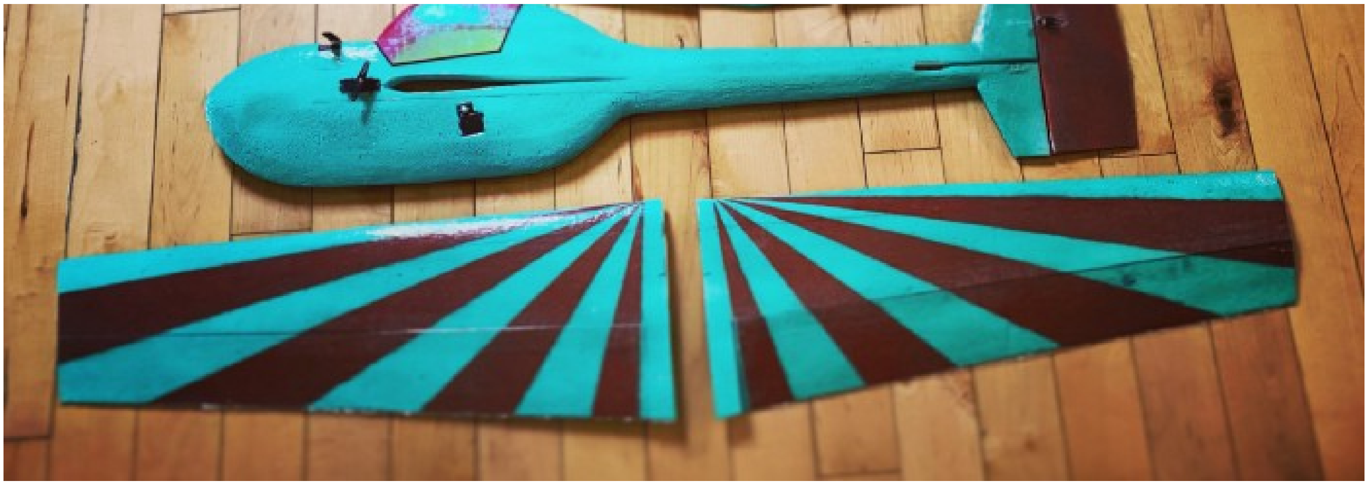
My initial plunge into this style of flying was done with a Dream-Flight *Ahi* and although it's a great flying plane and served me well for a few years, I wanted something with better performance. This is where the *Buzz* came in.

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

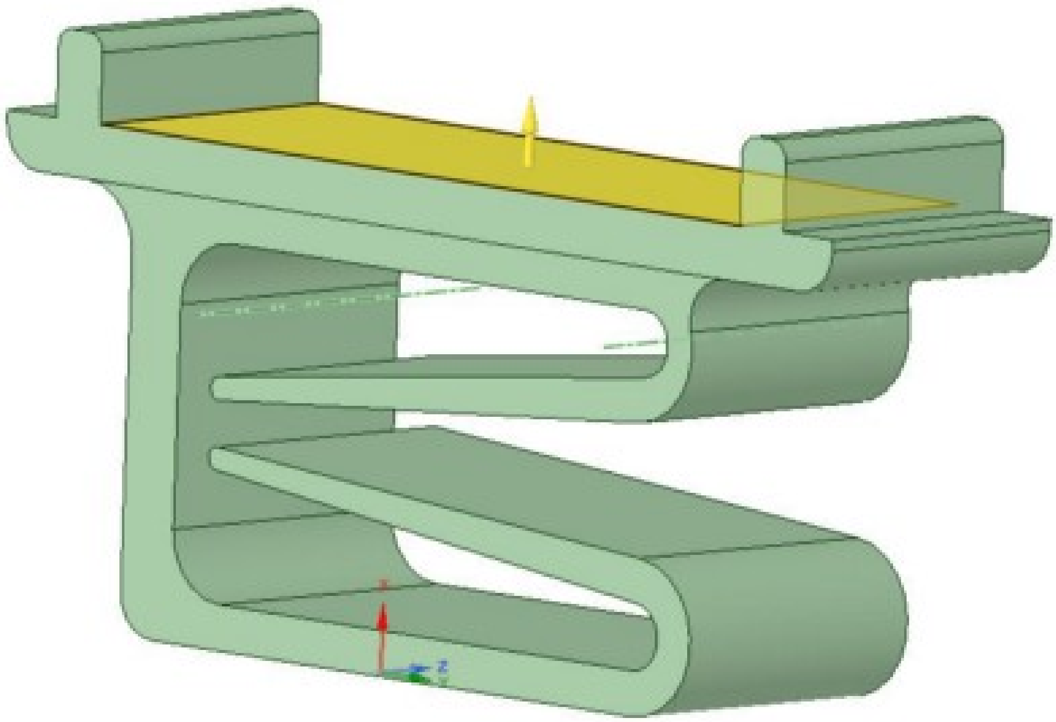


Photo 5: Design of the removable clip.

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.

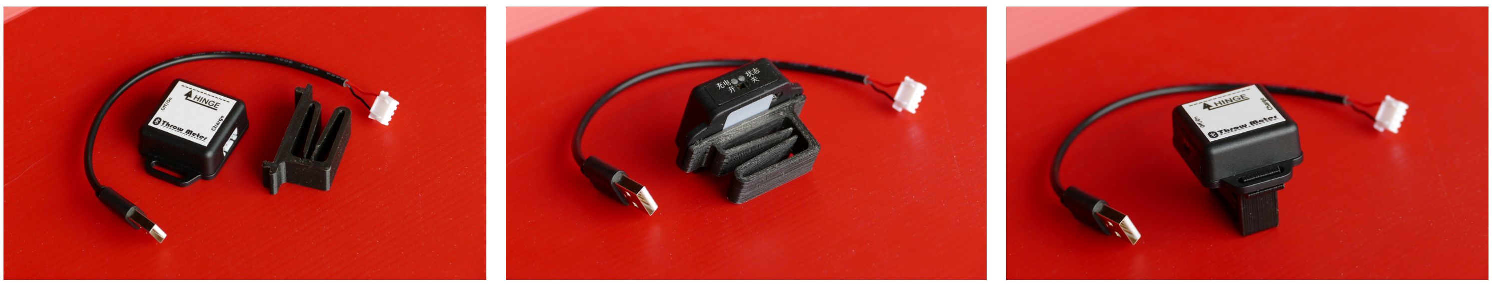


Photo 7 to 9 : Different views of the RC Throwmeter and its clip.

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

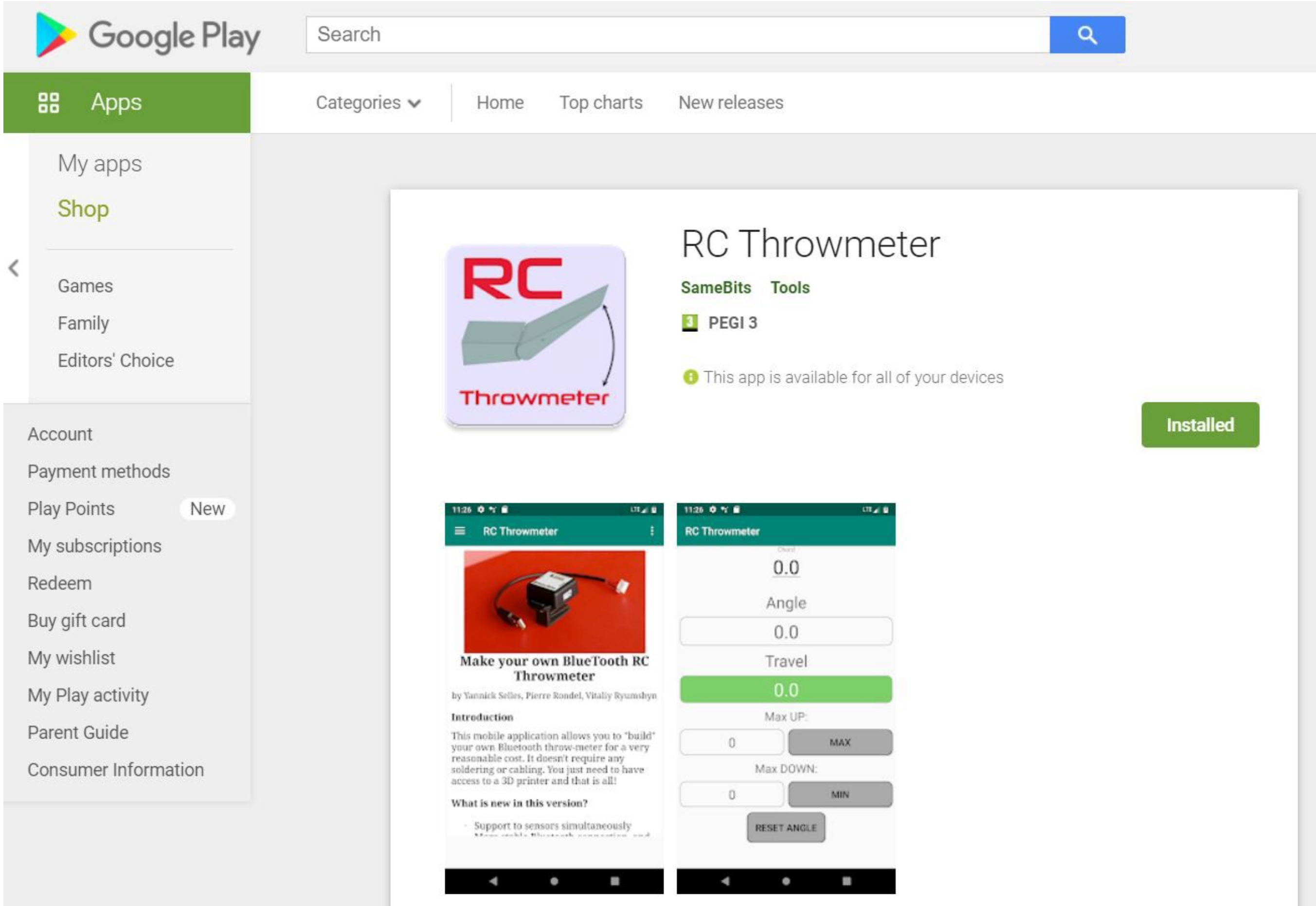


Photo 10: The mobile application can be found only on Google Play — sorry iOS users!

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.

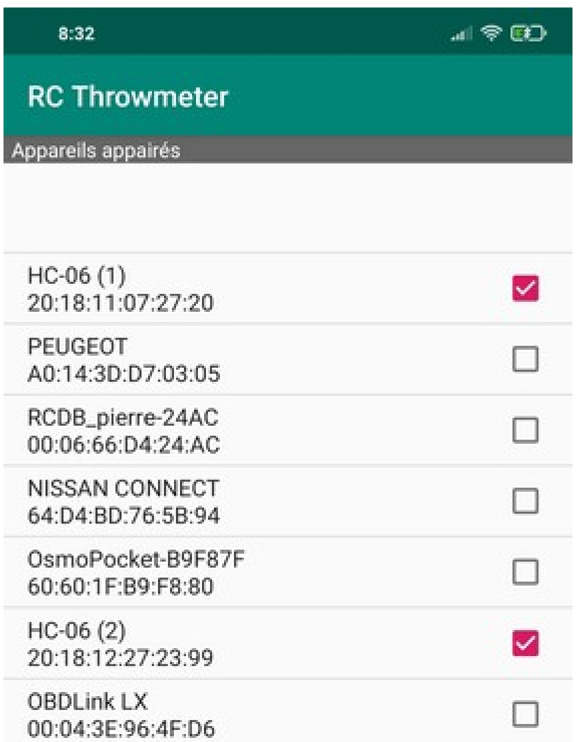
Features of version 1.4

- 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.



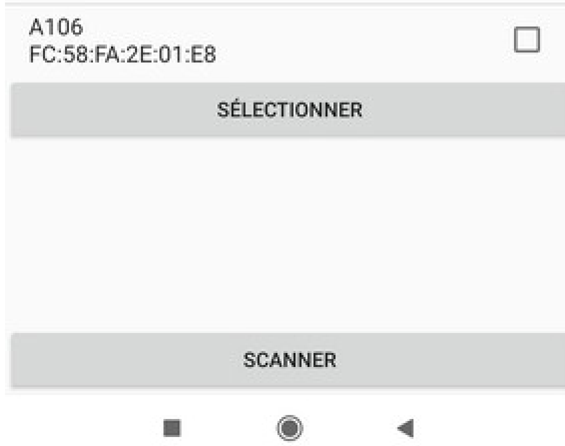


Photo 11: The binding page of the app where you select which device(s) you want to connect to.

- **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.

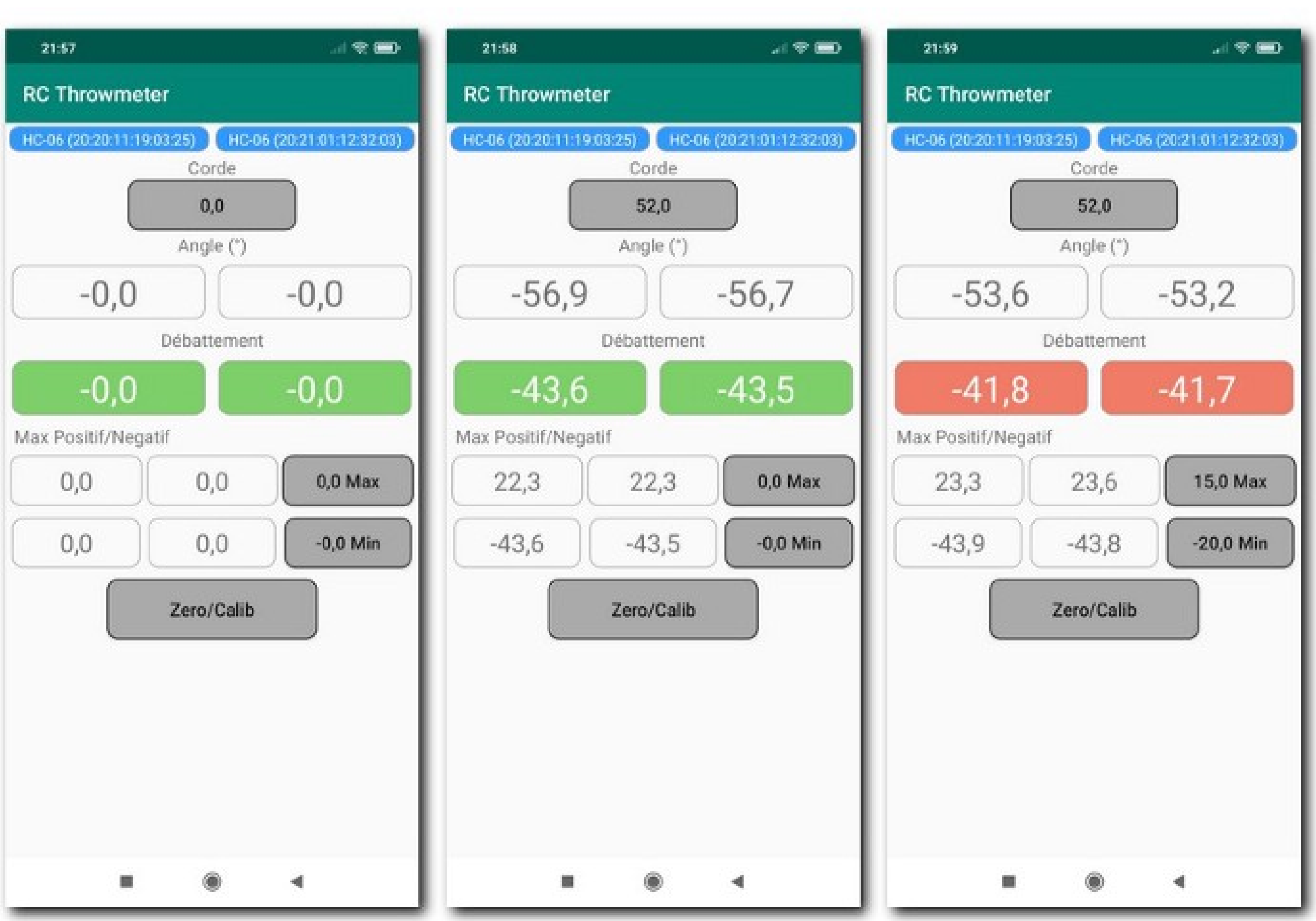


Photo 13: The measurement screen in action: measure, min/max and limits.

- **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.

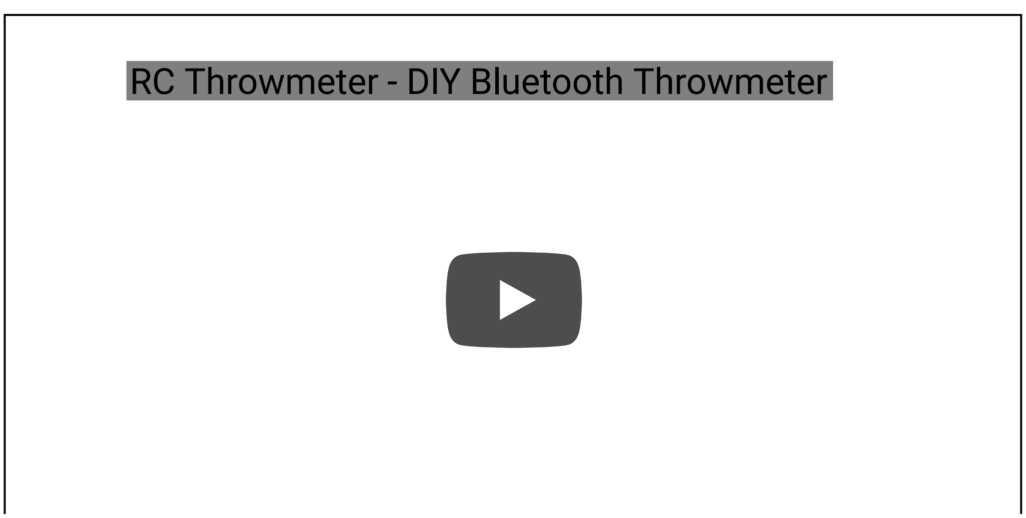
As an alternative, the app may ignore the vertical Z axis. This method is much more robust, but might add some absolute measurement error. In a real life context this can be accepted for the comfort of robustness, thus it is the default setting.

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.

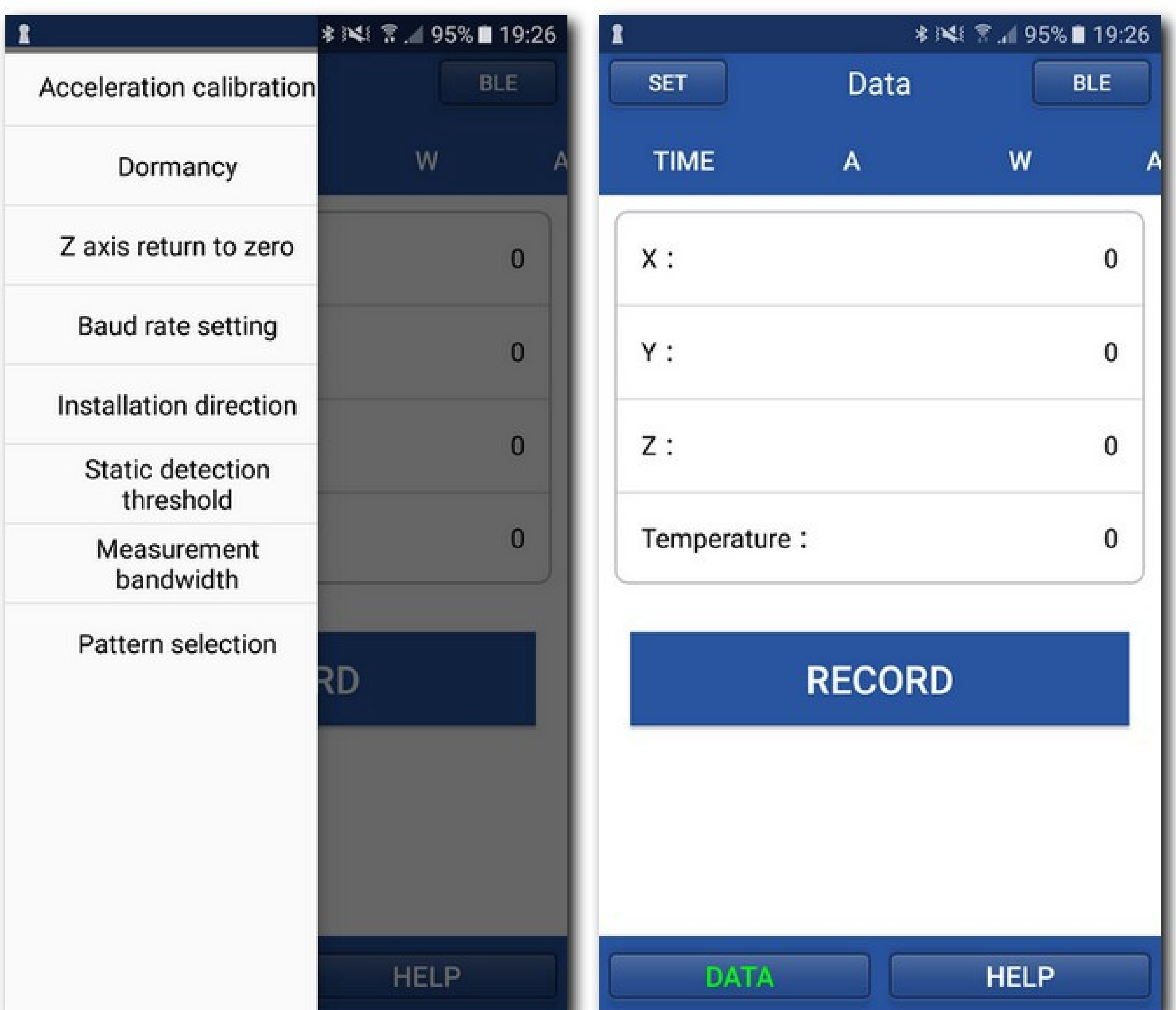


Photo 17: The manufacturer's app can also be used for the initial calibration.

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.

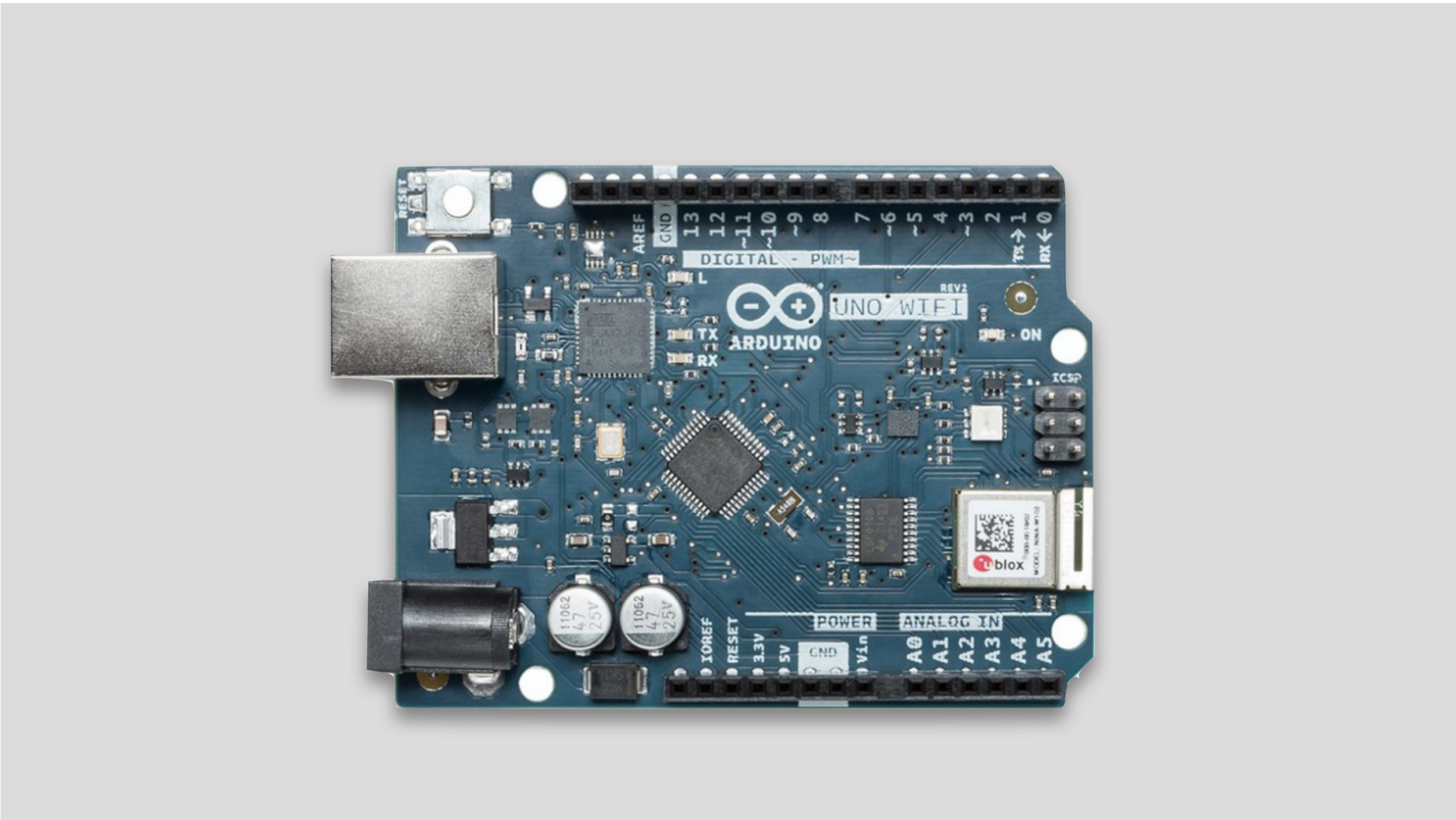
- This is a critical step to get the exact center. Take and push the blocks together and scribe a line on the main block. Flip the outer bocks the other direction and scribe again. This gives you an "X" right in the center of the block.

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

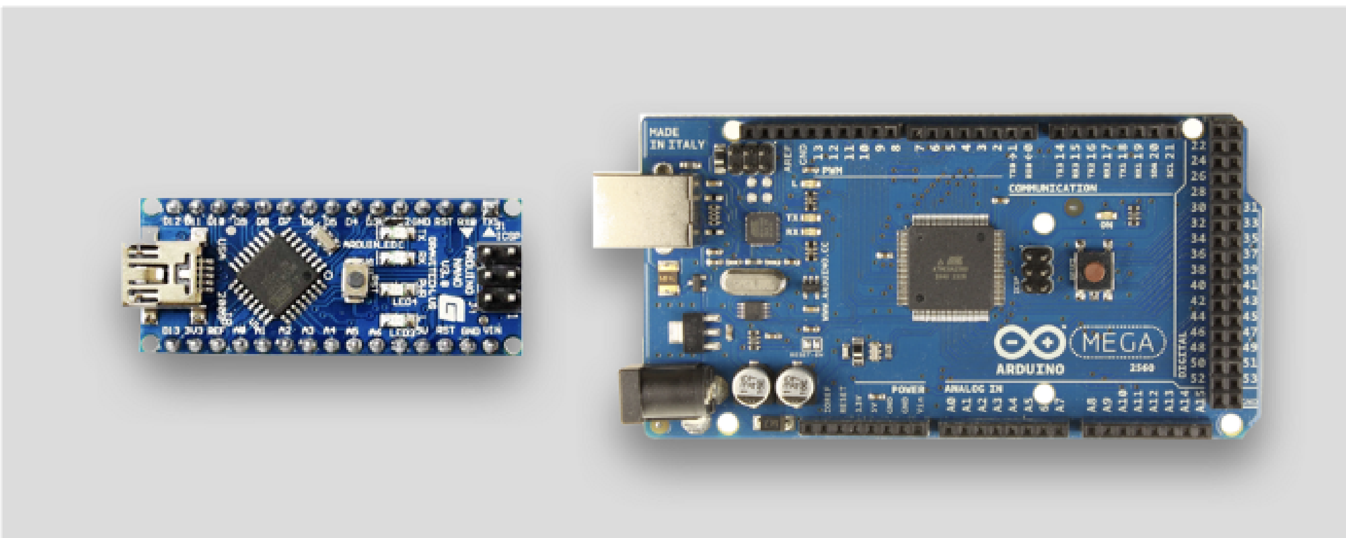
Add a little computing power to your next project.

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.*

1/3rd Scale Mita Type 3 Production Notes

The second part of a multi-part series.


Norimichi Kawakami Follow
May 13 · 23 min read

You may want to read the first part of this series before proceeding to this article Also if you prefer, you can read the this article in its original Japanese.

Fabrication Part 2: Center wing rib assembly

Rib cutting and assembly jig fabrication

Following the spoiler fabrication, I started to fabricate the main body of the center wing. It seems that everyone has their own way of making wings, but I'll explain mine.

First, I printed out a full-size drawing to cut out the ribs. At this time, as shown in the photo below, the rib and the assembly jig, which is about 30mm high and touches the underside of the rib, are also drawn and printed together.

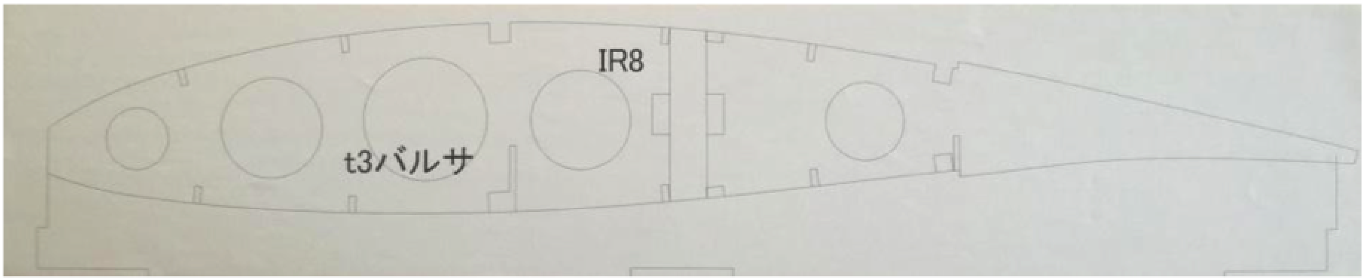


Photo 6: Printing the rib and assembly jig parts drawing.

The printed drawing is attached to the balsa sheet for the ribs with 3M removable glue spray, and then cut out along the lines with an OLFA 30° thin cutter.

Image 7: 3M removable glue spray and OLFA 30 degree thin cutter.

The drawing is printed with very fine lines of 0.09 to 0.13 mm, so if you carefully cut out along these lines, you can cut out with almost the same precision as a laser cutter. These are the rib and a component of the assembly jig after cutting out.

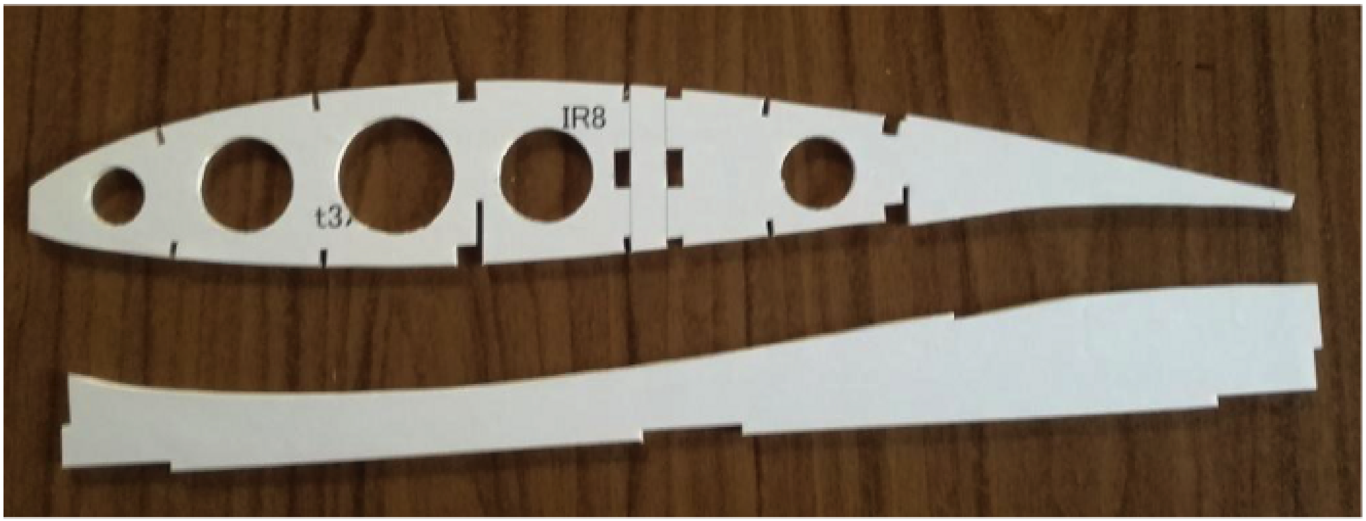


Image 8: Cut-out rib and assembly jig component

In addition to cutting out the ribs and assembly jig components, cut out the front and rear frames of the jig and the lower reinforcement part. After all the parts are cut out, the jig assembly was started. Since the center wing is 2 meters long, I decided to make it separately on the left and right sides for ease of handling during fabrication, and join them together at the end.

A full-scale printout of the drawing of the half central wing is laid out on a flat plate, and the jig parts are placed directly on top of it at the rib positions in the drawing. They are then supported by the front and rear frames and glued together with CA. The frames and parts have cutouts that interlock with each other for easy and accurate assembly. The drawing will stick to the jig due to the adhesives dripped during gluing, but don't worry about it. In this way, the center wing assembly jig was completed as shown below.

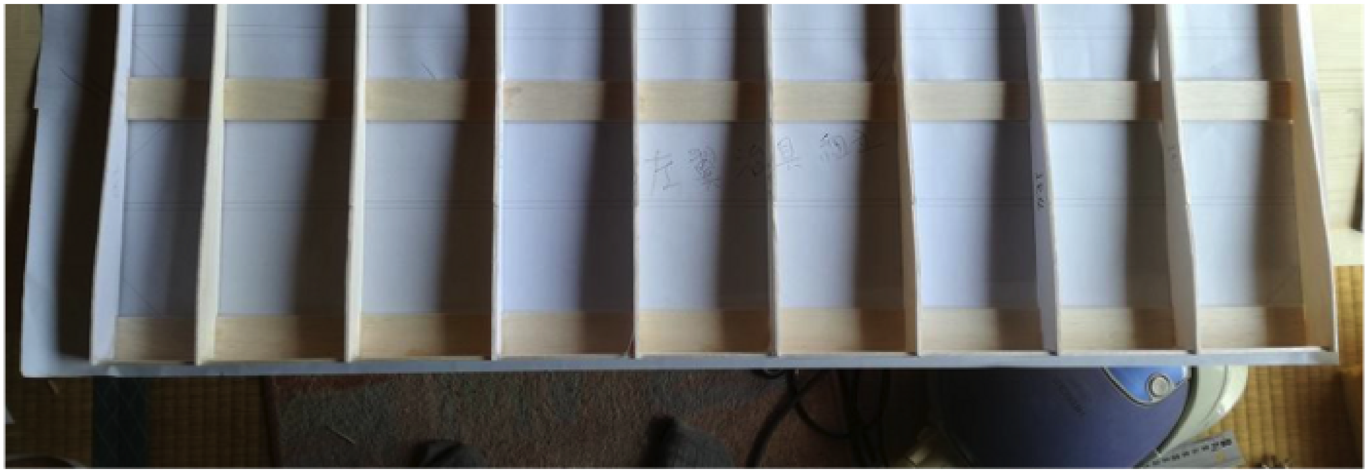


Photo 9: The center wing assembly jig completed

Assembling the center wing

Now that the ribs cutting and the assembly jigs are complete, it is time to assemble the main body of the center wing. Photo below shows the ribs for a half wing. The paper pattern is still attached.

Photo 10: Ribs for a half center wing.

The ribs were basically made of 3mm thick balsa, but 2mm thick was used for the ribs on the left and right sides that are planked to the trailing edge. The innermost ribs are sticked with 1.6 mm thick plywood, and the outermost ribs, which are in contact with the outer wing, are covered with 2 mm thick hard balsa as a protective board as explained before.

At first I thought I could leave the papers attached to the ribs, but I was surprised when I peeled them off and measured their weight. They weighed well enough to match a few ribs. Paper is heavy!.

Set these ribs in the appropriate positions on the assembly jig, and combine the spar flanges of carbon square pipe with the web cut from 1.6 mm thick plywood. In this state, the spoiler and the aluminum tube that will be used to support the carbon pipe to connect to the outer wing are also incorporated. After the assembly is complete, two or three heavy L-shaped steel bars are placed on top of the ribs as weights, and the ribs are aligned with the jig. The jig and ribs were originally made from a single piece of balsa, so they fit together perfectly.

Photo 11: Assembly of the center wing.

The balsa board standing on the leading edge of the ribs in the left photo is a jig that was inserted to make the ribs stand exactly vertically. In addition, a simple positioning jig as shown in the photo below was inserted because it is necessary to align the spar position precisely in order to join the left and right halves later.

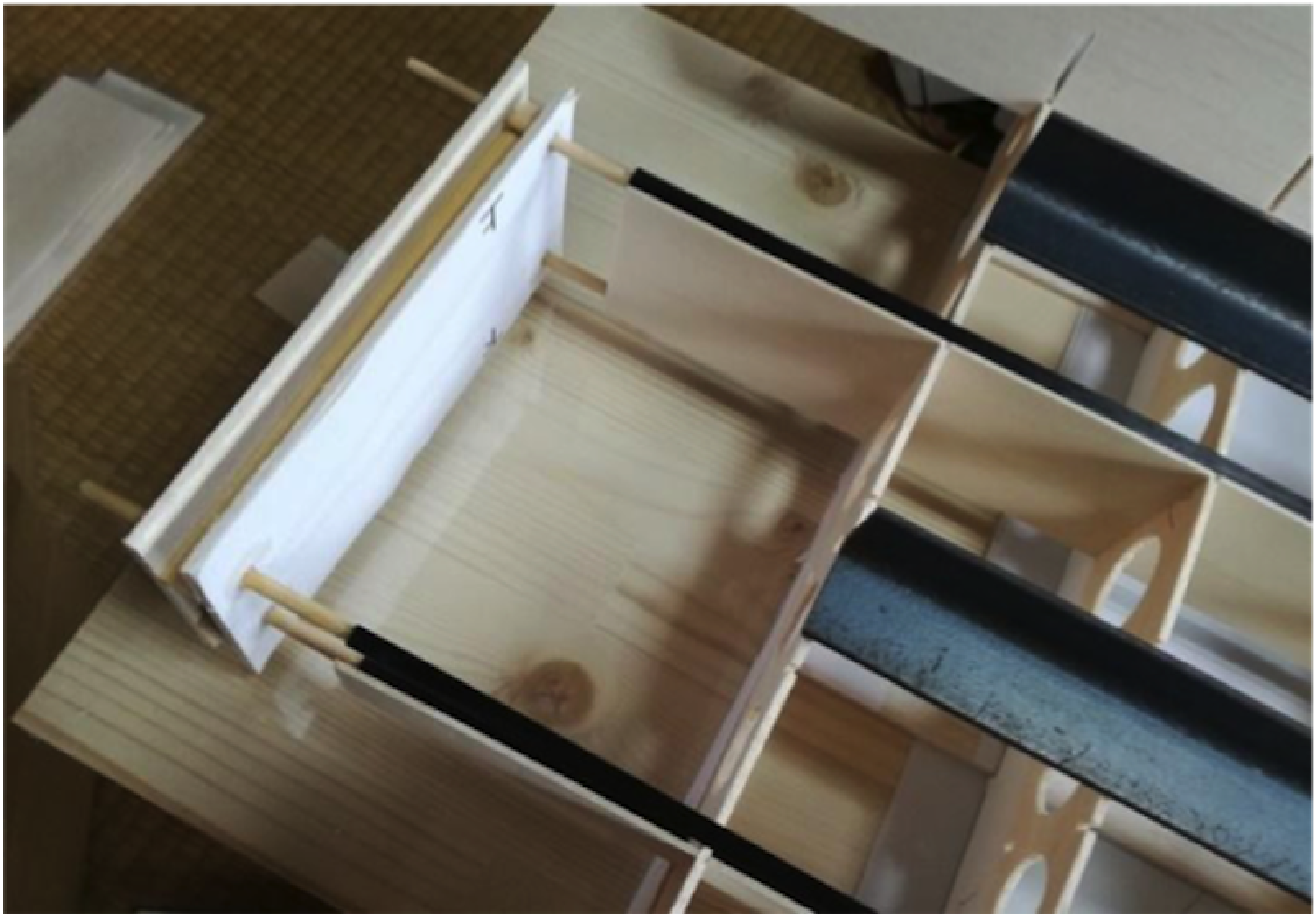


Photo 12: Spar positioning jig.

In this state, low-viscosity CA are dripped on the joints, and the aluminum tubes are glued to the surrounding spar webs with plenty of epoxy adhesives. Photo 13 shows the center wing rib assembly after gluing is completed. The red-colored part is the spoiler, and the aluminum tube is also visible.

Photo 13: Center wing rib assembly after gluing is completed.

Thanks to the assembly jig, accurate rib assembly was easy to produce. The jig is also very useful for the planking work after this. The left half weighed 355g and the right 344g, for a total weight of 700g. The weight difference between the left and right is a bit large.

Since a large amount of balsa powder will be generated during the planking process, I decided to stop making the center wing after the weather cooled down.

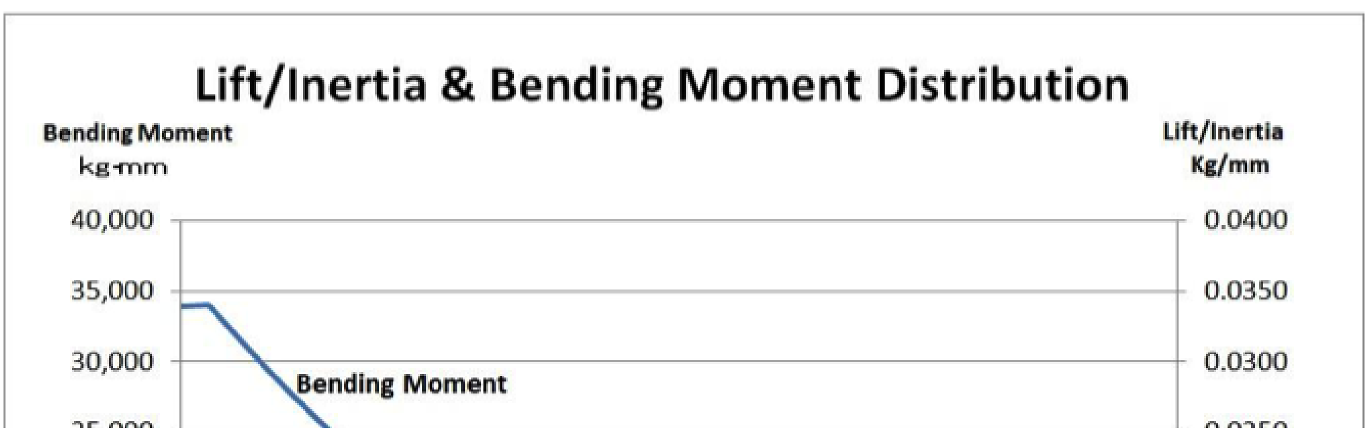
Structural Analysis of the Main Wing

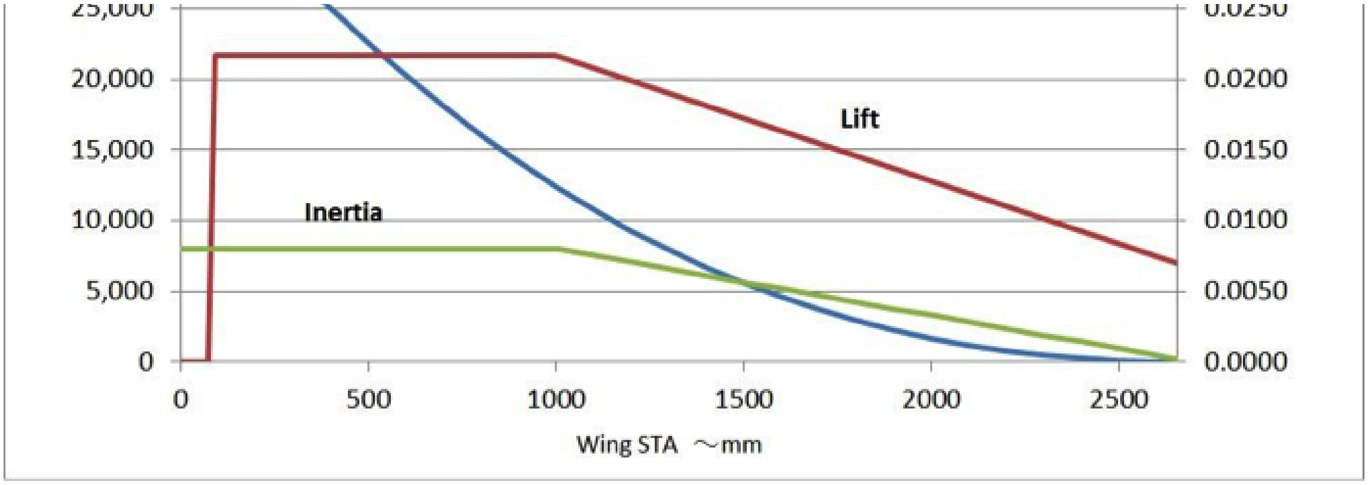
Since this is a large aircraft and heavy, I have conducted a structural analysis of the main wing.

Design load

The strength calculation of an aircraft is a process of confirming the aircraft will not break under the ultimate load (design load), which is calculated by multiplying the aircraft's limit load factor (the maximum G allowed) by a safety margin of 1.5. At the time I started the design, I could not find the limit load factor for the actual Mita Type 3 rev.1, so I adopted the factor of 6.0, which is applied to fixed-wing Class A aircrafts that perform acrobatic flights. By multiplying this by a safety factor of 1.5, the ultimate load factor became 9.0, but I took a margin of safety and calculated the design load factor as 10.

Applying 10G to the model with a maximum overall weight of 8.7kg means that 87kg of lift force will be applied to the main wing. Since the main wing has mass, the inertia force of 10G acts in the opposite direction of the lift force. The difference between the lift and inertia produces the moment that bends the main wing upward. The figure below shows the result of the calculation using EXCEL spreadsheet.





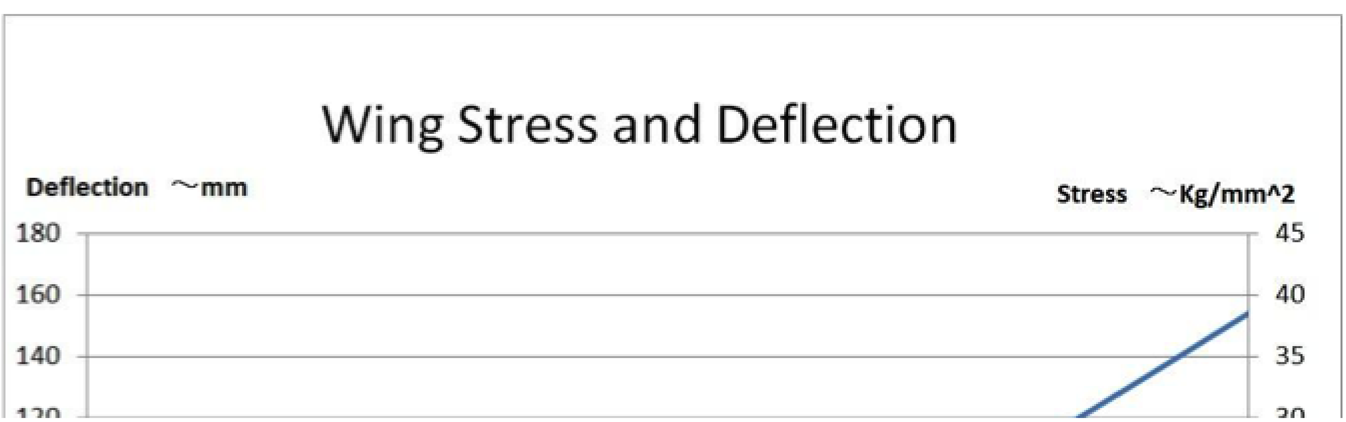
Graph 4: Design load of main wing.

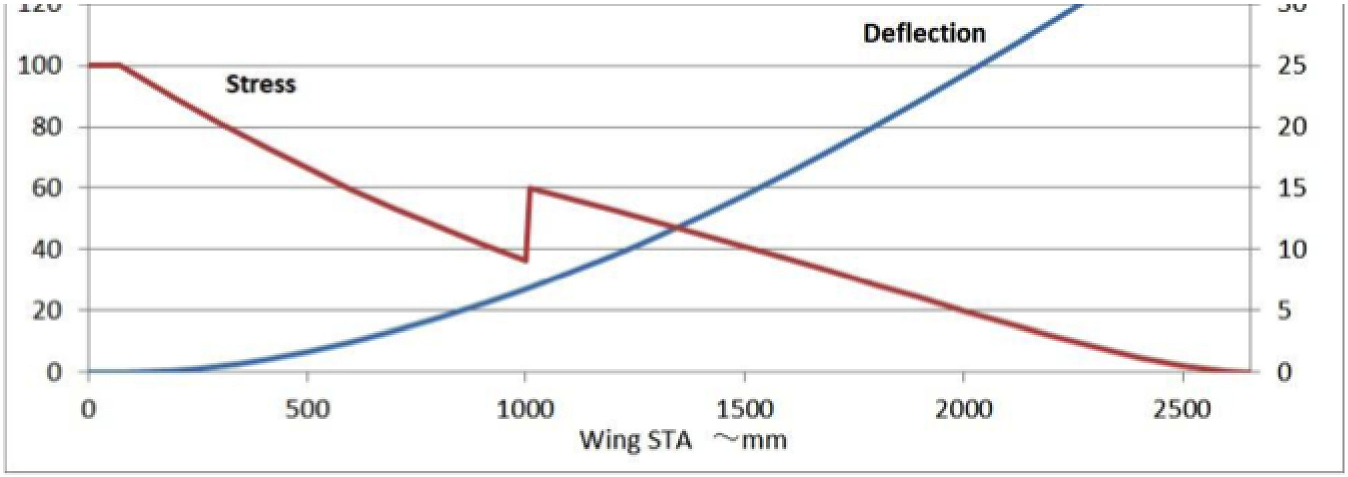
This is a graph of a half wing, with STA = 0 at the centerline of the fuselage and STA = 2655 at the wing tip. Both lift and inertia decrease as you move outward from STA = 1000, where the tapered outer wing is. The lift is zero inside the STA=100 because it is inside the fuselage.

The bending moment is zero at the wing tip and increases gradually toward the wing root, but it stops and remains constant near STA100 because the wing is connected to the fuselage at this point. The maximum bending moment is at this wing-fuselage connection, which is about 34,000 kg-mm = 34 kg-m.

Strength Calculation

The bending moment causes the wing to deflect upward, which in turn causes stress in the spar. The deflection and stress of the spar due to this moment load can be calculated using the beam theory of material mechanics. The detailed explanation is omitted, but the calculations were made using an EXCEL spreadsheet. The results are shown in the figure below.





Graph 5: Stress and deflection of main wing due to design load.

The deflection increases toward the wing tip and is expected to be about 154 mm at the wing tip. The stress is greatest at the wing root where the moment is large, and decreases toward the wing tip, but it increases again near STA1000 because the outer wing has a thinner spar flange from here. It can be seen that the maximum stress is about 25 kg/mm^2. This stress occurs in the flange of the carbon square pipe, but the allowable stress of carbon is about 70 kg/mm^2, so it is clear that the wing is strong enough.

The center wing is connected to the outer wing by a carbon pipe with an outer diameter of 20 mm and an inner diameter of 16 mm, and the STA1000 uses this pipe alone to transmit the moment. The stress generated at the outer edge of the pipe is calculated to be 26.8 kg/mm^2,which is more than enough.

Later, I learned from a former instructor of the glider club of Tokai University that the limit load factor of the actual aircraft is 5. Also, the finished weight increased to about 10 kg. The design load under these conditions is 10 x 5 x 1.5 = 75 kg, so I was able to confirm that the design load of 87 kg mentioned above is on the safe side.

Selection of power system

It sounds somewhat strange to select a power system for a glider, but my RC club is located in a flat area and I don't have a winch for my glider, so all of my RC gliders are equipped with a motor and a foldable propeller for self-takeoff. The 1/3 model will also have a motor and foldable propeller like the others, so I need to select a power system consisting of a motor, power battery (LiPo), and motor controller (ESC).

Selecting a motor

First, I need to decide the size of the motor. Based on my vague knowledge that a glider of this class requires a motor of about 130W per kg of weight, I decided that a motor of about 1,100 to 1,200W would be appropriate for this glider, which weighs a maximum of 8.7kg.

I researched and listed the combinations of motors, LiPo, and ESCs in this class in the table below.

	Candidate Power Systems			
Candidate Motors		OS OMA-5020-490	FSD FC5065-6T	E-MAX GT4030/06
KV	rpm/V	490	430	420
Normal Current	A	50	60	
Max Current	A	90	70	60
Weight	g	350	361	380
Price	¥	14,900	7,236	6,483
Candidate LiPo		KYOPOM 5,100mAh	KYOPOM 5,101mAh	KYOPOM 5,101mAh
Number of Cells		5	5	5
Capacity	mAh	5,100	5,100	5,100
Weight	g	600	600	600
Price	¥	0	0	0
Candidate ESCs		Hobbywing Flyfun 100A	sunrise Model 80A	sunrise Model 80A
Allowable Current	A	100	80	80
Weight	g	76	65	65
Price	¥	6,804	4,495	4,495
Total Weight	**g**	**1,026**	**1,026**	**1,045**
Total Price	**¥**	**21,704**	**11,731**	**10,978**

Table 1: Candidate motors and their corresponding LiPo and ESCs.

Three brands of motors, OS, FSD, and E-MAX, have KV values of 420 to 490 and weights of 350 to 380 grams.

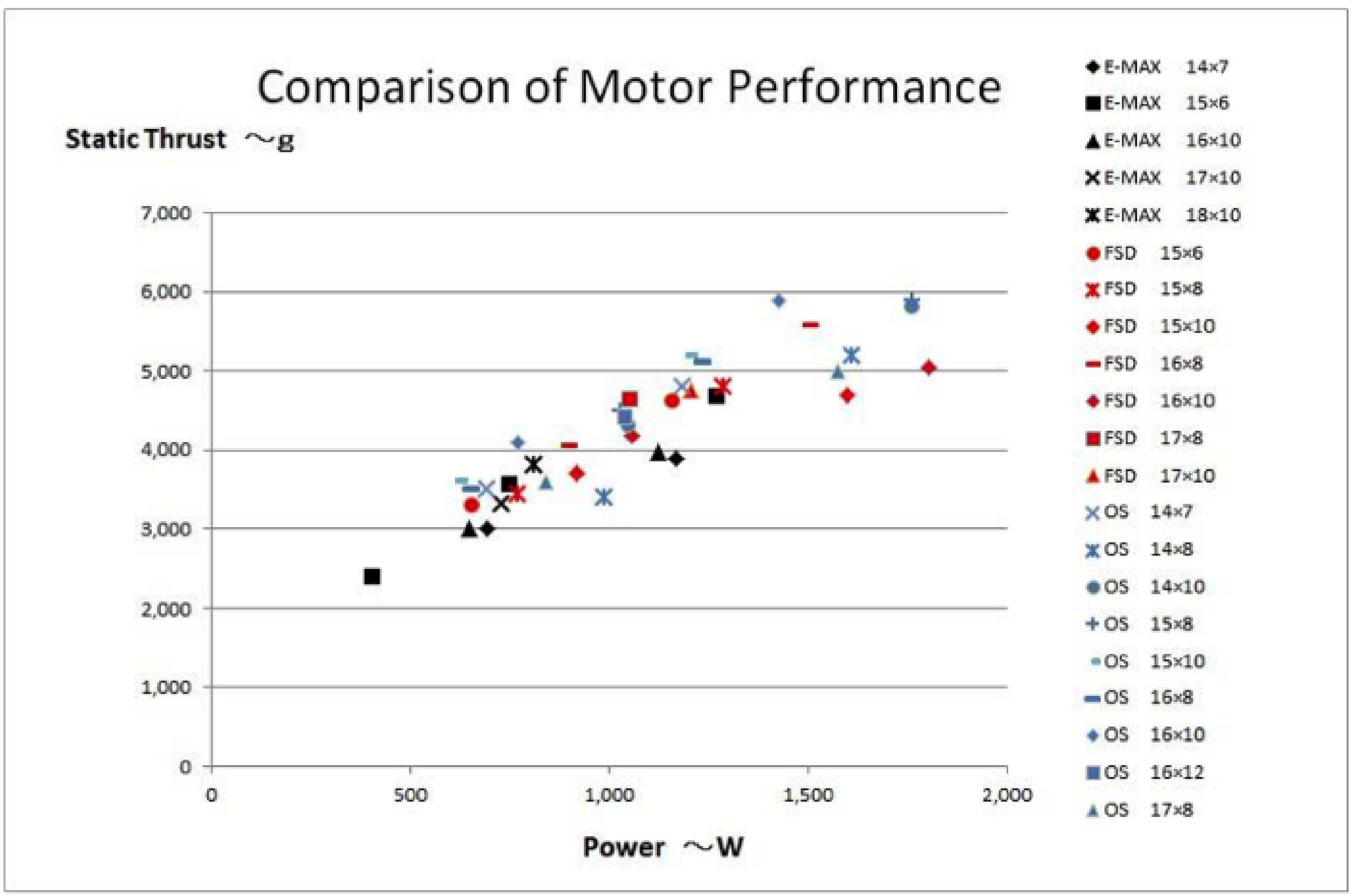
I have used several OS motors that are a class smaller than these. I am satisfied with the quality and performance of those motors. The OS motors have a slightly higher KV than other manufacturers' motors, so they have more power for their weight.

FSD motors are reasonably priced and offer good performance. I use a smaller motor for my 1/5 Mita and 1/5 Minimoa.

The E-MAX motor is the least expensive motor, but it is well made and has no problems. I use this same motor in my Curtiss Jenny.

Photo 14: My Curtiss Jenny with E-MAX GT4030/06 motor.

The figure below shows a graph comparing the performance of the three motors using published data, with the OS motor data from the OS website and the FSD and E-MAX motor data borrowed from the KKHOBBY website.



Graph 6: Performance comparison of candidate motors.

The horizontal axis is the power consumption (W) and the vertical axis is the static thrust. There is a slight difference depending on the propeller installed, but there is not much difference in performance. However, there seems to be a slight difference in the appropriate power range, with E-MAX motor consuming around 1,000W, FSD motor consuming around 1,100 to 1,200W, and OS motors consuming around 1,200 to 1,400W.

LiPo battery for power

The nominal voltage of a 5-cell LiPo is 18.5V, but when fully charged it is over 20V, and even in normal use it is close to 20V, so 60A will give 1,200W. The required battery capacity was calculated as follows.

If you run the motor at full power of 60A for one minute, you can gain a lot of altitude. After that, you can stop the motor and enjoy it as a glider. Once you get a thermal, you don't need any more power. If the thermals are weak and you are losing altitude, you can do another motor run to regain altitude. If you do three such motor runs, you will probably be flying for more than 10 minutes, and you will get tired, so you will have to land the plane. In other words, we only need a LiPo with enough capacity to run 60A current for 1 minute 3 times (60A x 1/60h x 3 = 3Ah = 3,000mAh). 50–70% consumption of LiPo is usually the best, so a battery with a capacity of 4,300–6,000 mAh would be appropriate.

Fortunately, the battery for the Curtiss Jenny pictured above is a 5,100 mAh 5-cell LiPo, and it fits the requirement perfectly. This battery had no other use and was underutilized, but now I don't have to buy a new battery.

ESC

The OS motor has a maximum current of 90A, so it needs a 100A class ESC, but the FSD and E-MAX motors have a maximum current of 70A or less, so an 80A class ESC is sufficient. This is also important for Sunday flyers because ESCs become more expensive as their capacity increases. Sunrise ESCs are also used in my 1/5 Mita model and other and are very solid ESCs for the price.

Conclusion

Based on the above considerations, I decided to use the FSD FC5065–6T as the motor, taking into account its power range, price, and experience with similar products, and decided to use the KYOPOM 5-cell 5,100mAh LiPo and Sunrise 80A ESC (which I also had on hand) and ordered the motor.

As for the propeller, from the performance comparison graph above, I thought that 16 or 17x8 would be good.

> **Mistake 4:** *As I will explain later, this decision was not well thought out and I had to buy a new motor/ESC/LiPo. I made the mistake of assuming 130W per 1kg of weight without thinking too much about it. It was a painful expense.*

Payload weight

The above power system is included in the payload that I discussed in the target weight. The payload also includes the receiver and its power supply, so I estimated the total payload weight including them here.

Estimated payload weight

Motor	361 g	
LiPo	600 g	
ESC	65 g	
Folding propeller & hub	50 g	
Receiver	10 g	
Power supply for receiver	155 g	(2,500mAh NiMH)
S/W for saame	11 g	
Harness	100 g	
Total	1,352 g	

The target payload weight was 1,800g, so it would be about 450g lighter. However, I may need to add some weights to align the center of gravity, so next I calculated the CG.

Weight & Balance Calculation and its Management

I found that the payload weight is lighter than what I had planned in the power system study, but I was not sure if the center of gravity would match. Therefore, I studied CG. I also set a method to manage the weight and balance by which I can check it as the design and fabrication progresses.

Target CG position

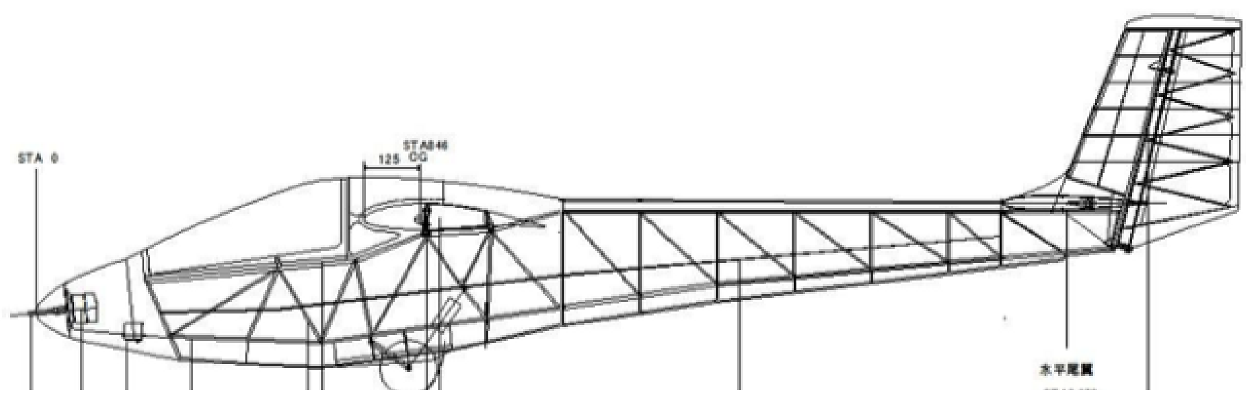
At this point, I did not know the allowable center of gravity range of the actual model. Therefore, the target center of gravity of the 1/3 Mita Type 3 Kai 1 was set to the same as that of the 1/5 model made by Thermal Studio. Since the center of gravity of the 1/5 model is 75 mm behind the leading edge of the main wing, the center of gravity of the 1/3 model is 75 x 5/3 = 125 mm behind the leading edge, which is STA846 mm from the nose.

0th check of weight and balance

The center of gravity was calculated based on the target weight of the aircraft's each component. In the target weight calculation, the long fuselage including the tails was combined into one body, but in the center of gravity calculation, it needs to be broken down a little more. So the fuselage is divided into front and rear at the narrow point just after the trailing edge of the main wing. Further, the rear fuselage is divided into three parts: the rear fuselage itself, the vertical tail, and the horizontal tail. The weight of the rear fuselage, vertical tail and horizontal tail is calculated as follows

Rear fuselage	560 g
Vertical tail	240 g
Horizontal tail	400 g

Therefore, the target weight of the front fuselage was 1,600g, subtracted from the target weight of the entire fuselage of 2,800g. These target weights and the positions of the payload weights considered in the selection of the power system are shown in Drawing 6.



Drawing 6: Weight of each component and its position.

Based on this figure, the moment created by the weight of each component is calculated in Table 2.

0th Weight & Balance	2018/5/15	Completion Ratio		0.00 %	
	Weight	STA	Moment	Actual Weight	Estimated Remain Weight
Outer Wing Left	700	860	602,000	0	
Outer Wing Right	700	860	602,000	0	
Center Wing	1,600	890	1,424,000	0	
Forward Fuselage	1,600	630	1,008,000	0	
Aft Fuselage	560	1,550	868,000	0	
Vertical Tail	240	2,450	588,000	0	
Horizontal Tail	400	2,270	908,000	0	
Motor	361	100	36,100	0	
Propeller & Hub	50	-10	-500	0	
Battery for Radio	155	200	31,000	0	
LiPo	600	340	204,000	0	
Others	186	600	111,600	0	
Total	**7,152**	**892**	6,382,200	**0**	
Target CG		**846**			
Weight	483	160	77,343		
Normal Flight Condition	**7,635**	846	6,459,543		

Table 2: Calculation of the 0th weight and balance.

Weights are target weights, not actual measured weights. In this sense, the completion ratio is 0%, and the accuracy is only moderate. This is the reason why I call it the zero-order calculation. The actual weight of each component will be measured as fabrication proceeds, I will revise this. If no weight is added the total weight will be 7,152g, but the center of gravity will be 892mm, 46mm behind the target of 846mm. The reason for this is that the motor and the power supply for the receiver are lighter than those expected from a 1/5 model. Since it cannot fly as it is, it is needed to put a weight of 483g on STA160 just after the motor in the nose. In the end, the weight in normal flight will be 7,635g, which is 35g over the target of 7,600g.

This is an unreasonable situation where the payload weight can be lighter than the target weight, but since the center of gravity is not aligned, an extra weight is loaded, and the total weight exceeds the target weight. It is obvious that the most effective way to solve this problem is to reduce the weight of the vertical and horizontal tails, which are located at the very rear.

1st check of weight and balance

The center wing rib assembly has been completed. The actual weight was 700g and the expected weight of the remaining work was 860g. Using this data, I quickly revised the calculation table and made the first weight and balance calculation as shown in Table 3.

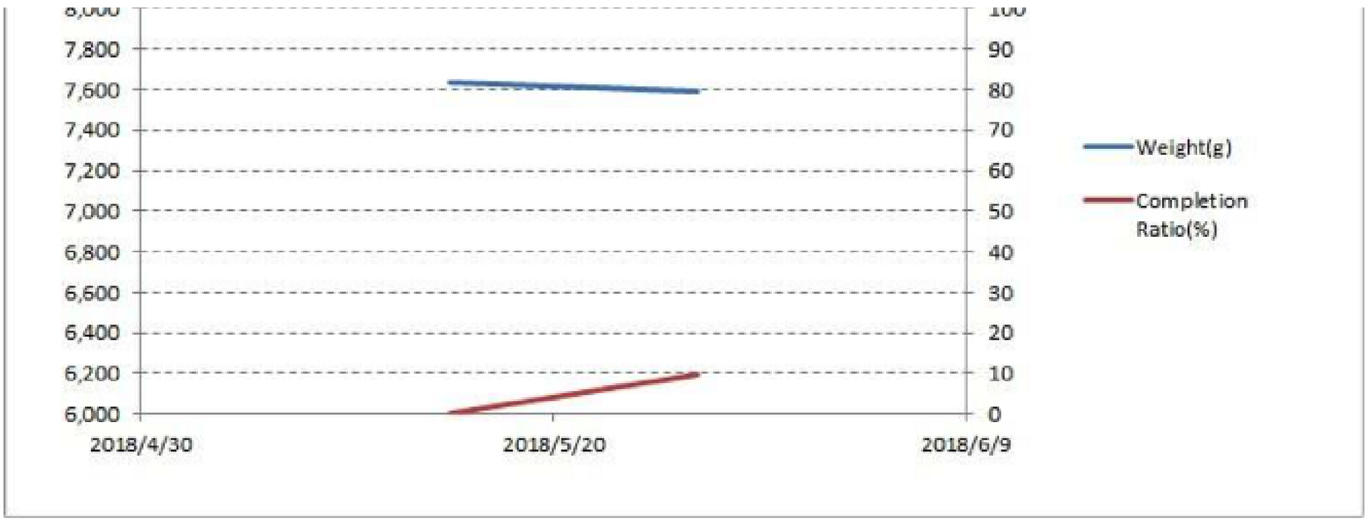
The total weight was estimated to be 7,112g, of which 700g was actually measured, so the completion ratio increased to 9.84%. The tail wings are still the same as in the 0th calculation, so there is no significant change in the center of gravity and the weight needed is 481g. The total weight in normal flight condition is expected to be 7,593g, which is barely within the target.

1st Weight & Balance	2018/5/27	Completion Ratio		9.84 %	
	Weight	STA	Moment	Actual Weight	Estimated Remain Weight
Outer Wing Left	700	860	602,000	0	
Outer Wing Right	700	860	602,000	0	
Center Wing	1,560	890	1,388,400	700	860
Forward Fuselage	1,600	630	1,008,000	0	
Aft Fuselage	560	1,550	868,000	0	
Vertical Tail	240	2,450	588,000	0	
Horizontal Tail	400	2,270	908,000	0	
Motor	361	100	36,100	0	
Propeller & Hub	50	-10	-500	0	
Battery for Radio	155	200	31,000	0	
LiPo	600	340	204,000	0	
Others	186	600	111,600	0	
Total	7,112	892	6,346,600	700	
Target CG		846			
Weight	481	160	76,932		
Normal Flight Condition	7,593	846	6,423,532		

Table 3: First weight and balance calculation.**Weight Control Chart**

Weight Control Chart

The following graph shows the weight and completion ratio obtained as a result of the 0th and first weight and balance calculations.

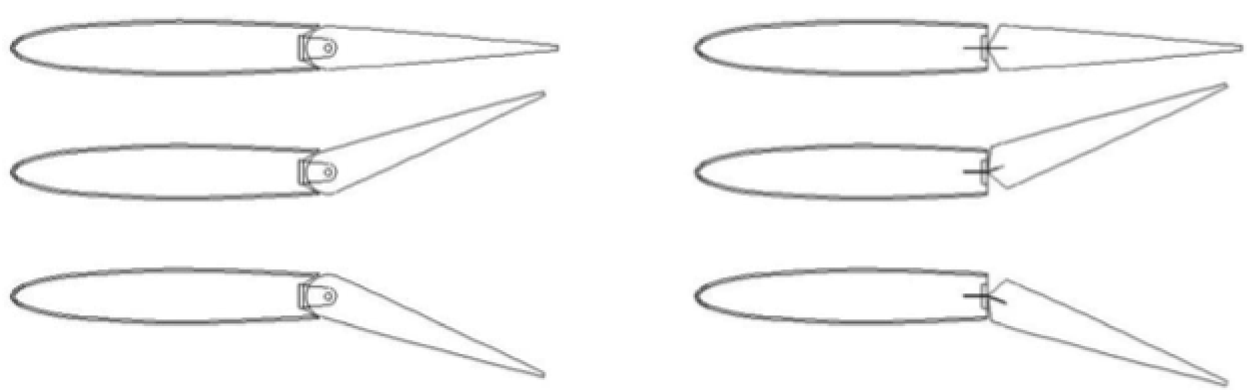


Graph 7: Weight control chart.

As the fabrication progressed, this figure also grew to the right as the calculations were revised. While keeping an eye on this figure, I proceeded with the design and manufacture of the glider, always taking care not to exceed the target weight. Although the completion ratio increases steadily, the degree of freedom for design changes that affect the weight decreases, so it is necessary to deal with this issue carefully from the beginning.

Fabrication Part 3: Vertical tail

After making the center wing rib assembly, I started to build the vertical tail. There is a reason for this. For this large glider, I planned to make the leading edges of the control surfaces rounded, just like the actual glider (drawing 7, left). These leading edges of a usual RC aircraft are pointed in a V-shape and attached with a cloth or rod hinge (Drawing 7, right).



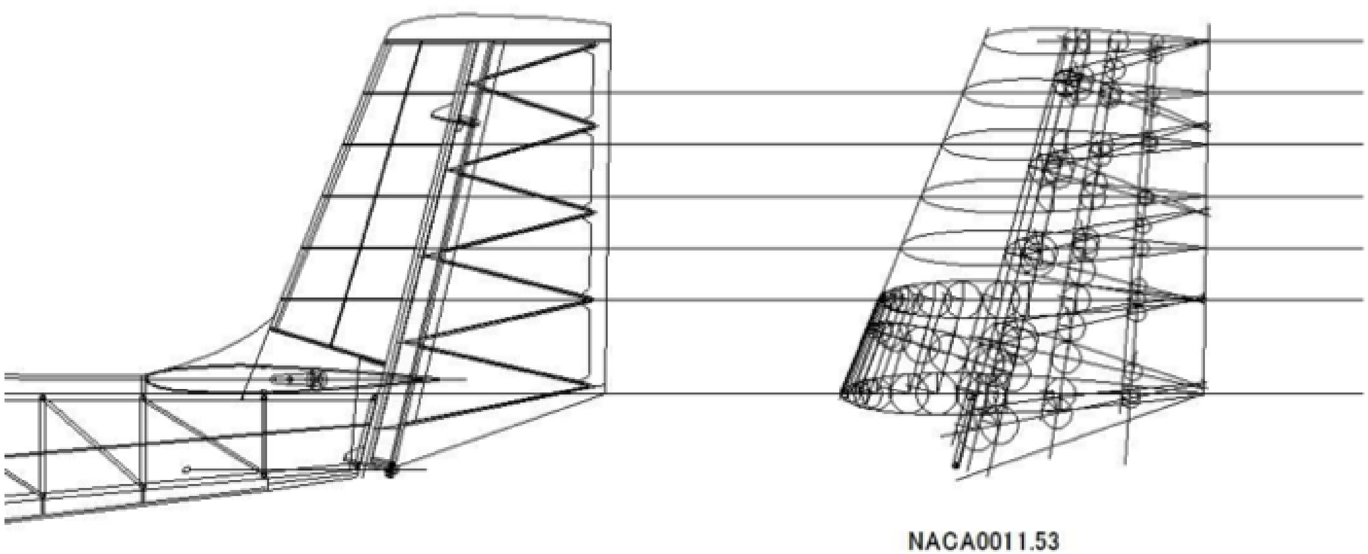
Drawing 7: Control surface attachment; actual aircraft (left), usual RC model (right).

All the aircraft I have built so far have been of this type. This is sufficient for a small RC aircraft, but for this aircraft, which is 1/3rd the size of the actual aircraft, the gap between the control surfaces and the wing will be large, which may have a negative effect on aerodynamic performance. In addition, the ailerons of the actual aircraft are of the so-called "frise" type, in which the leading edge juts out from the underside of the wing when the airelon is raised. To make ailerons that resemble this, it is impossible to apply the conventional RC aircraft's aileron attachment method.So I decided the leading edge of the control surfaces are rounded and covered by wing trailing surfaces. This minimizes the gap at the attachment point and makes the air flow smoother. The hinges also need to be changed in order to achieve this.

Since this is the first time for me to build this type of control surfaces, I thought I would first gain experience in building a vertical tail with one control surface and reflect the know-how I would gain in building the main wing and the horizontal tail that have two control surfaces.

Structure of the vertical tail

The figure below is the structural drawing of the vertical tail.



Drawing 8: Structural drawing of the vertical tail.

For the airfoil shape, I tried to make a smooth connection between the side of the fuselage and the vertical fin, and found that a target airfoil with 11.53% thickness was the best choice, so I decided to use NACA0011.53.

In the process of making this drawing, a troublesome problem arose. All the control surfaces of Mita Type 3 are covered with cloth and not planked. Therefore, all the ribs are attached diagonally to get torsional rigidity. Since the airfoil shape is naturally defined in the airflow direction, the rib shape of the control surfaces has to be obtained by drawing which are shown in the figure on the right.

The ribs of the rudder are 3 mm thick. For the front edge, I put several semicircular ribs on the rudder front spar and planked them with 1mm thick balsa.

Vertical fin is full plank. There is a thick 10mm spar at the very rear which is attached to the fuselage rear end with two bolts. A hard board is embedded in the mounting area for reinforcement. The stringers are made of 1 x 5 mm cypress sticks and run diagonally around the maximum wing thickness to prevent the planks from dent. In the actual model, it seems to run vertically a little further back. The ribs of the vertical stabilizer are made of 2mm thick balsa, and the planks are made of 1.5mm thick balsa sheets.

The rudder hinges are installed in two places, upper and lower, as in the actual model, and the rudder is hinged so that it can be removed freely. For the upper hinge, a short 4Φ bamboo string is attached upward to the end of the carbon plate stay extending from the fin to form the rotation axis, and the acrylic plate with holes attached to the rudder side supports the axis of the bamboo string. The hinge on the lower side is a 4Φ bolt inserted from the underside of the rudder and screwed into the rudder body through the stay of the carbon plate with holes extended from the fin. A carbon rudder horn is also attached to this part.

Fabrication of the rudder assembly jig

As with the center wing, the ribs of the rudder and the parts for the assembly jig were cut out at the same time. The photo below shows the assembly of these parts.

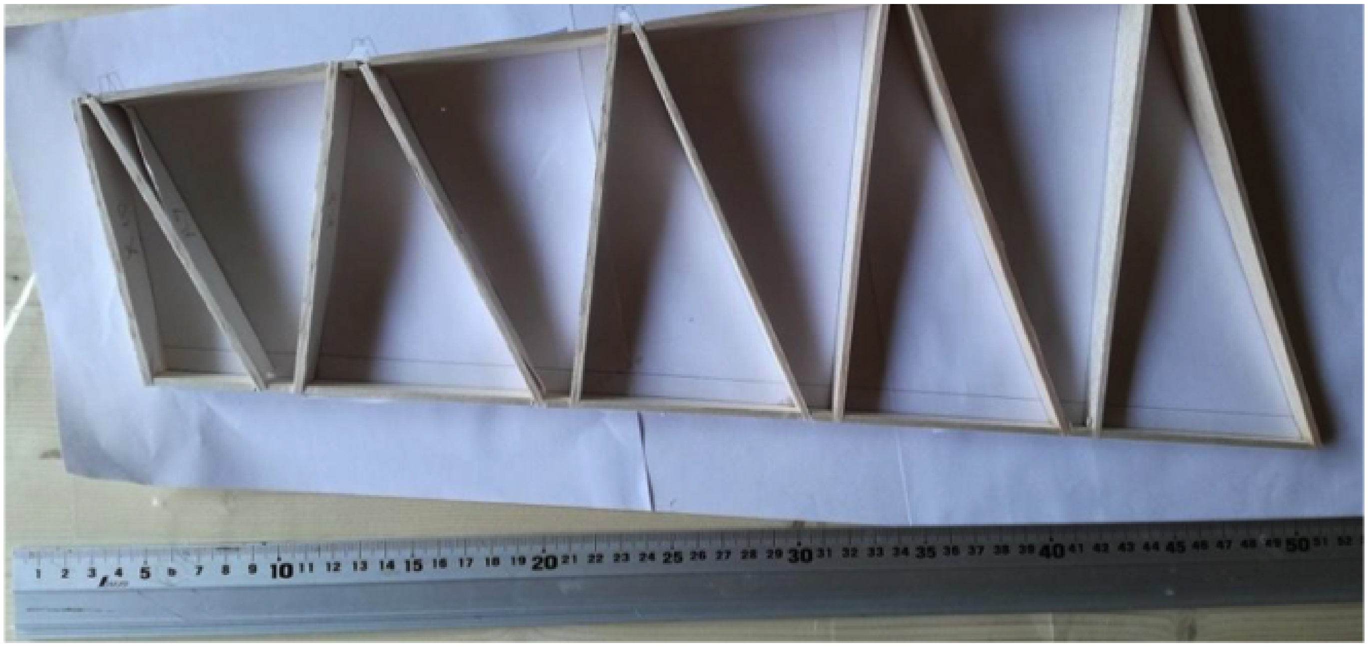


Photo 15: Rudder assembly jig.

Rudder parts

This is the rudder parts that have been cut out (Photo 16).

Photo 16: The rudder parts.

Rib assembly of the rudder

This is the rib assembly of the rudder. The heavy steel L-bars press it firmly against the assembly jig.

Photo 17: Rib assembly of the rudder.

Rudder rib assembly completed

Rib assembly is now completed. Thanks to the jig, the contour of the rib surface is nicely aligned.

Photo 18: Completed rudder rib assembly.

Fabrication of the vertical Fin

The vertical fin was assembled following the same procedure as the rudder. The assembly jig (left) and vertical stabilizer parts (right).

Photo 19: Assembly jig and parts of the vertical fin.

The bottom rib runs diagonally, so the angle of the assembly jig to receive the rib is different from the others. In order to firmly attach the ribs to the spar, the parts are not butt-jointed, but rather the ribs are inserted through holes in the spar.

Photo 20 shows the vertical fin rib assembly completed. The assembly jig was very effective, and accurate assembly was completed very easily.

Photo 20: Vertical fin rib assembly.

After this, the hinge shaft was attached to the spar and planked with a 1.5 mm balsa sheet. Then the rudder was attached and the vertical tail was assembled.

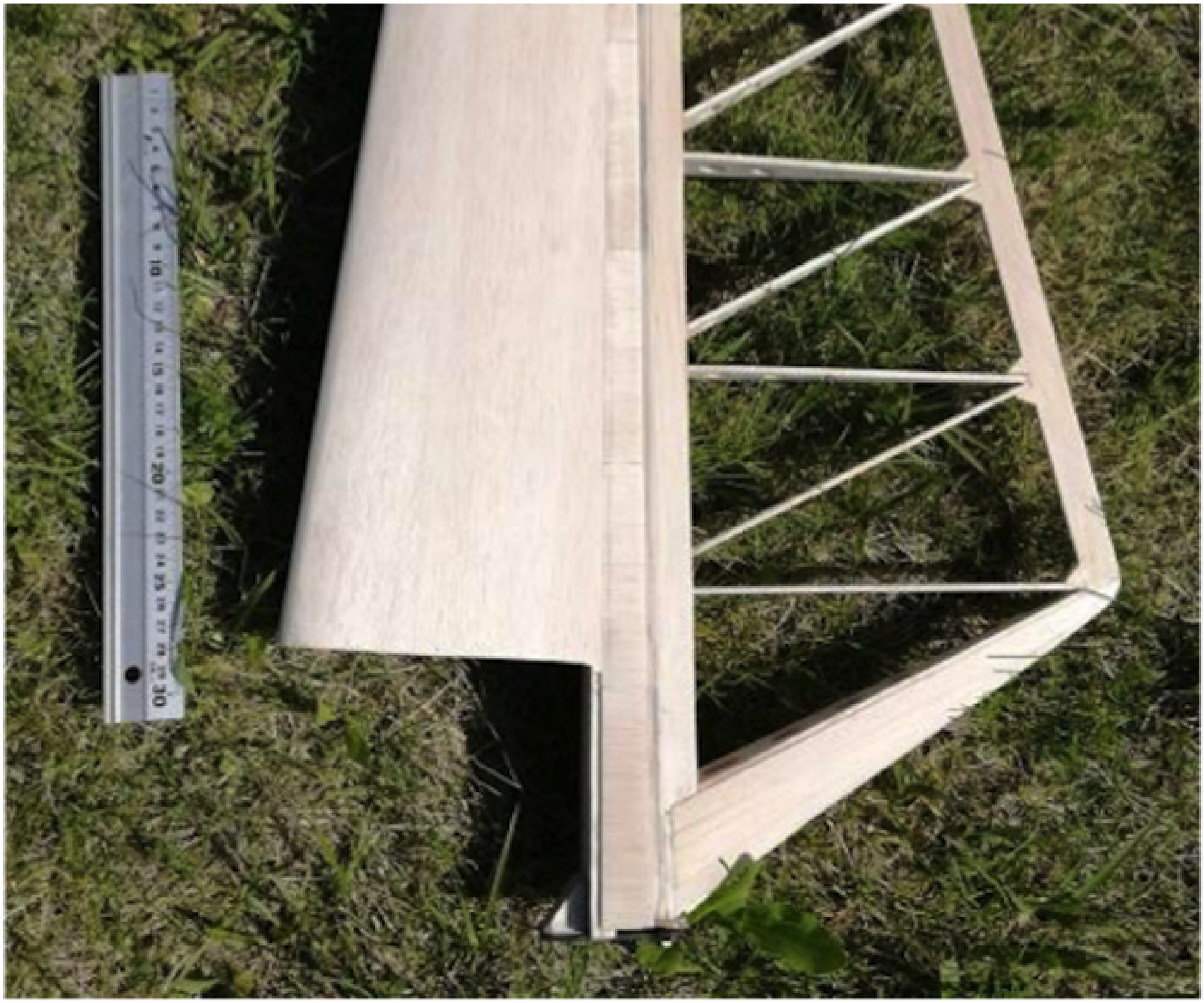


Photo 21: Finished vertical tail assembly.

I forgot to take a picture of the important R-shaped leading edge of the rudder. However, the rib spacing was too wide and the 1mm plank material was too thin, so the leading edge of the rudder did not become a beautiful semicircle, and some distortion occurred. I had to apply patches to the large dents, but fortunately they are no longer noticeable after covering.

The plank that protrudes behind the spar of the fin also has a few points to be considered in terms of accuracy. I simply attached a balsa plank to the spar in the vertical direction and stretched it over the leading edge of the rudder, but this caused a slight undulation in the longitudinal direction.

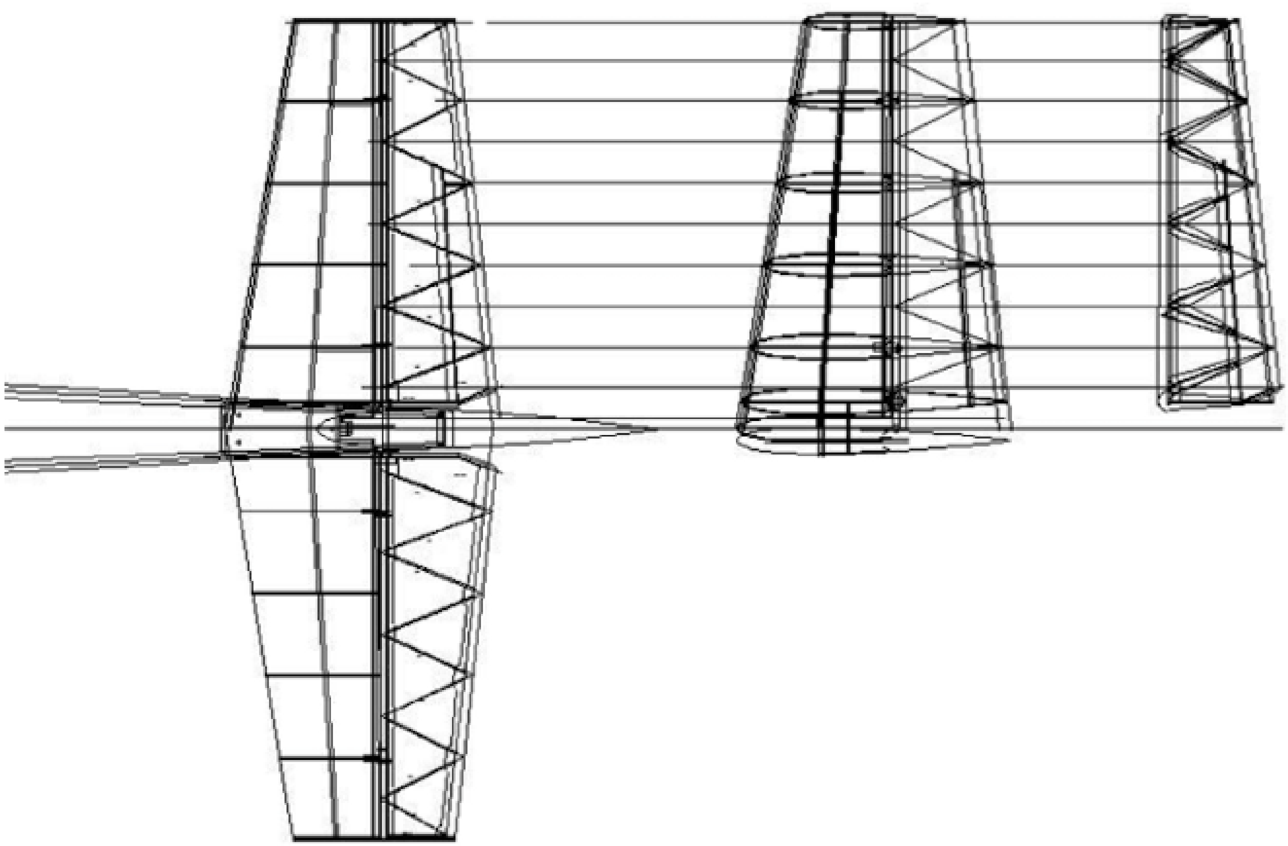
This experience taught me the following lessons for future elevator and aileron construction.

> ***Lessons Learned 2:***
>
> 1) The plank material at the leading edge should be thicker, or the number of ribs should be increased.
>
> 2) If the radius of the leading edge is small, it may be difficult to make a semicircular plank.It would be better to use a method of shaping by attaching a solid material to the leading edge with the intention of increasing the weight slightly
>
> 3) In order to secure the positioning accuracy and strength of the overhanging plank that covers the leading edge rounded part, the rear part of the rib should be triangular and extend to the rear of the spar to support the overhanging plank. (See the section on horizontal stabilizer below)

Fabrication Part 4: Horizontal tail

Outline of the horizontal tail

This is the drawing of the horizontal tail.



Drawing 9: Horizontal tail.

The span is 996 mm, or about 1 meter. Although the airfoil of the actual aircraft is not known, I found that the NACA0010 with 10% thickness would make the connection with the upper surface of the fuselage smoother, so I decided to use it. Since there are 10 ribs in one elevator in ±45 degree direction, the airfoil design was quite troublesome.

The right elevator has a large trim tab on the inside. The trim tab is not necessary for servo-driven RC airplanes, as they are used to trim the steering force for human control, but I decided to make them just like the actual airplane in order to give a sense of scale. However, it is not necessary to operate it, so the hinges are made firm so that it can be moved by hand.

The leading edge of the elevator is a semicircle. Since the elevator is tapered, its radius decreases as it moves outward. The structure of this part will be shaped from a thick plate, reflecting the lessons learned with the rudder.

There are two hinges on the left and right elevators, and the elevators are inserted from the outside. The shaft connecting both elevators is designed to be attached with screws so that the elevators can be removed. The elevator is operated by a horn attached to the center of the shaft, which extends into the horizontal fin and is connected to a link that rises from the fuselage side. For this purpose, there is a notch on the rear side near the center of the fin. In the actual model, a counterweight is attached to the tip of the horn to prevent flutter, and I have made it possible to attach a weight to the 1/3 model as well.

The trailing edge of the horizontal fin is a spar, but as mentioned above, the center area is cut out, so a thin I-shaped sub-spar was installed at the maximum wing thickness with a 2×5 cypress flange and a 2mm balsa web. In the actual model, the spar is set vertically from the notch, but in this model it is passed through the maximum wing thickness to get high bending rigidity, so it is a sweptback spar. The horizontal fin is fully planked with 1.5t balsa to ensure sufficient torsional rigidity.

Elevator fabrication

These are the elevator components placed on the elevator assembly jig.

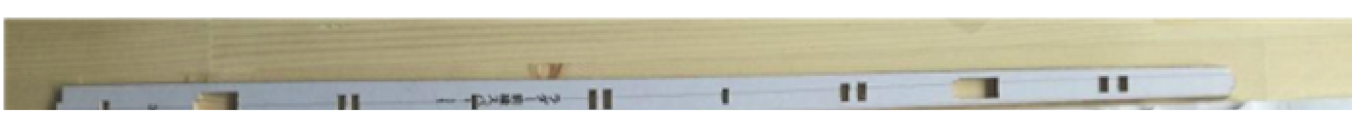


Photo 22: Elevator components placed on its assembly jig.

This is the left elevator. The paper pattern for the cutout is still attached. Note the many square holes in the spar and the protruding ribs. The protruding portions of the ribs fit into the holes in the spar, contributing to assembly accuracy and rigidity. The small holes in the ribs are for ventilation to prevent the covering film from swelling due to the expansion of air inside the elevator in the sun.

This is the completed elevator assembly.The rounded front edge was fabricated nicely.

Photo 23: The left elevator completed.

Making Elevator Hinges

There are the hinges for the elevator. The upper parts are attached to the horizontal fin and are made of 2mm thick carbon plates and 4mm diameter bamboo strings. The hinge holders on the bottom side of the picture, made of 2mm acrylic plate, are attached to the elevator side.

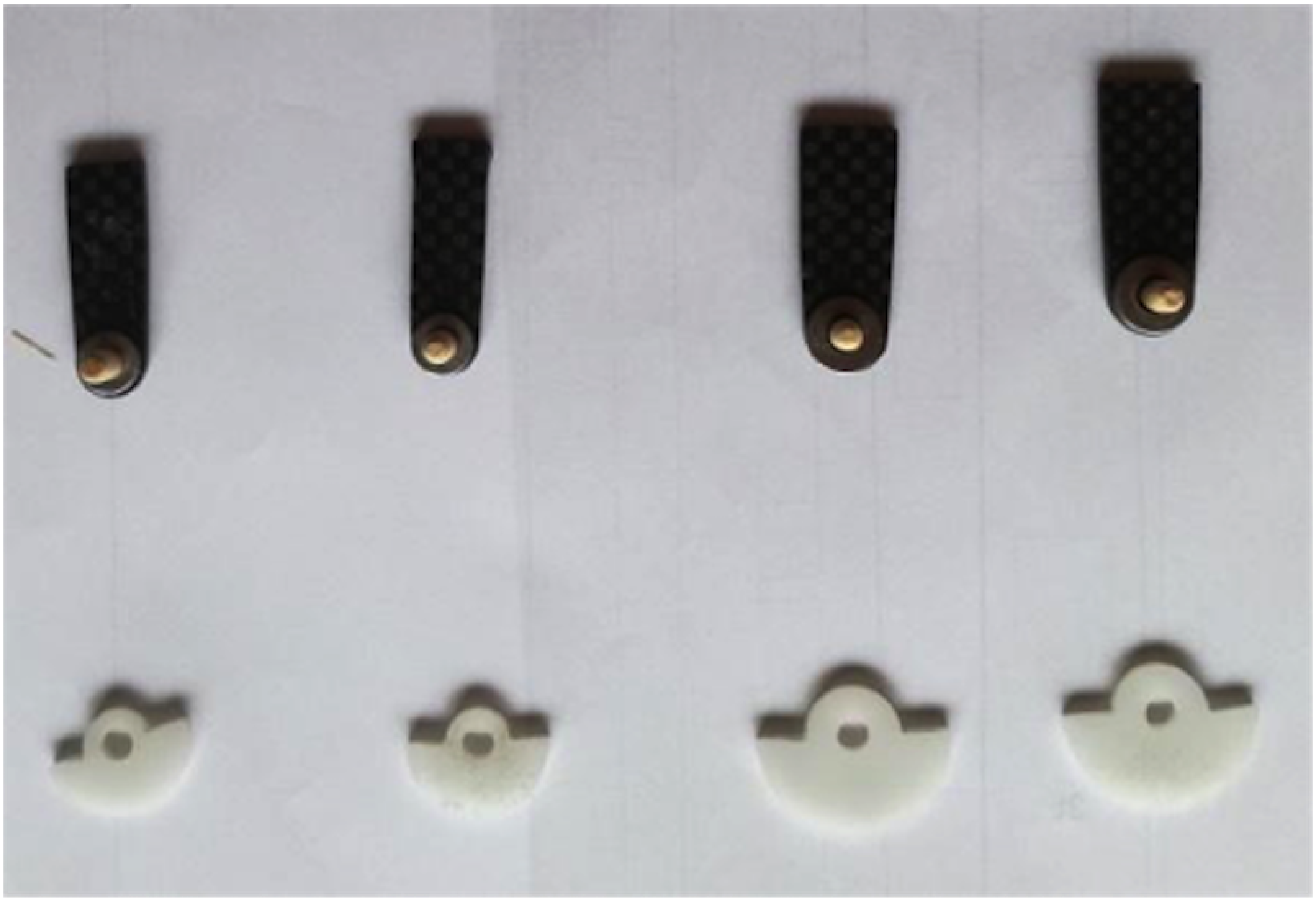


Photo 24: Elevator hinges.

Rib assembly of the horizontal fin

The rib assembly of the horizontal fin was fabricated in the same way.

Photo 25: Completed rib assembly of the horizontal fin.

The hinges are attached. Notice that the trailing edge of the ribs are cut in a triangular shape and extend behind the spar. This is the new improvement. This structure supports the planking plate that covers the front edge of the elevator to ensure the accuracy of the distance from the front edge R. In the case of the vertical fin, the planking plate attached to the spar was simply stretched out to the rear without this structure, so its accuracy and rigidity were not good. This design is based on the lessons learned 2.

Photo 26 shows the horizontal tail rib assembly with elevator and stabilizer. You can see the outline of the large horizontal tail.

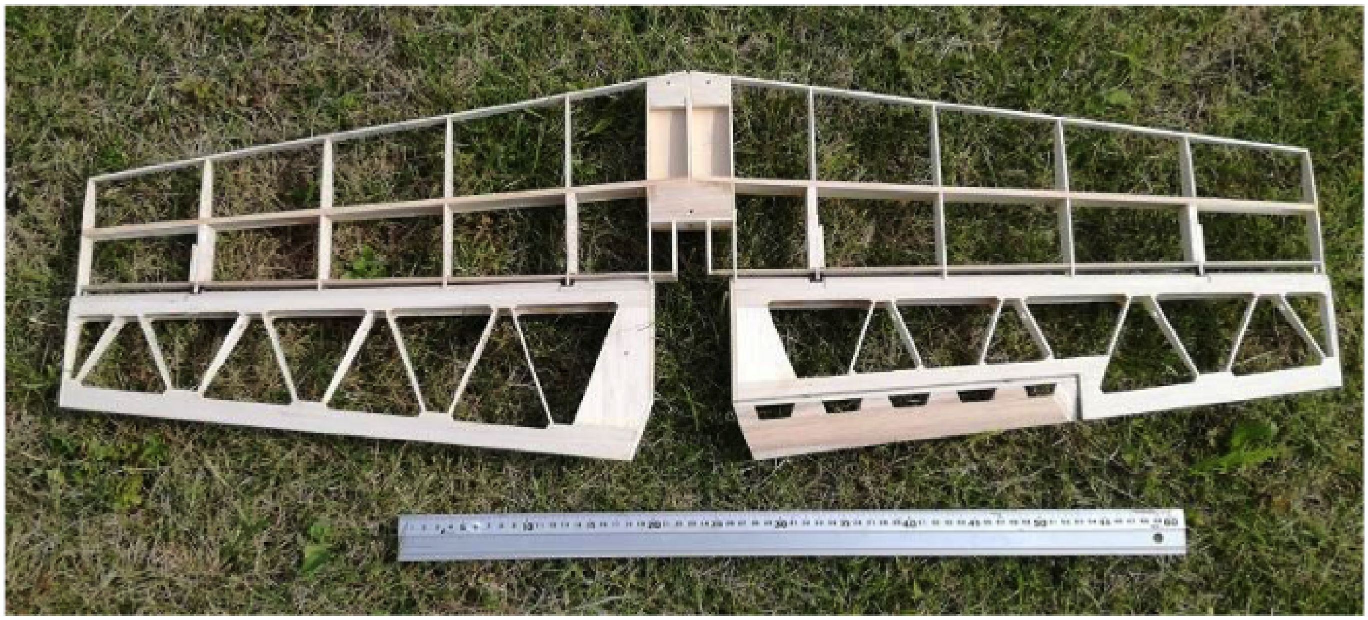


Photo 26: Horizontal tail rib assembly completed.

Assembly of the horizontal tail completed.

I purchased 1.5 mm thick balsa plates for the horizontal fin plank. Balsa plates are usually sold cut to 80 to 95 mm in width, which is not wide enough for a large aircraft like this one. The plank material was made by joining multiple plates together. Then it was carefully attached along the ribs. After shaping the leading edge of the plank flat, I attached a 5mm thick leading edge material and shaped it into a round leading edge. The completed horizontal tail structure is shown in Photo 27.

Photo 27: Finished horizontal tail structure.

There are three holes near the center of the fin. 3mm bolts are inserted here to fix the fin to the fuselage. The left and right elevators are connected by a carbon pipe with carbon round plates at both ends. Photo 28 is a shot of that part.

Photo 28: Elevator connecting part.

The round plates at both ends of the shaft are screwed to the protective plywood ribs affixed to the innermost ribs of the elevator. A horn is attached to the center of the shaft. It is connected to the link coming up from the fuselage side by a pivot near its center. The horn extends forward from the pivot and a weight can be attached there to prevent flutter and reduce steering force, but nothing is attached in this picture.

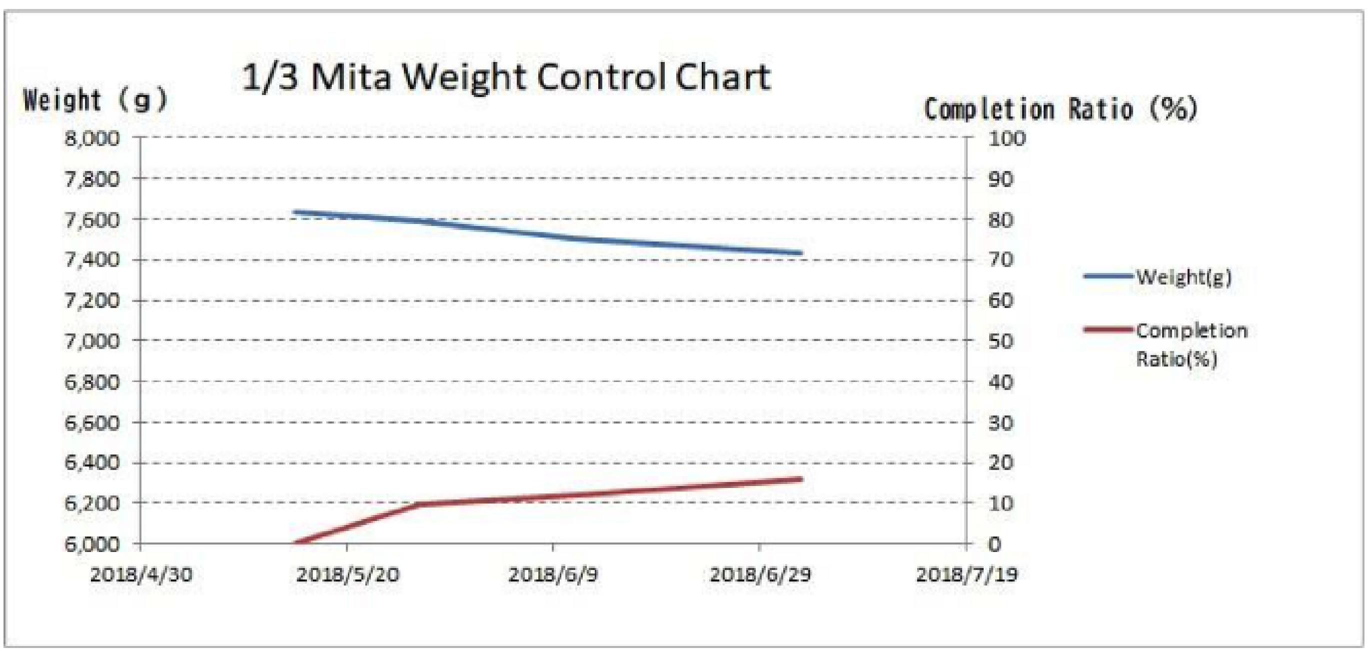
This completes the structure of the horizontal tail. The weight measured was 268g. The remaining works are covering and painting, which weigh about 70g. Including the weight of 40g for the flutter prevention, the estimated total weight remained is 110g.

3rd Calculation of Weight and balance

At this stage, weight and balance was reviewed as shown in the table and graph below. The 2nd calculation was done when the vertical tail fin was completed, but is omitted.

3rd Weight & Balance	2018/6/11	Completion Ratio		16.00 %	
	Weight	STA	Moment	Actual Weight	Estimated Remain Weight
Outer Wing Left	700	860	602,000	0	
Outer Wing Right	700	860	602,000	0	
Center Wing	1,560	890	1,388,400	700	860
Forward Fuselage	1,600	630	1,008,000	0	
Aft Fuselage	560	1,550	868,000	0	
Vertical Tail	212	2,450	519,400	162	50
Horizontal Tail	378	2,270	858,060	268	110
Motor	361	100	36,100	0	
Propeller & Hub	50	-10	-500	0	
Battery for Radio	155	200	31,000	0	
LiPo	600	340	204,000	0	
Others	186	600	111,600	0	
Total	7,062	882	6,228,060	1,130	
Target CG		846			
Weight	370	160	59,151		
Normal Flight Condition	7,432	846	6,287,211		

Table 4: The third calculation of weight and balance.



Graph 8: The 3rd Weight and CG Chart.

The actual weight increased to 1,130g and the completion ratio increased to 16%. The weight of the horizontal tail mounted at the rear of the fuselage was lighter than planned, so the weight needed to balance the center of gravity was reduced, and the weight in normal flight is 7,432g, which is 168g lighter than the planned 7,600g. It seems that the main reason for this is that the balsa weight is lighter than I used in the prediction. The weight of balsa varies depending on its hardness even with the same thickness, so in the planning stage, I measured the weight of several types of balsa I had on hand and used the heaviest value for safety. It seems that I can expect to reduce the weight of balsa parts in the future.

*This is the second part in a series. Read the **next article** in this issue, return to the **previous article** in this issue or go to the **table of contents**. Downloadable PDFS: just this article or this entire issue.*

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!

*Read the **previous** article or go to the **table of contents**. Downloadable PDFS: just this article or this entire issue.*