In The Air

Our modest role in making the world a better place.

Terence C. Gannon

An exciting launch into big air at an F3F event in Taiwan in September of 2008. (image: ©2008 Yusr Wang, all rights reserved, used with permission.)

An essential element of the re-launch of the NEW R/C Soaring Digest was to clearly articulate, through our *Community* and *Social Media Policy* statements, the ground rules for interaction with the RCSD readership and the aspirations for how the readership would interact with each other when using any of RCSD's platforms. In doing this, I more-or-less assumed there would be some push back of some sort at some point. The truth is, there has been virtually none. In fact, the opposite: feedback has been much more on the supportive side of the ledger. Anecdotally at least — and it's early days, I realize — it seems that there is an appetite for a community which simply focuses on its shared interests and, for a while at least, sets aside those things on which we undoubtedly differ in an increasingly fractious world.

That works for me. And I truly hope it works for you too because in my role as Managing Editor, I intend to actively stick at it.

I recently did some data analysis which approximated the breakdown of the RCSD readership by geographic location. Roughly half are based in North America, a third in Europe and about 7% are in Australia and New Zealand. The unfortunately small factor remaining are made up of readers in Africa, South America, Asia and the Middle East.

Going forward, my aspirational goal is twofold: to grow the audience everywhere at every opportunity, of course, but also to grow the audience so that the readership more closely reflects the populations of those various regions.

Growing a global audience is a truly Sisyphean task for a nascent online publication, but at the very least it provides a high level 'prime directive' for selecting the stories for each issue. To that end, I encourage **anybody** from **anywhere** here on this Big Blue Marble to submit *your* story. Everybody has at least one. These articles should focus primarily on any aspect of R/C soaring, of course, but if they can also help others better understand your particular roost on said Big Blue Marble, then you have accomplished something a bit more profound. We are all richer for that. I would even go so far that with a bit more shared understanding we have, indeed, a chance of leaving the world a slightly better place than how we found it.

It is in this spirit that I'm proud to welcome a new RCSD contributor: Mr. Norimichi Kawakami. For those for whom that seems familiar, it was likely in connection with his remarkable 1/3rd scale *Mita* project. The aircraft resulting from this work is magnificent as you will soon see — but in my experience, I don't recall having seen a project which was more meticulously documented. In this issue, we are presenting the first of a number of instalments of Mr. Kawakami's build log — **in the original Japanese**. English-only speakers please don't panic: the author also provides an excellent English translation which we present right along side. But if you **do** happen to read Japanese, the original text is there for you to enjoy.

Furthermore, I encourage any potential contributor who may not be comfortable writing in English to consider submitting your article in whatever language is best for you. We'll figure out a way of getting it translated so we can present both versions to RCSD readers around the globe.

Also in this month's issue we welcome the return of Pierre Rondel who provides his thoughts on the *Orden* from RTGmodel. Like his *MicroMAX* article in the March issue it is lavishly illustrated and features some of the most beautiful flying sites in the world, bar none (one of which graces this month's cover). James Hammond also returns with the second of his four part design series. This time round, James' master class is dedicated to designing a slope 'allrounder': under his tutelage you, too, can realize that perfect design which can float away on virtually no lift at all and yet can give Spencer Lisenby a scare if you take it to the dark side of the slope. OK, I'm totally exaggerating, but that doesn't make James' article anything less than 'must read'.

Stéphane Ruelle writes entertainingly about the *Spring Soar for Fun Aerotow* in Cumberland, Maryland which he attended recently. One of our favourite photographers, Mike Shellim, contributes a great article on *OpenTX*. The affable Peter Scott has a true nugget that unexpectedly connects the Golden Age of Hollywood to the precious avionics on which we all depend. Tom Broeski also returns with another one of his tips each one of which triggers that highly desirable 'but of course!' response. There are a few other bits and pieces thrown in there, so without further ado, here's the April 2021 issue of RCSD. I hope you enjoy it as much as I have enjoyed putting it together. And thank you *so much* for reading.

Fair winds and blue skies!

One of the goals for every issue is to kick it off with a really eye-popping photo and this month's fit that bill to a tee. Joël Marin's composite photo features frequent contributor Pierre Rondel launching his Aerotec Shinto *at Col des Faïsses in the French Alps during August of 2017. Pierre provides the following comments: "Conditions were windy and rather cold temperature for this season. We had very good flying afternoon with good wind and lift in a stunning place!" Yet another place we have* **got** *to go. Thanks Joël and Pierre. Now, please turn to the* ***first article*** *in this issue or go to the* ***table of contents****.*

Orden from RTGmodel, Fly Different!

A top notch and versatile F3F competition glider from Slovakia.

Pierre RONDEL

Green is green! Trying a camera filter to obtain a nice visual effect!

Photo 1: The Orden in the snow during 2020 spring

RTGmodel is a Slovak-based manufacturer that has been producing F3F gliders for many years now, and is synonymous with top notch molding quality and attention to details. Long based on HN profiles, this new glider, the Orden, marks a breakthrough in aerodynamic design to bring it into line with current standards (new dedicated wing profile, thin fuselage, rounded tip, ailerons running all the way out to the wingtip), while marking its difference by making some original choices. I propose with this review to see if the Orden achieves its objective of competing with the best sellers of the moment.

Kit Overview

Photo 2: The kit parts. It is missing part of the ballast on the picture.

With a wingspan of 2.88m, the Orden is rather small compared to the current trend of 2.95 to 3 meters. The choice of a small 230 mm root wing cord and tail cord is giving it a visual aspect ratio so that the glider looks bigger. The first wing panel is almost rectangular so that the wing area is comparable with other gliders on the market. The tips are rounded without being elliptical, and the ailerons run all the way out to the wingtip to maximize roll rate. The wing has a ballast compartment that can accommodate 1.6kg of brass ballast. The wing joiner can host 600gr of additional ballast for a total of 2.2kg. As with the previous RTGmodel gliders, the Orden has its proprietary LDS system, which has the particularity of having the removable control surface axis using a tool supplied with the kit. It is a brass rod with the inside of the threaded tube at one of its ends. Axes also have a thread. The tool is screwed onto the axis and simply pulled. On the servo side, a wooden servo frame receives an epoxy cage for a ball bearing that takes up the forces of the servo output gear. Do not forget to indicate the servos’ brand you want to use when ordering.

Photo 3: The servo tray is molded and drilled perfectly, with Kevlar reinforcement toward the nose

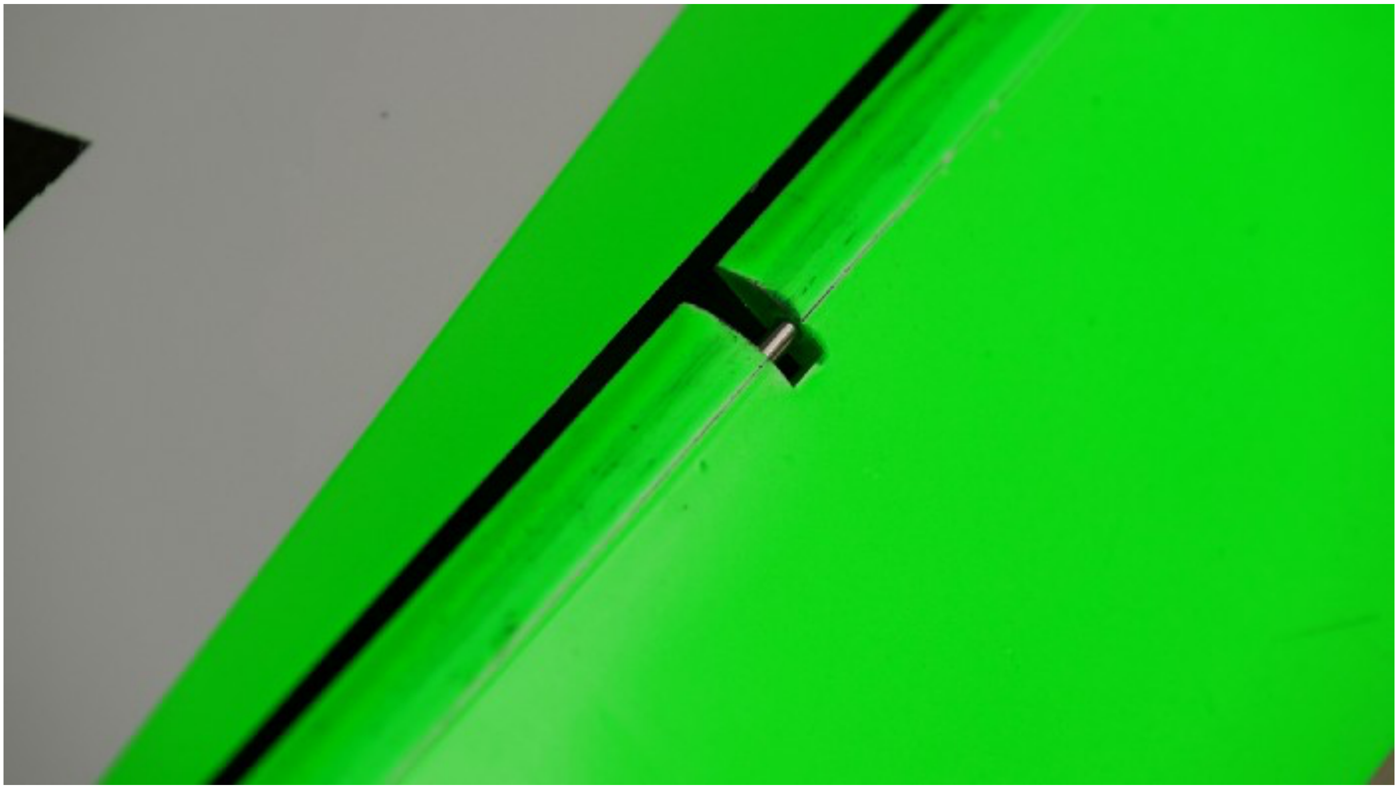


Photo 4: Removable LDS axis on the control surface side

Let’s move on to the fuselage: the diameter is reduced to a minimum on the front part to reduce drag, like the Stribog+. On the other hand, there is no more wing root and the nose is slightly more plunging. As in all RTGmodel productions, the servo tray is molded and drilled, with Kevlar reinforcements: Thus, 2 large Kevlar strips run far enough towards the nose for more strength. This fuselage is closed by a small canopy that offers sufficient opening to access and extract all the radio elements without any problems.

Photo 5: Elevator is using standard metal clevises, easy to remove with a screw driver

Tails are a strong innovation of the Orden: Rather small in size, they are made full with a core in Rohacell and 'spreadtow' carbon fabric, but above all, they are articulated by the middle, i. e. the hinge is inserted between the two half cores, which avoids this hinge to work with time. It is no longer necessary to make sealing wipers, as the gap is reduced to a minimum. Another positive point of these tail planes, they are very light at only 30/31gr including the carbon rod joiner, but still robust. On these tail planes are the usual aluminum horns facing upwards, which receive the 2mm metal clevises (no ball joint clevis). In use, it is very practical to mount / remove tails when travelling.

RTGmodel' s trademark remains the quality of molding and finishing down to the last detail, and the Orden is no exception to the rule, all adjustments are perfect, the surfaces and paint offer a superb shine, deep colors, in short, a very beautiful work. Finally, here are the weights of the various components:

- **Left tail**: 31gr
- **Right tail**: 30gr
- **Left wing**: 602gr
- **Right wing**: 608gr
- **Fuselage**: 275gr
- **Wing joiner**: 95gr
- **Total**: 1640gr before assembly

Straight Forward Assembly

In the more than 25 years I have been doing F3F in competition, I have had the opportunity to fly a large number of gliders. Some require a little more work and attention. This is not the case with the Orden, which has no surprises or particular difficulties. At first glance, I thought that the radio installation in the fuselage would be complicated because of its narrowness, but this is not the case. I even found the assembly more 'spacey' than on the Stribog+. The molded servo plate is perfectly positioned in height and the slight offset in opposition of each servo makes them ideally positioned and the control rods perfectly aligned. The servos are inserted without forcing on the plate, without risk of damaging the output of the servo wire. A little trick on the way to screw the servos in place: I place the servos at the stop of their housing and insert a small custom-made part between the two servos, with two screws. This assembly ensures that the servos are perfectly held without any lack of material for the screws.

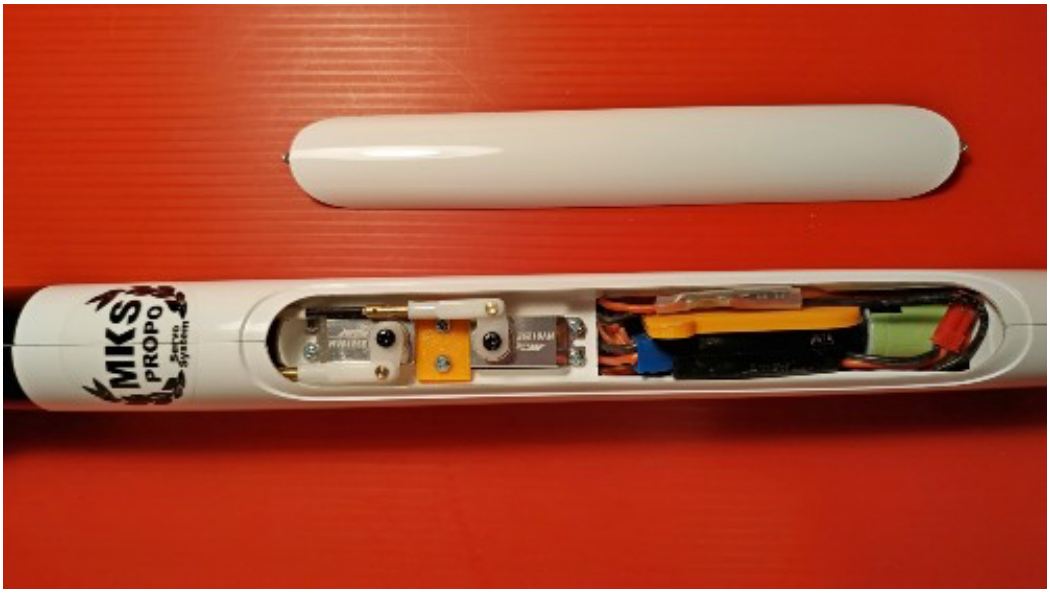


Photo 6: Fuselage is tight but finally components find their place easily

Personally, I mount the female green plugs on the fuselage and the male plugs in the wings. Plug recesses on the fuselage root are perfectly adjusted. Once the wiring is done, I make two small parts in 1mm plywood to serve as a stop to the green plug (with a 2mm shrinkage on the edges), and improve the bonding. First of all, I glue these two pieces with fast epoxy, then I install and glue the green plugs, always with fast epoxy. To ensure that the grips are positioned perpendicular to the root, I have made 3D printing templates in which I block the green grips during gluing, which also allows me to use clamps during drying.

For the wings, the work consists in gluing the wooden servo frames in place, wiring and then assembling the servos. However, I always add a step which is to put an additional piece of carbon fabric to stiffen the skin even more so that the glued frame and its servos do not deform the top surface. A small sanding before gluing the frames allows a better grip.

The LDS system is unique to RTGmodel and includes a wooden frame, an epoxy cage receiving the external bearing, an epoxy arm, and an aluminum servo head with its axis and clamping screws. The arms for the flaps are a few millimetres longer, so I advise you to identify them first.

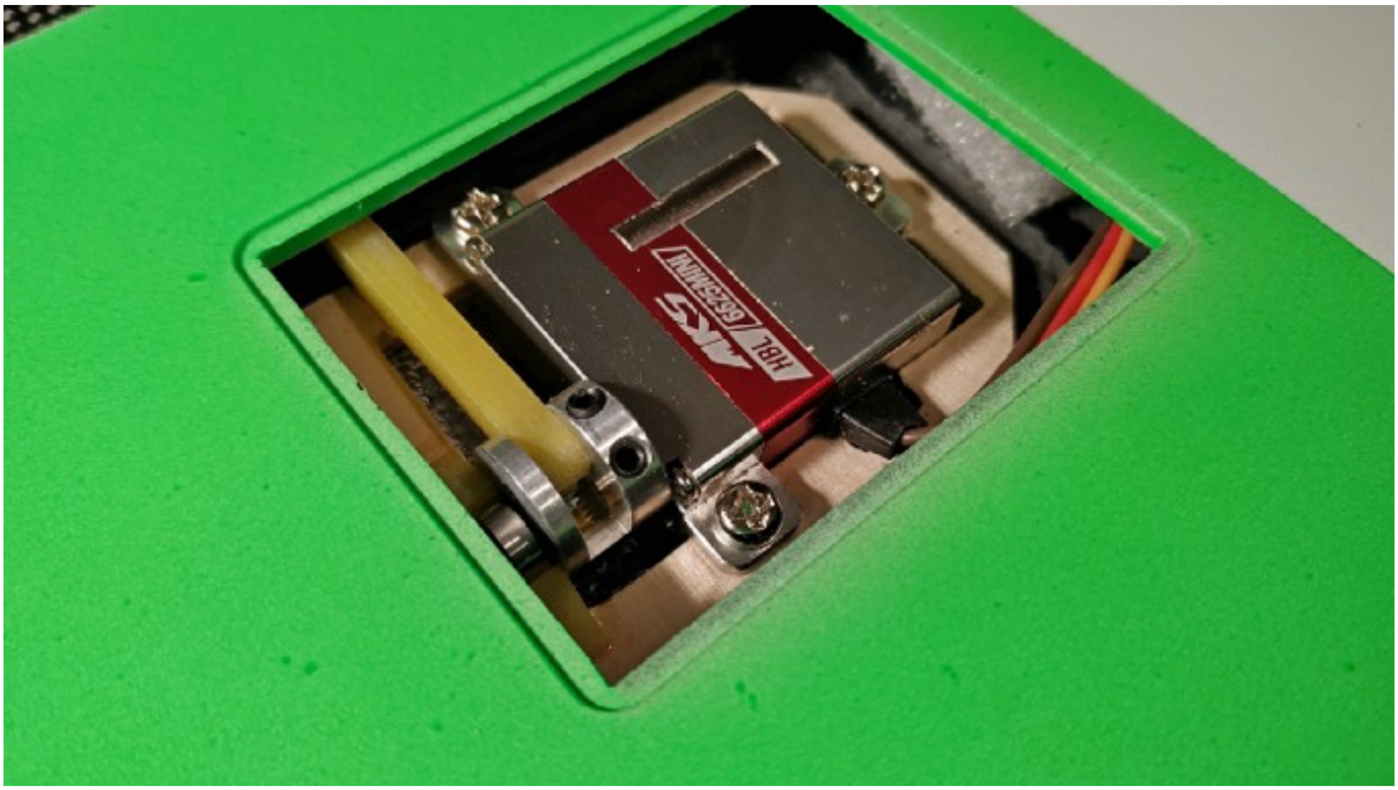


Photo 7: Ailerons LDS mounted on a MKS HBL6625mini. No slop at all, even after a season.

Start by gluing the bearing cage to its wooden frame, and then insert the ball bearing into it. The frame must be glued in the correct position, so it is necessary to start by installing the epoxy arm on the steering side and then connect the roll drive to the arm. This then makes it possible to glue the frames, perfectly positioned, with the roll drive in its housing, and optionally the servos, protected from the glue by a plastic film or thin tape. Do not forget when gluing to put a small piece of 3mm by 3mm paper tape on each frame screw hole so that the glue does not get in.

The green plug is glued to the root rib with the wing in place on the fuselage, all surfaces being protected with fine tape and release agent (polyvinyl alcohol solution).

A picture is often better than a long speech, so you can find all the pictures of the glider assembly here in my RTGmodel Order Assembly Log.

Small check on the scale, 2175gr empty in flying order, it's very good and let oversee a versatile glider!

Let's go to the slope!

I finished assembling the Orden just before leaving for the FAI competition at Col de Tende mid-July 2019. So I stopped on my way, near Gap, to make the maiden flight. Lift conditions were rather light that day, but the Orden perfectly performed its flight, I just moved back the CG a little to help retain energy in turns.

Video 8: Orden maiden flight video

Forty-eight hours later, following a crash where I damaged my primary glider, I switched to the Orden and finished the competition with it, winning three out of seven rounds with the Orden, and winning the competition, so very satisfied with such an introduction!

Photo 9: Onboard picture with a camera attached to the wing tip

What about the glider: in F3F, we don't only look for straight line speed, but a clever mix between speed and energy retention in turns. The Orden has precisely these two qualities. Able to accelerate and fly fast in a straight line, its turning behaviour is excellent, combining stability and acceleration when exiting the turn, provided that the snap-flaps are well adjusted. Under certain conditions you can even feel a kind of ‘kick in the ass’ acceleration of the glider. According to the manufacturer, the CG range is between 90 and 100mm. I’m personally started at 95mm and finished at 98.5mm.

In light conditions, the low weight of the glider at 2175grs is an advantage. You can then stick to the slope and tighten the turn without any problems. As soon as the lift is becoming stronger, the turn is widened to an ‘energy management’ style turn, i.e. the glider describes a turn away from the ridge with a 45° slope to get grip while on the edge, then return to the ridge and ‘screw’ in front of the pilot to start preparing for the second turn. This turning technique requires heavier flying.

In very strong wind and while flying ballasted around 4kg, I noticed a slight bending of the wings in high G turns, without any consequences. For information, my version is a ‘standard’ version, double carbon, i. e. a sandwich composed of a 90gr/m2 outer fabric / Airex / 60gr/m2 spread tow inner fabric. A strong double carbon version is always available with a sandwich composed of a 160gr/m2 outer fabric / Airex / 80gr/m2 inner fabric.

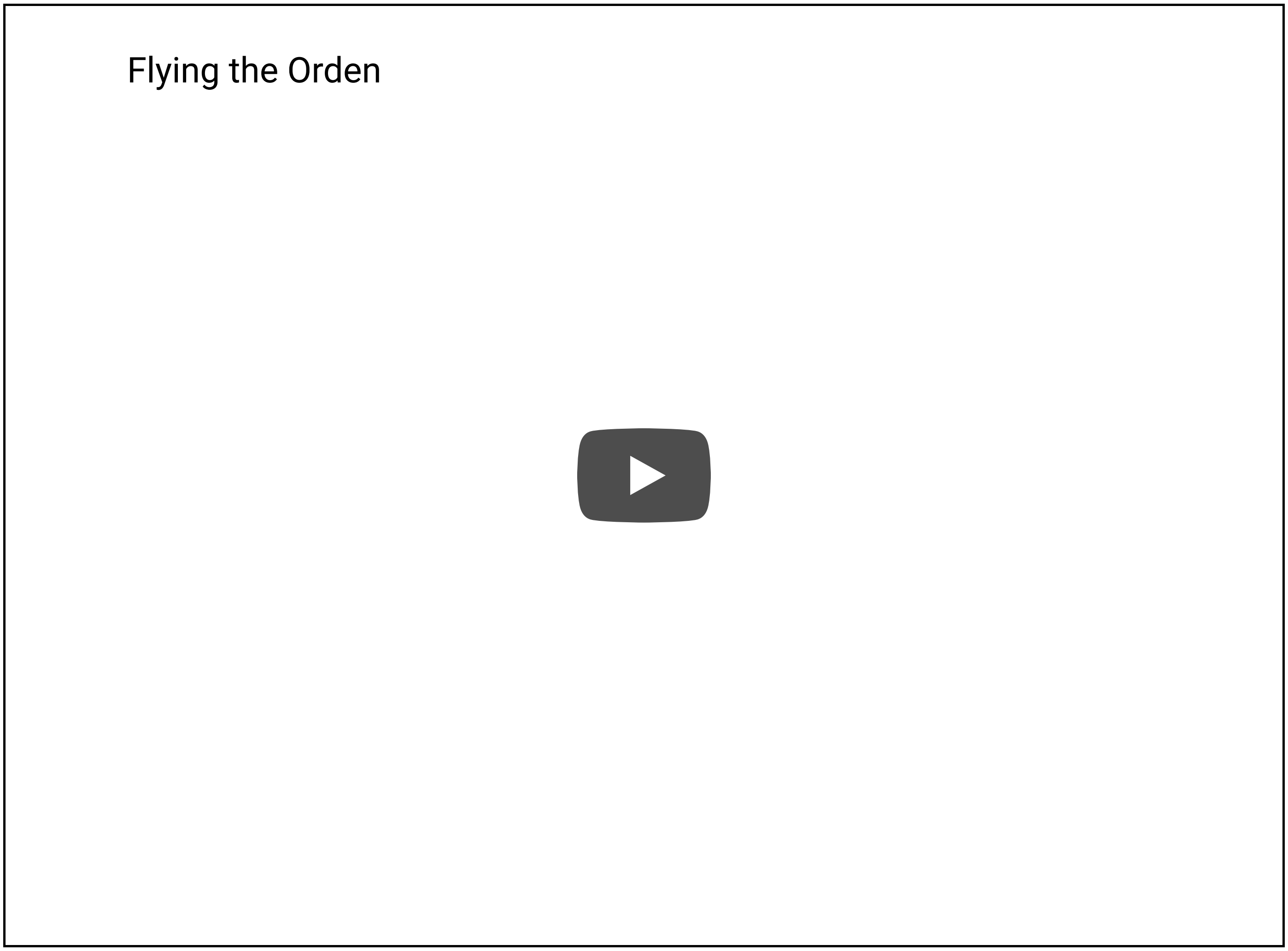
Since then, I have also tested this strong layup wings and could check the excellent stiffness for an empty flying weight around 2350gr only which remains an excellent compromise to cover most of the conditions.

Photo 10 trough 19: Pictures of the Orden in flight. The plane is providing an high level of performance, both for sport flying but for F3F competition too

The Orden accommodates many different flying and turning styles. It is just the amount of elevator that allows you to switch from one style of turn to another; there is no need to change the snap-flaps ratio.

Photo 20: The Orden in good company with the Penguin F3F from Jean Luc Foucher a home designed, milled and molded F3F plane with radical choices

In typical sport flying, the qualities mentioned above make the Orden an excellent companion that adapts to all conditions: Light weather and thermal ‘hunting’, more dynamic wind or aerobatics, very strong wind and ballistic flight. Circling holds perfectly, helped by the small dihedral of the wing. Transitions to travel from thermal to thermal are a simple exercice and allow you to explore the airspace quickly without losing altitude, and the flaps in the thermal position are effective.



Video 21: Another video with some onboard sequences

All the basic aerobatics goes smoothly even if it is not the glider's vocation. Quadroflaps bring vivacity and precision. On landing, the 'butterfly' mix works perfectly and allows you to land short.

In short, the versatility is there and the Orden will give a lot of satisfaction to its pilot whatever the flying conditions or the flying style!

Photo 22: The author with his Orden few minutes before the maiden flight

The final word

RTGmodel has succeeded in his bet because the Orden offers much more than just an evolution of the Stribog and Stribog+ but is now able to compete with the market best-sellers. It therefore offers a beautiful alternative for those who want to fly different, with an extremely well built glider, and dreadfully effective in all circumstances. To fly without moderation, whether for sport flying or F3F competition. Have a good flight, everyone!

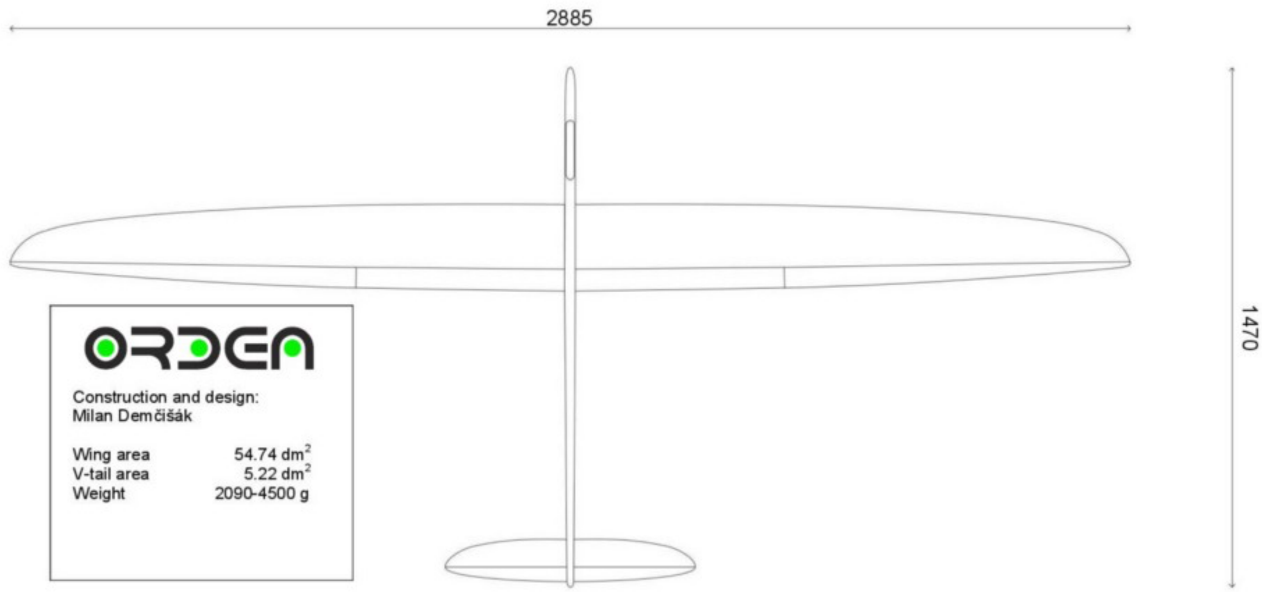


Photo 23: RTGmodel's Orden plan view. (image: RTGmodel)

Characteristics

- **Wingspan**: 2885 mm
- **Length**: 1470 mm
- **Wing area**: 54.74 dm2 (FAI : 60 dm2)
- **Empty weight**: 2175gr (max FAI : 4500gr)
- **Manufacturer**: RTGmodel
- **Contact**: Milan Demcisak, Polna 3174/6, 01001 Zilina, Slovakia

Settings

- **CG**: 98.5mm
- **Elevator** : 6mm up/down
- **Rudder**: 8mm up/down
- **Function ailerons**: Ailerons : 28 up / 14 down, Flap: 15 up / 8 down
- **Function snap-flaps**: Flaps: 7mm down at full elevator, Ailerons: trailing edge aligned
- **Function butterfly**: Flaps: 45mm down, Ailerons: 23mm up, Elevator compensation: 5mm down
- **Thermal position**: Flaps: 4mm down, Ailerons trailing edge aligned

- **Speed position**: Flaps: 1mm up, Ailerons trailing edge aligned

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**.*

Designing for a Slope Allrounder

Insight into the thought processes behind a balanced design.

James Hammond

Typhoon 2M (80″) showing its versatility.

In this article I'm going to go through the basic thinking and outline design process for my Typhoon 2M — still a popular choice and now holding the record as the most produced moulded 2m slope allrounder ever. While you, the reader may not have the skills or maybe lack the right facilities to make your own all-moulded glider, and indeed it's a lot easier these days to just buy one; I hope that this article will help to give you an insight into the thought processes behind the design procedure. — JH

What Do We Want From a Multi-Purpose Slope Allrounder?

Zzzz…cool man, got to be cool looking…I need cool slick looks from my baby…oh boy, I need blistering fast…yeah…whistling fast…I need TOTALLY aerobatic…I need DS…I need STRONG, dude…got to have strong…yeah… getting there…got to be really light to for those really light breezes…Whoa… what time is it?

Damn, is it that time already? But…what a nice dream…

Unfortunately, however hard we try, our dream will remain just that, a dream — a slick looking sloper that does everything really well, in fact to the max, will never happen. But at least, if we are smart, we can actually fulfill large parts of the dream, push back the limitations a bit and turn them into reality. And that can be a lot of fun.

Let's Get Down to It…Decisions, Decisions…

Realistically the very first thing we have to decide before we set out our list of requirements is wingspan: big or small? We all have different spaces and indeed different priorities — it's sometimes a teeny bit difficult to convince 'she who must be obeyed' (SWMBO) to leave the kids at home so you can go fly your stonking 150″ allrounder.

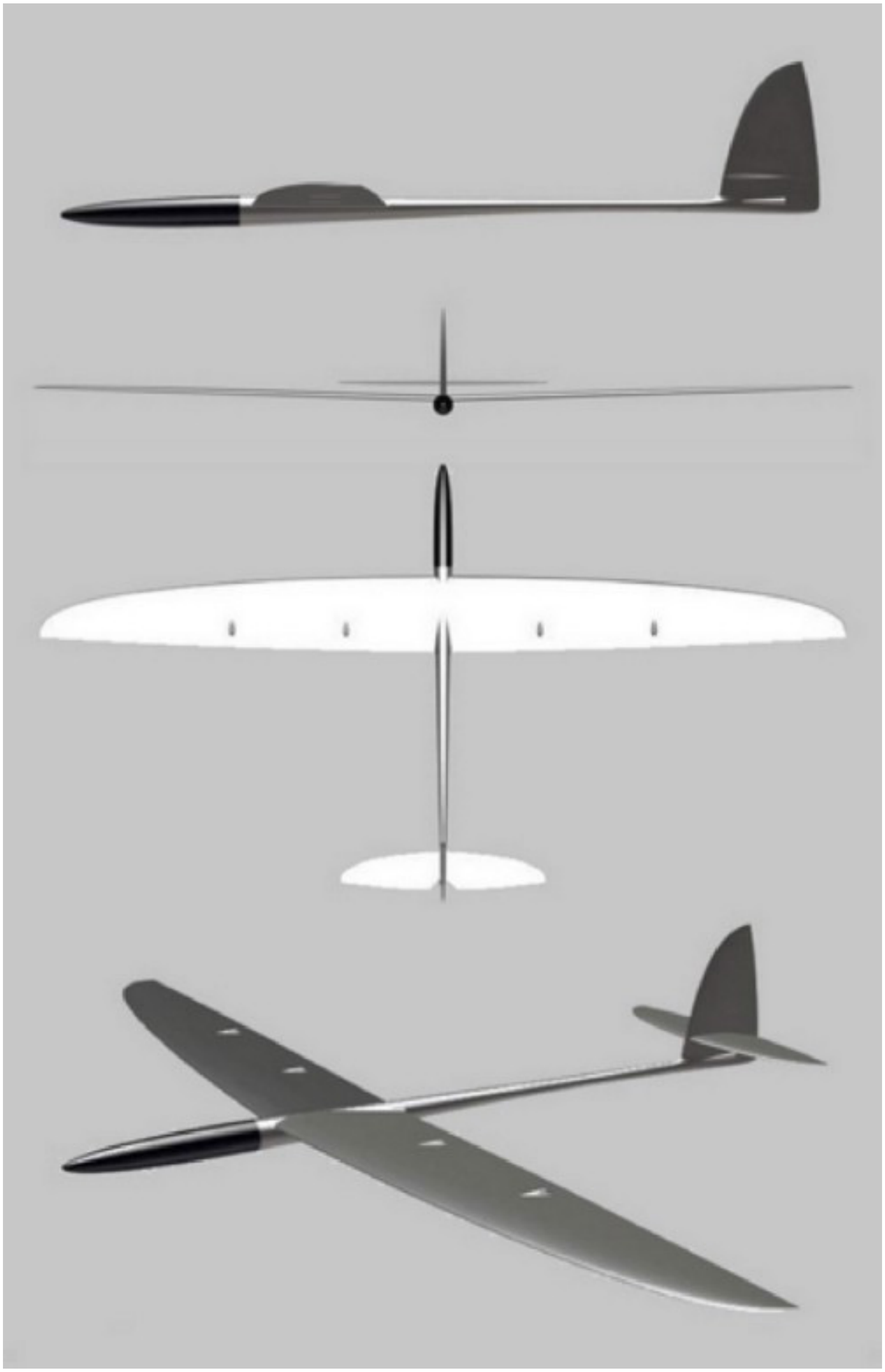


Figure 1: For reference a review of the Typhoon by ace flyer and world champion, Pierre Rondel can be found on his excellent website.

For almost any model aircraft, there is a truism in that the larger it is, the better it will fly and this 'kinda' rule also applies to our slope soarers. For pretty much every slope soarer type — and in this series we will be dealing with aerobatic, allrounders, high performance competition types, and alpine soarers — at the correct weight for the type, the bigger the model is, the easier it will be to fly, and the better it will perform the tasks we demand of it — at either end of the design envelope. Though more convenient, possibly less expensive, and certainly easier to transport and store, smaller models are twitchier and more sensitive, and really demand a lot more skill overall to fly well, so it's best not to think too tiny.

> *Takeaway: Big is better than small, so it's best to go as big as we can. But do consider other factors of influence.*

But Hmmm...How Big Is Good For Me?

An average allrounder is the kind of ship that breaks down pretty small with the fuselage normally representing the longest component. If designed conveniently small, when disassembled it could maybe be kept (hidden) in the car most of the time, and flown when the opportunity presents, or maybe could easily be stored in a bag like a set of golf clubs and then quickly put into the trunk with other models in our fleet. Probably for most of us, the width of a standard car trunk, back seat or maybe car windowsill are the most convenient reference measurements for deciding size. This means we need a model with something between 72″ (1.8m) at the small end and 100″ (2.5m), with the sweet spot at 80″ (2m) span… so this is where I started back in 2008, when considering the Typhoon 2M model

> *Takeaway: For the size of the model, try to consider what's a happy medium between performance and convenience for you.*

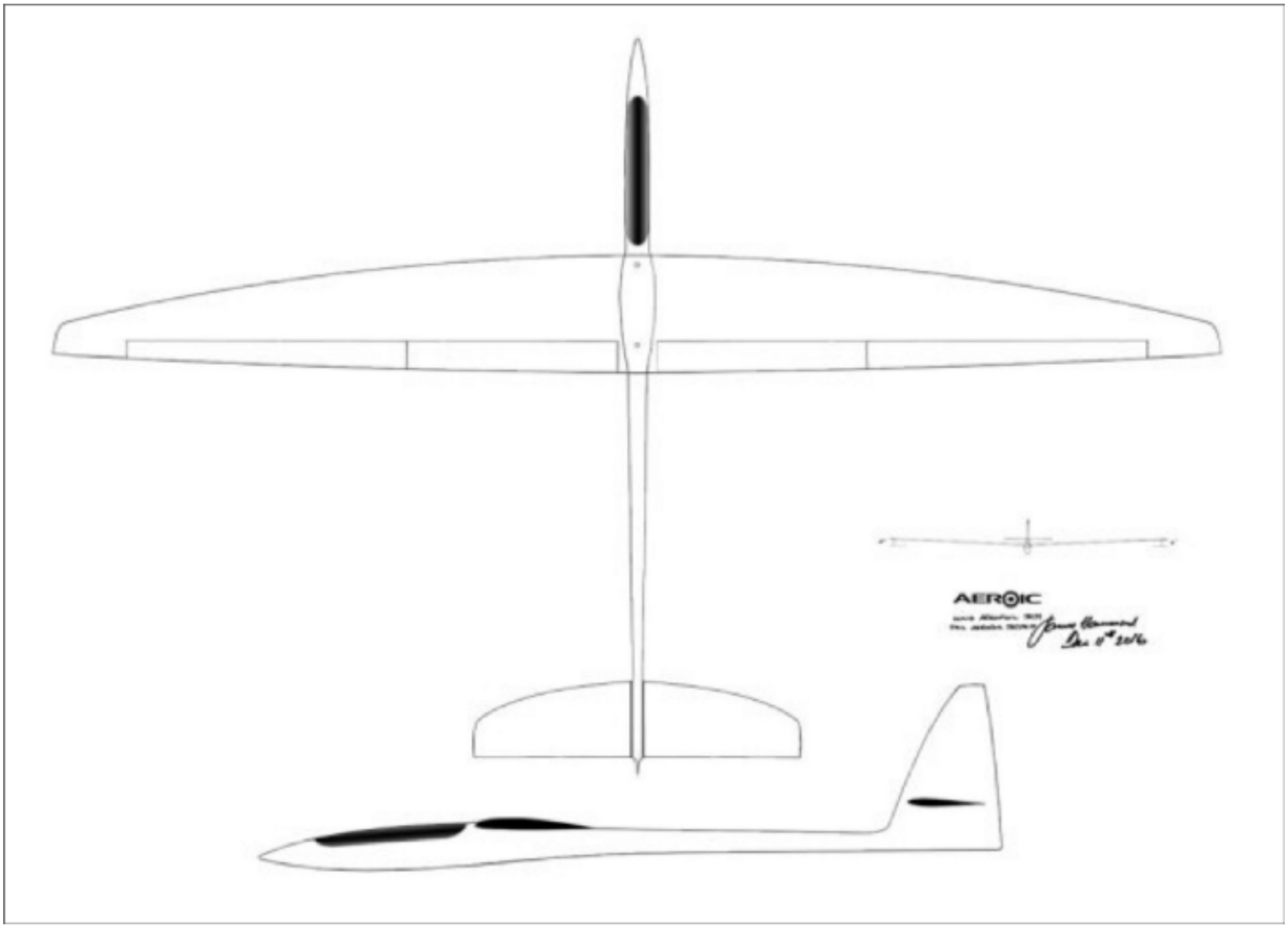


Figure 2: Sessanta 60″ (1.5m) — a smaller allrounder — this time with correct aileron extent.

So Now We Know How Big It Will Be, What Do We Actually Want From the Model — Or at Least What Can We Realistically Expect?

Remembering how I was gathering my thoughts for the Typhoon design back in 2008, I listed my own parameters in probable order of desirability:

Flying parameters: fast, pretty aerobatic, got to fly well in a wide range of conditions, is easy to fly, is easy to land, and looks good. For the most part all of these are functions of aerofoil choice, and wing planform/aspect ratio arrangement.

Static parameters: good looking! Strong, and durable enough to survive some of my less than ideal arrivals, has standard size ballast capability, is easy to install the radio, is easy to transport, assemble and disassemble, and the cost will not involve limb amputation. These tend to be related to the construction design i.e. what materials and how they will be used, though to a lesser extent the actual shape of the model and the radio access will also have some influence.

One good thing about your own moulded model is that you can change the materials and the quantities used at will, to make a gossamer-light model through to a stonking DS Blaster and anything in between, all using the same mould set. But we also need to remember that more material means more resin which means more weight. Also, its often not the amount of material you use that has the greatest effect, but which kind, and how you use it.

> *Takeaway: With your own moulded model you have complete control over weight and strength.*

Wannahaves

Has standard size ballast capability, is easy to install the radio, is easy to transport, assemble and disassemble, and the cost (don't tell SWMBO!) will not involve limb amputation. Well that's quite a lot of wants and needs, but actually pretty achievable. So, let's kick off with the wing design as this is easily the most important part of an allrounder, or in fact any slope soarer. First of all, we need an aerofoil:

Choosing an Aerofoil

Uh oh — now we could be back to making lists again. Here I may be able to save some time. I have designed at least four very successful allrounder slope models between 80″ (2M) and 100″ (2.5M) and I can tell you pretty much what we need, and why: What's required is a semi symmetrical section (Not flat bottomed) with a thickness of between 7.5% and 8.5% — this is the sweet spot. Why? because at this thickness the camber line of the section will have a good curve, which will create enough lift to carry ballast if needed, and it will be quite aerobatic. At this thickness range the section can deal with a large variety of model weights, 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 on a smaller 2M model escalates pretty fast with thicker sections. Last but not least. Any modern aerofoil with a decent alpha performance does not need any rigging angle. Repeat: Any modern aerofoil with a decent alpha performance does not need any rigging angle.

> *Takeaway: Choose a nice proportioned aerofoil between 7.5% and 8.5% to get the best overall performance from your model.*

> *Takeaway: Don't design your model with any rigging angle — it will destroy the performance.*

> *Takeaway: Sections like the RG15, MH32, JH25, and JH35, fit the bill.*

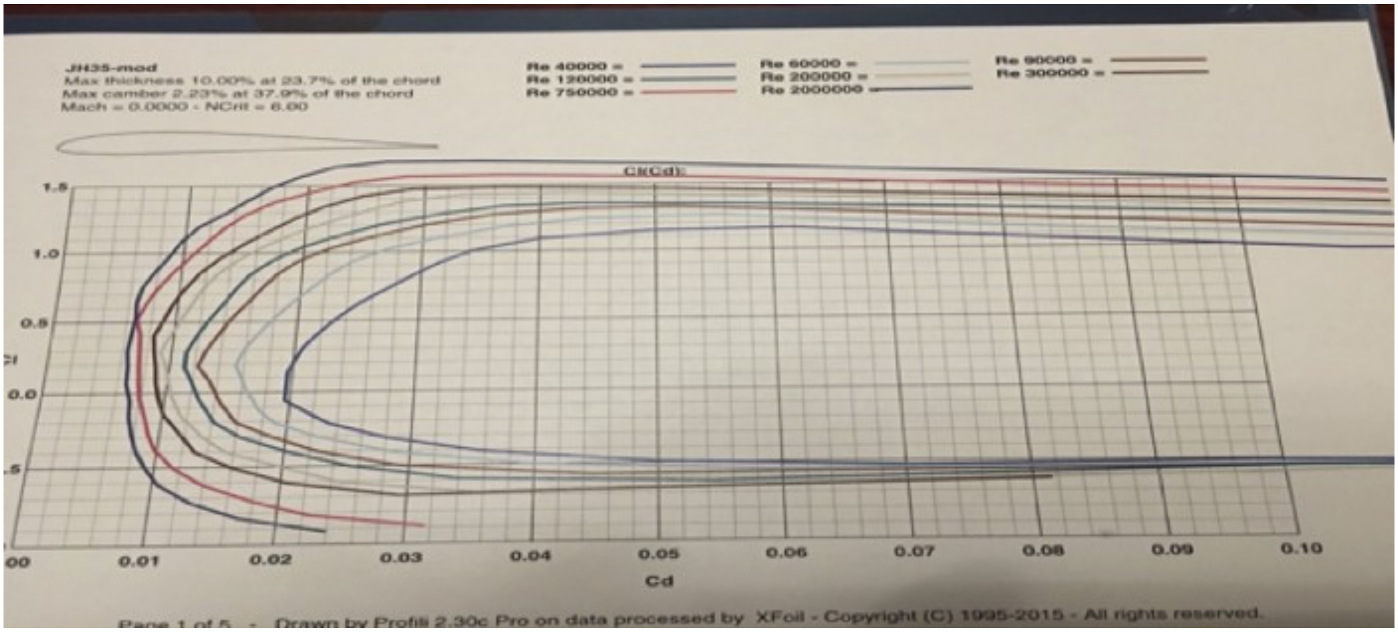


Photo 3: A set of L/D curves for the JH35 Alpine soaring section.

Here are some polars for the JH35, a more "lifty" aerofoil that I designed to give low drag with high response to control inputs, but this time more with Alpine Soaring in mind. For this section, lift has been given priority over out and out speed, yet its still surprisingly fast. I have used this 'foil on only one of my larger 3.2/3.7M span models so far, and it is surprisingly fast, very well behaved, highly responsive to control inputs, thermals exceptionally well and also slows down safely." More about this one the next article.

Note the Double Cusped (undercambered and 'overcambered') configuration with its nice CL/CD curve with no drag bucket, and also the nice lift curve with little effect on the drag.

Figure 4: Profile of JH25 — an open source 8.25% thick section specifically designed for better control response.

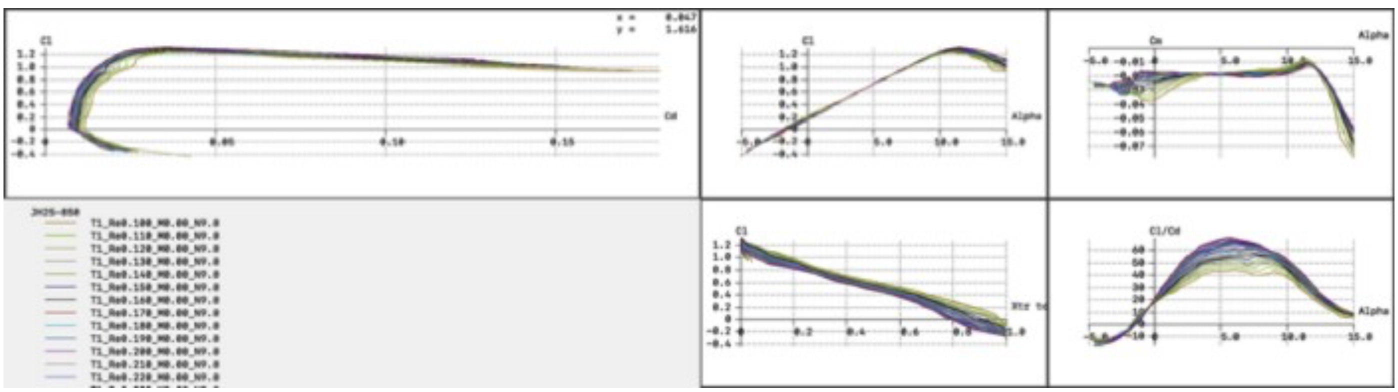


Figure 5: JH 25 polars.

Now for a design point that in my experience is far more important even than the aerofoil section.

The Wing Planform

We all know that we need lift to make our model fly, and we probably know that lift can easily be swapped for speed. Logically though, we don't need a lot of lift out near the wing tips, but we do need more lift closer to the fuselage. In an ideal situation we need 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. So why not just make the wing elliptical — a true beautiful ellipse just like the WWII Spitfire? Yummy!

Well it turns out that a true ellipse might be great for the lift — at least in theory — but it's actually not so good for model flying qualities. What tends to happen with a true ellipse, 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.

> *Takeaway: Ideally, we want a nice elliptical lift pattern.*

> *Takeaway: It's best to try to modify the ellipse to separate the MAC and the CG as much as possible.*

> *Takeaway: We don't want the problems that true elliptical tips bring.*

Photo 6: Forza 2M shows its plan view in a fast turn.

The other problem with our true ellipse planform idea, is that if carried out to the end of the wings, the air can’t find a good way to leave, and then complex and unstable vortices tend to form which can lead to stall propagation. The reason for this is that the air — let’s say the isobars since we can divide them into waves by pressure — have to be directed to where WE want them to go and not left to their own devices.

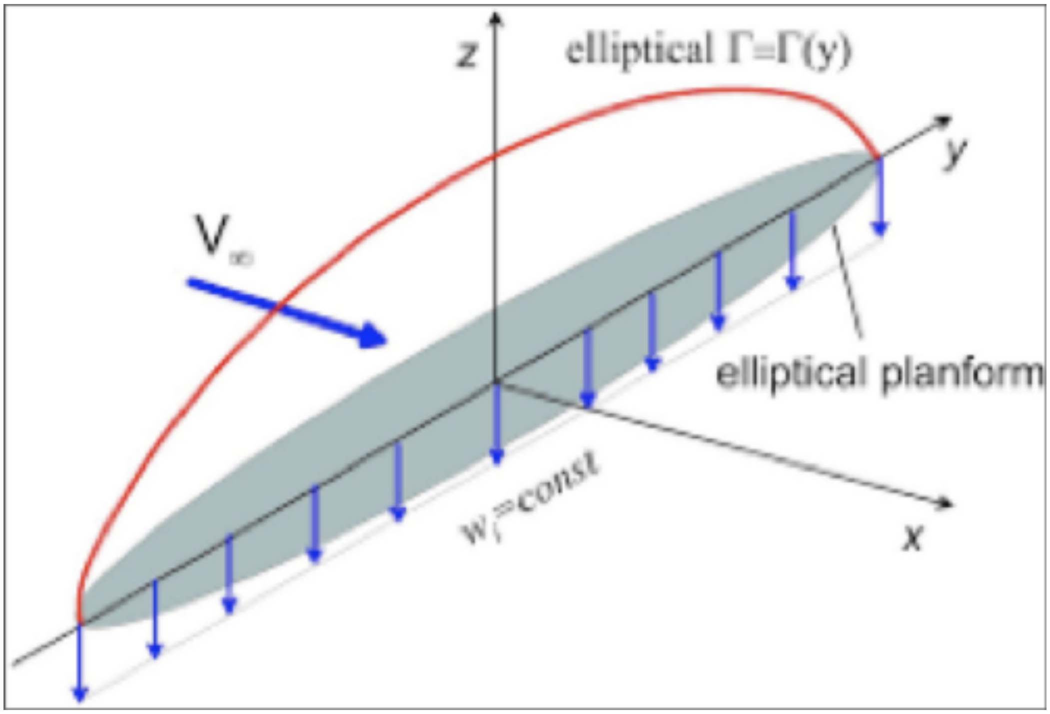


Figure 7: Elliptical lift distribution diagram — note that if the wing really was the same shape as the drawing, then the ends of the red lift curve would be doing some rather strange and unwelcome things.

Remember — the isobars will always find the path of least resistance, which is mostly the shortest path and that can vary a lot with the attitude and speed of the model. This is the seed of the dreaded tip stall, plague of many an otherwise well-designed model, and cause of many heart attacks as its completely unpredictable.

Why Is This so Dangerous?

Wrongly designed tips: Thing is that if the vortices just happen to be departing in the wrong ways — which as they are disorganized is very likely to happen — then this could propagate a stall as the boundary layer becomes suddenly detached from the wing following the path of a vortex. This then starts a stall which rips up the wing and kills all the lift on that wing immediately — but not on the other wing which will mean complete and instantaneous loss of control.

> *Takeaway: tips that are wrongly designed are the*

> *most common cause of the tip stall and should be avoided at all costs.*

Dangerous Liaisons…err, Ailerons

Wrongly designed ailerons: ailerons that end too near the tips on fast slopers, or with too much chord will not give you more control, or if they do you won't notice it. These are not often thought about as stall inducers, but are really dangerous as they can cause stalling if applied in the wrong volume, and/or at the wrong time. This is another phenomenon that often leads to the dreaded tip stall, and it always seems to happen when we are not expecting it — like in a high-speed turn, or when its least recoverable — like on landing.

> *Takeaway: The tip stall can happen at high or low speed.*

Photo 8: A Schwing 2M rests between flights in sunny California.

Actually, there are four kinds of tip stall possibility to be really careful of when designing:

1. *Wrong wing chord profile:* Too much wing area (Chord) too near the tip can cause a stall, as sometimes too much lift is being generated at one time, on one wing only, especially when the wings are travelling at different speeds such as in a turn. The difference in lift is often enough to induce a stall.
2. *MAC and CG too close together:* You could say that the MAC is where the main characteristics of the wing can be seen. It's the centre of lift averaged out over the entire span. So maybe you could imagine it as a kind of inverted pivot point where the hanging wing would go to positive or negative angles. As the CG is also the pivot point of mass balance then if we have MAC and CG too close together they can, and will influence each other, often in an unwanted manner.
3. *Badly designed tips:* In this case the departure of the span-wise flow at

the end of the wing is random and can be stall inducing.

4. *Aileron induced departure:* The outer edges of the ailerons is where we have the least control. Far away from the roll axis — the fuselage — they can however become dangerous as there is the tendency is to give more control inputs, or possibly more control throw than is needed. The ends of the wing are where we have the highest possibility to have unplanned departures from our intended flight path, so it’s best to disturb the airflow in that area as little as possible.

Hmmm…thinking…A nasty bag of problems, especially as I want to do aerobatics as well as high speed and thermal flying. Ho hum…so what to do?

Photo 9: Smiles all round after a successful Schwing 80 maiden — Tick Point, California. Stars of the show are myself — the slim handsome dude with the model, Wayne Flower in the foreground — owner of Aloft Hobbies and chief test pilot that day, and ace flyer Bruce Anderson who probably has more of my designs that anyone else on the planet. (image: Julia Liu)

Compromised or ‘Clipped’ Elliptical Wing Design

My thinking process: I know that I really want an elliptical lift pattern, and since I can use CNC (or even carving if I’m good enough) to make the wing master, then I can really have whatever wing shape takes my fancy — within the constraints of the wing span and chord size. But I also know that a true ellipse that extends to the tips will bring problems, plus I know that the pesky chord distribution might also have an effect too. Aileron size and span problems are OK because I can deal with them after the model is made.

Thinking cap on, and the answer comes. Pondering “control” I know I need to control the 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, and not let those random elliptical vortices whistle (yes, they do) every which way they feel like and possibly start a tip stall.

So, putting those together 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 I’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.

Example (photo 10) of a non-elliptical ‘legacy’ wing planform on the left, and one of my more modern stretched ellipse designs on the right. i.e. Left side design has too much chord in the wrong places, not enough MAC Vs CG variation, has badly designed tips, plus the ailerons are too close to the ends. Flying slowly, this type of planform might be OK, but as the speed goes up, the problems will show.

Photo 10: Legacy vs more modern wing planforms.

Here is an example (figure 11) of the original Stormbird 2M with pretty much all the features discussed so far. This is the original Stormbird 2M drawing before rendering into CAD. Designed in 2015, this model was really my first excursion into the "dangerous" wing shapes that I now carry in all of my designs. Note the long fuselage — this gives a little more leverage, but also allows the model to be made in 2.5m (100") form as an alternative — hence the Forza 100 was born.

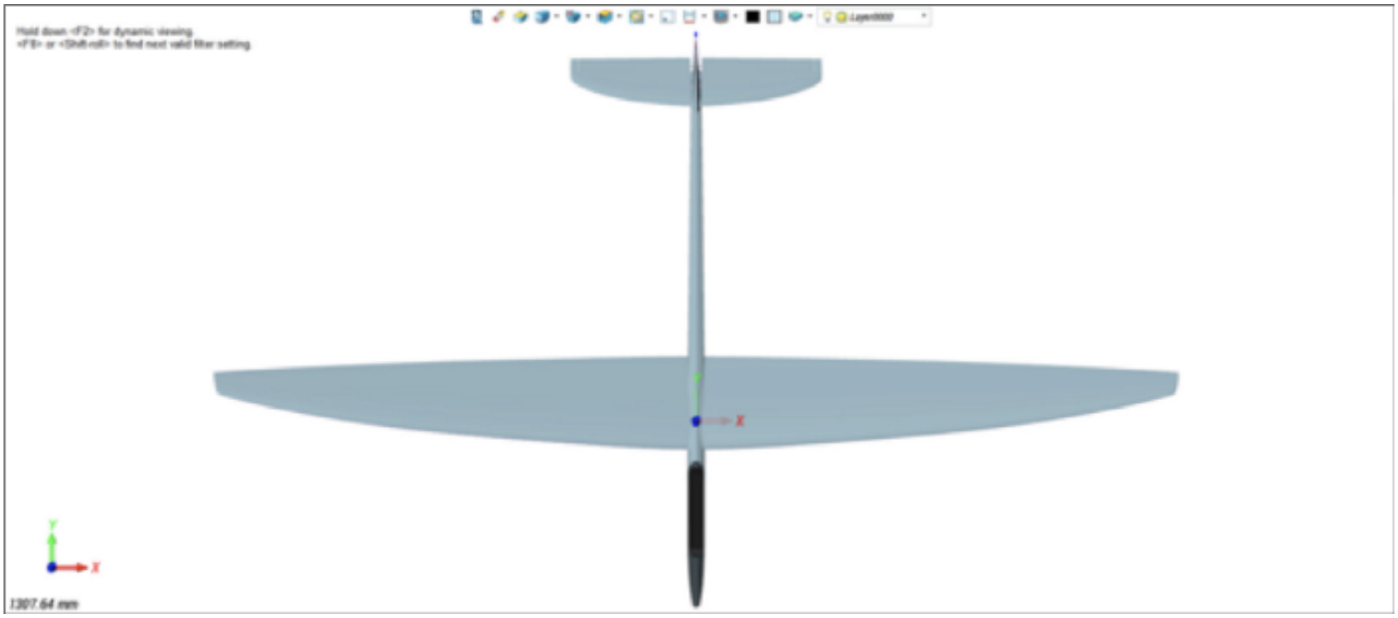


Figure 11: Stormbird 2M plan view — note the 'dangerous' wing shape.

> *Takeaway: Many people when they first saw this new wing shape, believed it to be a tip stall nightmare, and said so quite volubly. Well, it has proved to be exactly the opposite. High speed or low speed tip stalls are very, very, rare with this model and also for its larger and smaller brothers with a similar wing shape, thus proving the design philosophy.*

Now How About the Tail Feathers?

V-Tail good points: fashionable, less pieces/joints so theoretically less drag, can be helpful in stabilizing the model in strong winds, less chance of landing damage.

V-Tail bad points: loss of much of the rudder control, less control effectiveness overall, little or no drag advantage in practice as the inputs need to be greater for the same responses, not so good for nice aerobatics as the control forces can be in the wrong directions.

X-Tail good points: better overall control, with little or no actual difference in drag, decidedly better for nice aerobatics.

X-Tail bad points: not fashionable, more pieces so theoretically more drag, more risk of landing damage.

The choice is up to you. I have done both types with success, but if I was asked which is better for an allrounder, I'd go for the X-Tail every time due to the more open and detailed flight envelope that it allows.

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

Photo 12: Schwing looking nice over the Australian Southern Ocean. (image: Adam Fisher)

Secondary considerations are the stabilizer aerofoil to be used, the area and whether to go for an all moving tail (AMT) or a conventional elevator setup.

Stabilizer aerofoil choice is pretty easy: A symmetrical aerofoil of between 7 to 10% is required. I use 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. This is likely due to the way the air flows around and separates on the thicker section when the elevator is deployed compared to a thinner section where it can have an entirely different separation path.

Stabilizer area choice not a problem either: On a smallish 2m model, 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.

The third decision is more controversial: to AMT or not to AMT? For control effectiveness I can tell you — through many long hours of wind-tunnel and practical flight testing — that the elevator setup is more effective in every way than the AMT. On the other hand, the elevator type can be a bit trickier to make with its hinges, and to actuate — but I'm assuming that if you do actually get to making a model then this is well within your capability. The AMT works well enough for most people, and is a lot less work. Your choice, but for me it's always the elevator type. The elevator chord should be suitable for the aerofoil section but normally 25% is good.

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: 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.*

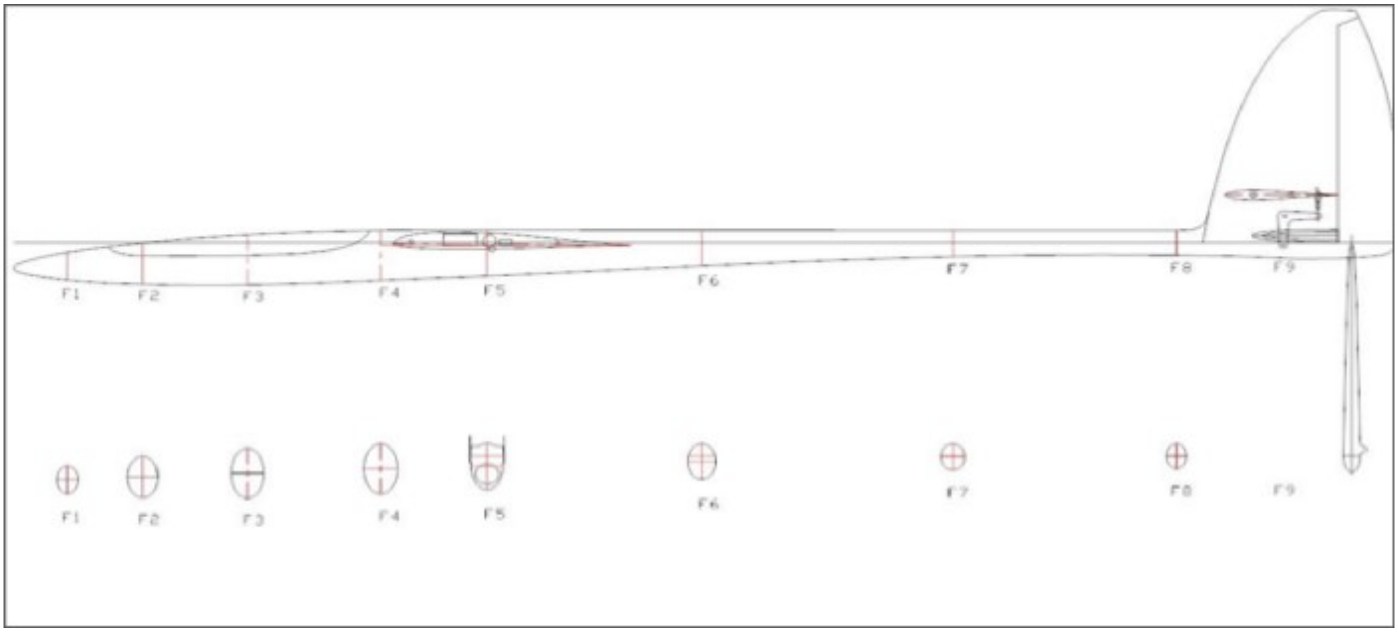


Figure 13: Corsa fuselage drawing — note the downward pointing nose…gives a nice predatory look.

The Fuselage

Finally! I guess the first thing to be considered for the fuselage is the moment arms. By this I mean the distances between the wing and tail, and the wing and 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, the easier it is to move the load which is the area in front of the CG. These are pretty critical as if they are too short you will need big control movements to change the pitch and yaw, but too long and they will add unnecessary weight which will need to be counterbalanced by adding weight in the nose.

So here, without going into it too much, I'll give some moment arm references based on my own experience and using the wing root chord as the yardstick:

- Nose moment length to wing leading edge: 1.5 to 1.7 x wing chord
- Tail moment Stabilizer leading edge to wing trailing edge: 2.75 to 2.8 x wing chord.

Corsa 108″ (2.75m) a larger allrounder. Note that on this test flight model the ailerons have been set too close to the tips. Some tape, a ruler, a sharpie pen and hacksaw soon had that sorted!

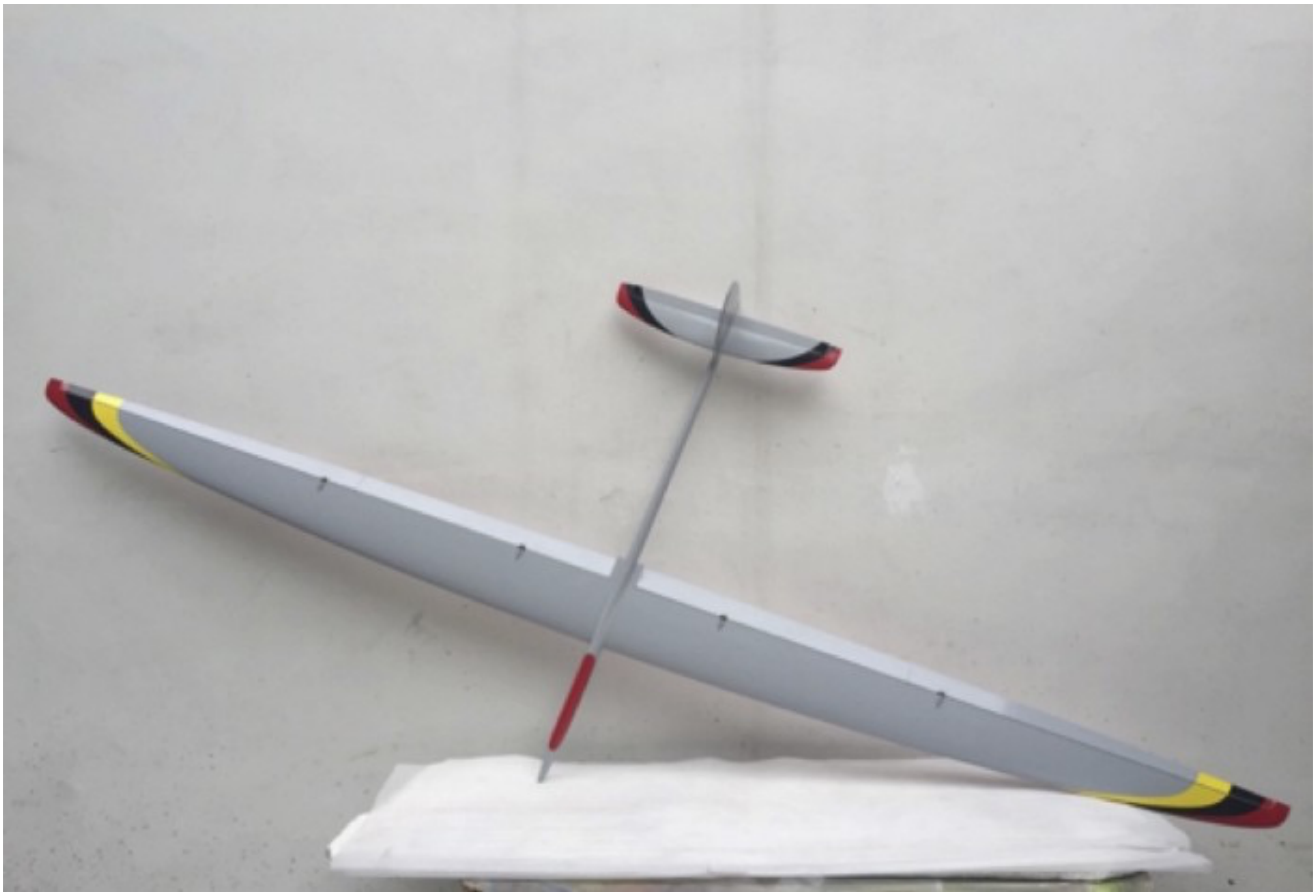


Photo 14: Corsa 108 prototype — not the incorrectly cut ailerons…the hacksaw soon came out…

Fin Size

For an X-Tail a good start point is go to 2 to 2.5 the size of the total horizontal stabilizer area and allow a good-sized rudder. Frankly any aerofoil section can be used from 7 to 10% The reason for the greater volume here is that we are not doing the work of the Horizontal Stabilizer that is working against the MAC and the CG, here we are trying to force large amounts of wing to yaw — which it usually does not want to do. With the advent of smaller, lighter, but super strong servos you may decide to put both of the servos' rudder and elevator in the fin — remember to make the internal fin area large enough plan access hatches.

2.75M Corsa in its OEM guise showing what you can expect of a well-designed slope allrounder, fast, aerobatic and easy to fly. (video: Composite RC Gliders GmbH*)*

One last parameter for the fuselage: make it look good! Mess about with it — especially the fin which defines the fuselage to a large degree — 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 — especially before and after the wing positions. The strongest cross section is the round shape.

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


© Jógvan Hansen

Photo 15 and **Photo 16**: Corsa 108 flies its magic over the Faroe Islands. (images: Jogvan Hansen)

This is the second part of a four part series. Coming up in the May issue of RCSD, author James Hammond provides his take on designing for high performance 3M ships. 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**.*

Never Trust the Weather!

The Spring Soar for Fun Aerotow in Cumberland, Maryland never fails to please.

Stéphane RUELLE

Overview of the pilot pit, with the main building in the background. SH Minimoa and Baudis Antares on the foreground.

After a winter frantically spent building, the spring fever started to build in me for our fist aerotow of the 2021 season, the 12th edition of *Spring Soar for Fun Aerotow* near Cumberland, Maryland. This event is usually taking place end of March, close to the first day of spring. And in the past 12 years we have known all kind of weather, from snow cold to T-shirt hot, it has been a quite interesting exercise to predict what next year will be! the only thing I can say is I always looking for the event — the season starter — as it is always good to do some aero talking if flying is not available.

As always, a week before you look the forecast and try to judge what weather will be. This is where the roller coaster of emotion is going on as every day in that end of winter, beginning of spring the weather changes radically, going this year to a total wash down with snow mix to beautiful sunshine. At some point you need to commit and walk away from forecast, last that I saw was nice on Wednesday, rain on Thursday, maybe snow mix on Friday and sunny on Saturday to Monday. I committed to leave Michigan very early on Wednesday to be able to grab a piece of Wednesday afternoon weather.

Photo 1: Early departure with the trailer to arrive in time for the afternoon.

After the drive to Maryland (flying site is in actually in West Virginia at the border with Maryland), the weather gods kept their promises, and allowed for some flying Wednesday afternoon, a bit overcast with lower ceiling but very flyable weather with some light thermals. We have been able to fly until dark and stored the plane in the hangars that Jim D the owner of the place installed couple years back.

Photo 2: Diner on the deck around a pit fire, how better end a day of flying.

Once this done most the people stayed for a diner at the field grilling and picnicking until pitch dark to watch the International Space Station moving in the sky over us. This is one of the positive effects of 2020, people try avoiding hotels and restaurants, going to a more authentic experience very similar to the spirit you find in Europe for that type of event. I hope it will last as the best memories are after the flying of the day is over, storytelling about the day or previous experiences.

Photo 3: Pilots (left-to-right) Len, Kevin, Bert, Steve K and Steve P.

Thursday the weathermen played against us with low ceiling and drizzle that allowed some of use to proceed with the necessary repairs on retract or other mechanical devices or bring back some improvements to the radio programming. The aerotowing community is always here to help putting back everyone in flying condition when so usual snags are showing up, and as a fact Len’s trailer is always a key of success on the east coast, as he has always something that could help you getting back in the air!

Photo 4: One of the two hangar, that hosted the repairs and fixes of Thursday.

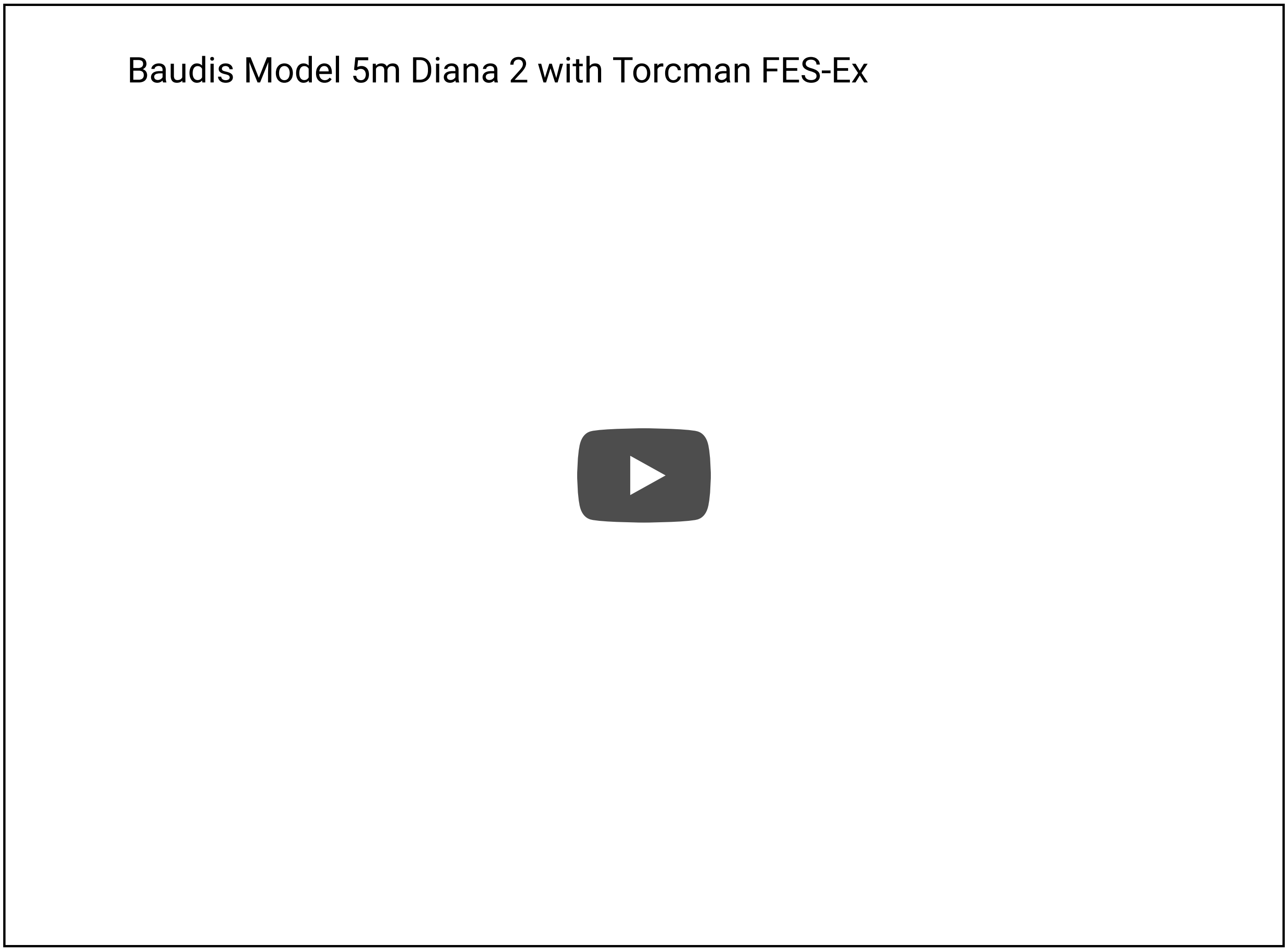
Friday that originally was calling for snow mix, showed up with a totally different face, when I woke up a beautiful blue sky was there without any clouds, clouds that did not showed up during the rest of the weekend. Temperature progressively rises to 70F (20C) making up of some very pleasant spring days spent on the top of the mountain! Thermals have been present every day, very weak but flyable until noon, giving a very nice training to improve your circling and thermal hunting skills. About lunchtime to 2:30 some very pleasant condition took place with some more robust thermals (and some very noticeable sink!, I clocked +5m/s and -7m/s on my vario that day!) that allowed some of the participant to train their skill on GPS triangle racing (30 minutes work time on a 2.4km course, forcing you to travel on every sides of the flying site, I will be back on a future article on how it appeal to me).

Photo 5: Kevin K getting ready to take of with his 6m KV model Shark for an initiation to a 30mn session of GPS triangle, he will come back from this hooked.

Photo 6: Peter and Caroline G assembling the Peter Goldsmith Design L-19, one of the tug on duties during this week end. Foreground, Slingsby Swallow Caroline's personal model.

This weekend has been for me like other the occasion of maidening the winter built aircraft, in my case a 6m ASG 29 kit. The conditions where perfect for maidens, light lift light wind, very adequate to get a good feeling on how is answering the plane. As all my sailplanes now (most of) I have taken the habit to install and electric motor in the nose, it appeals to me as it is an insurance (some airframe can be pricy or in regard the time invested to build the airframe) on the sailplane to be able to bail out of a bad situation, like a crowded landing, of flying lower than the landing area on a slope without finding lift. The other big advantage been able to fly much more often by yourself, either as the sailplane can ROG (rise off ground) by itself or like this one, use a bungee to get necessary prop clearance to be able to start the motor. On this particular sailplane as the nose was quite round with difficulties to use a matching nose cone, I decide to use the Torcman FES system, that is on my view a very good solution also for safety as you connect the prop just before taking of, no risk to hit a switch and get sliced!

Photo 7: First flight for my winter project, a 6m ASG29. Powered with Rimfire 1.2 (Kv 450), 6S 5000mA and RFM 16x10 mounted with a Torcman FES system



Video 8: Video of my Diana 2 taken the day after the even enjoying the emptyness of the place

this edition has been quite a success, and I can only encourage people to come and join us, the event is organized three times a year for each of the flyable seasons. All events are held at the Highpoint Aviation Airfield:

Figure 9: Where you will find the Highpoint Aviation Airfield. (image: Google Maps)

The next event on the calendar will be the 9th annual *Summer Soar for Fun Aerotow* will be held on July 15th through 18th, 2021 (registration). After that, the 55th edition of *Fall Soar for Fun Aerotow* will be held November 4th through 7th, 2021 (registration).

See you there and don't forget **not** to look to the forecast!

All photos and videos are by the author unless otherwise noted. Read the ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents***.

I've Got the Power: OpenTX

An open source operating system with the Lua progamming language.

Michael Shellim

Some OpenTX-compatible transmitters. Left to right: FrSky TX12S, X9D, X9 Lite, RadioMaster TX12.

Few topics generate more noise and hot air than OpenTX, the popular open source operating system. Some love it. Others hate it, and for the rest OpenTX remains a mystery. In this article I'm going to explain the background to OpenTX, as well as its unique approach to programming.

I will also show how, with the aid of the built in Lua facility, you can do some pretty advanced stuff — like a continuously variable trim system!

Humble Beginnings

OpenTX's popularity is remarkable when you consider it started life as an obscure operating system for cheap Chinese transmitters. It finally hit the big time in 2013, when FrSky chose it for their first transmitter, the Taranis X9D. Thanks in large part to OpenTX, the X9D became a huge hit.

Part of the appeal of OpenTX is the free Companion software. This provides a model editor, and a simulator for testing your setups. It's also a great way to familiarise with the OpenTX before purchasing a transmitter.

OpenTX also incorporates a Lua interpreter. This allows users to create powerful extensions in the form of *scripts* — we'll look at an example later in this article.

Designing a Setup

As with any serious pursuit, knowing the lingo is key. Architects use lines and curves. Mathematicians use symbols. And OpenTX'ers use *interactions*. An interaction expresses the relationship between one stick and one servo.

Here's how you might write an interaction representing a simple elevator function.

```
Elevator stick → CH3/elevator (pitch)
```

The first step in designing a setup is simply to make a list of all the interactions required. Here's an example, for a 4-servo glider with twin aileron servos. Note that the aileron stick generates two interactions, one for each servo:

```
Aileron stick → CH1/RtAil (roll)
Aileron stick → CH2/LtAil (roll)
Elevator stick → CH3/Elev (pitch)
Rudder stick → CH4/Rudd (yaw)
```

The beauty of this approach is its simplicity: this four-line table completely describes the basic operation of the model.

Implementing the Design

While the design is concerned with interactions, the implementation is all about *mixers*. And a mixer in OpenTX is very simple — it takes an input, applies a transformation, and assigns the result to a channel.

The similarity with interactions is obvious, but it gets better… to implement your design, simply reverse the interactions and enter them into the Mixes menu:

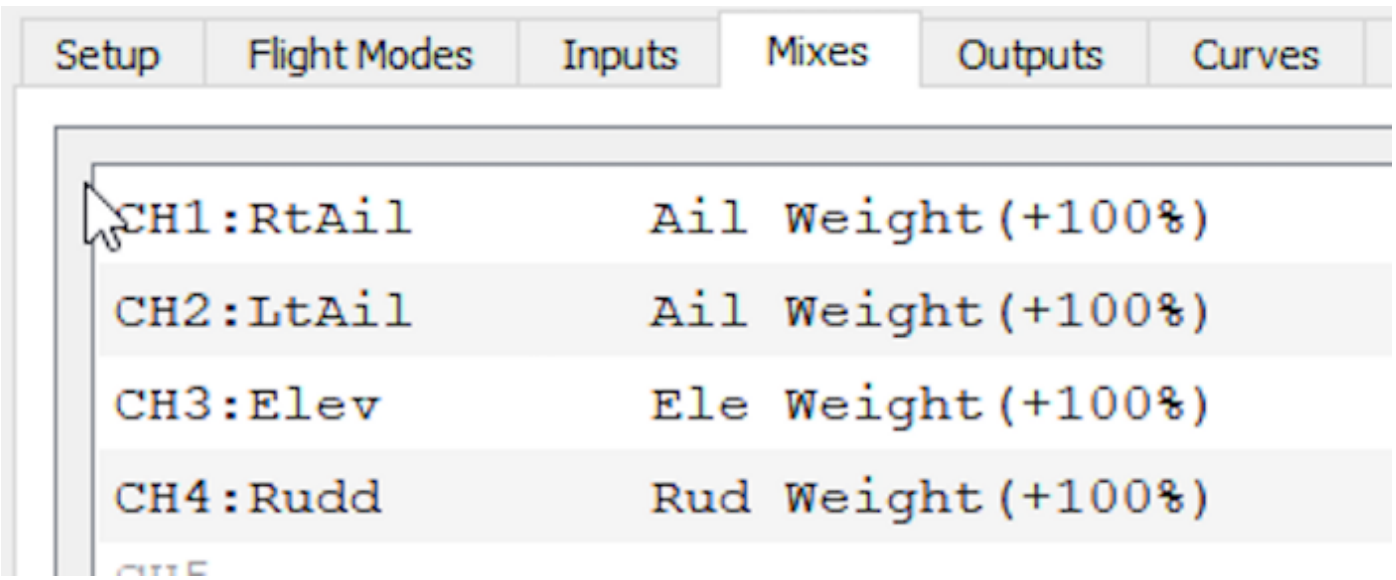


Figure 1: Mixers for a 4-servo glider, shown in OpenTX Companion software.

Want to add snapflap? No problem — just add two interactions:

```
Elevator stick → CH1/RtAil (snapflap)
Elevator stick → CH2/LtAil (snapflap)
```

… and again, those translate into a couple of extra mixes.

The 1:1 relationship between interactions and mixes makes it easy to design a setup. And because your work can be expressed as a list, it's easy to browse and document.

The Beauty of Lists

Mixers are just one aspect of OpenTX. Others elements include:

- *Inputs* — flight controls with rates and expo
- *Logical switches* — combine switches using AND/OR operators… and much more.
- *Outputs* — set servo end points and centres
- *Gvars* — define integer variables
- *Special functions* — trigger actions like telemetry logging, timers

All these elements are shown as simple lists.

It should be clear that OpenTX is very simple at heart. Yet it's also extremely powerful. Part of this is due to its simplicity — building complex systems is easier if you start with small building blocks. However, a large part is also due to an embedded Lua interpreter. What follows is an example of a powerful Lua based extension for a continuous trim system.

The Power of Lua: A Crow Aware Trim System

Anyone who has used crow brakes will know that they can wreak havoc with pitch trim. The usual antidote is a crow-to-elevator mix with a *compensation curve* to deal with any non linear behaviour.

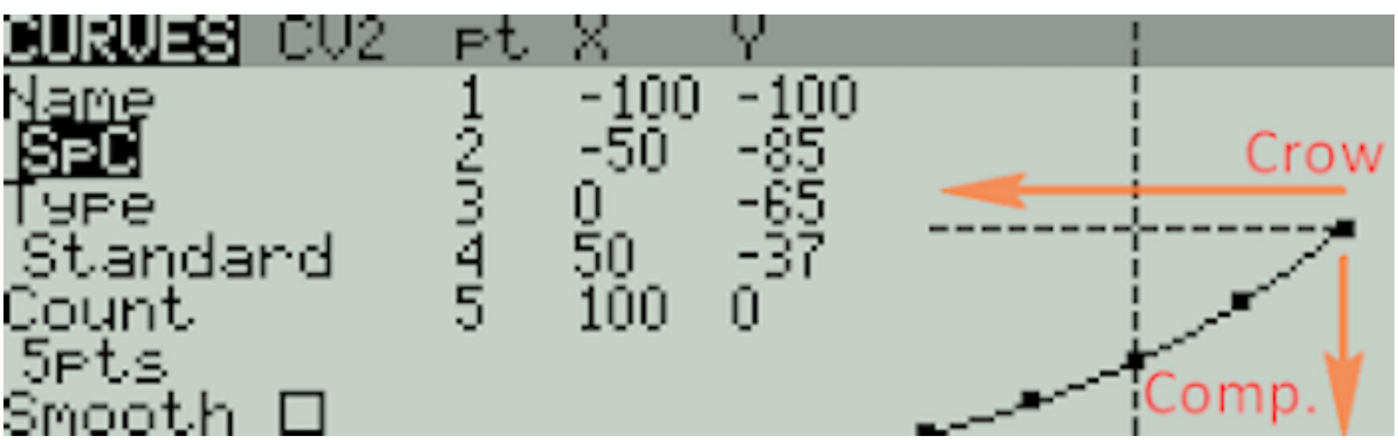


Figure 2: Crow compensation curve on author's Stribog F3F model.

The problem is that adjusting the curve can take several flights to get right. But hey, why not just *use the trim to bend the compensation curve*? For such a system to be useful, it would need to be completely transparent.

Turns out that with the help of Lua, a practical solution is possible. I call it the 'crow aware adaptive elevator trim'. A bit of a mouthful, I admit, for what is essentially a continuously variable trim system!

The solution, in three parts

There are three parts to the solution. The first is to decouple the elevator trim from the elevator stick — easily achieved in OpenTX. Once freed from its normal duties, the trim behaves like a dumb (double-throw) switch.

The second part is getting the trim to bend the compensation curve. This is where Lua comes in...

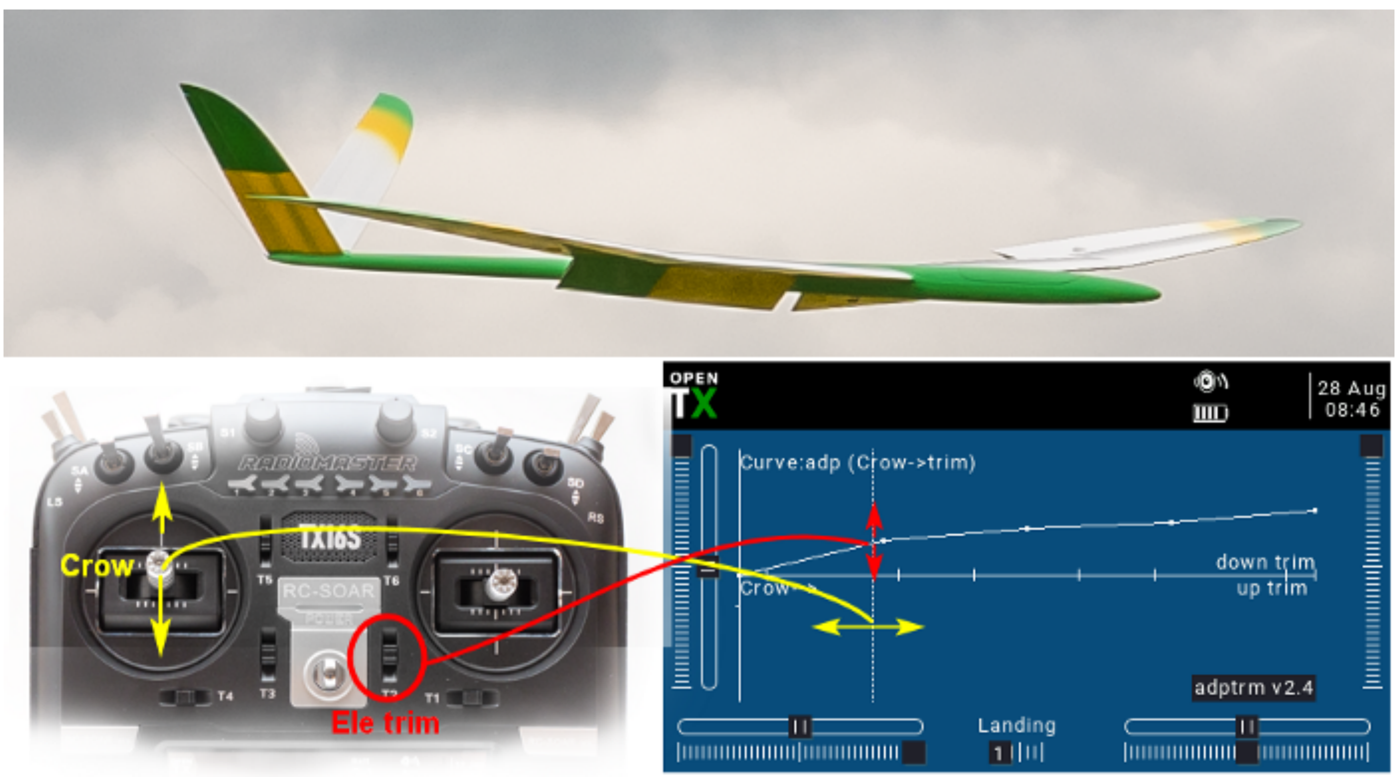


Figure 3: Crow aware trim system. Bottom right shows live view of compensation curve.

The script runs in the background under the control of OpenTX. When a click is detected, the main part of the script springs into action; it determines the crow setting, recalculates the compensation curve, then writes back the updated curve. The key API call is:

```
model.setCurve (cv_idx, {name=cv.name, smooth=1, y=pt_y})
```

As far as I'm aware, there's no equivalent to the `Model.setCurve()` function in other systems, so this is an application where OpenTX has a unique advantage.

The third and final part is to assign the compensation curve to a crow-to-elevator mix. The output of the mix is the crow compensation.

Using this script it's possible to optimise the crow trim before a new model's first landing. The script in use by several pilots and is available for download from my website OpenTX Clinic (see links).

Summing Up

I hope this has given you a flavour of OpenTX — both its simplicity and its power. I won't pretend that it's all roses — the overview I've presented has of necessity been greatly simplified. However, if you're technically inclined, you'll find it a uniquely capable and satisfying operating system.

Finally, I'm eternally grateful to the developers for their continued commitment to this project. OpenTX has been the mainstay of my soaring activity for almost eight years — as it has been for thousands of modelers around the world controlling everything from drones to competition F3X models. Long may it continue!

Additional Resources

- OpenTX.org — home of OpenTX
- OpenTX Clinic — author's site, with sailplane templates and tutorials:
- Crow Aware Trim Script

- List of Interactions for an F3F Model

All photos and figures by Michael Shellim. Read the ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents****.*

1/3 スケール三田式 3 型改 1 製作記

マルチパートシリーズの最初のパート。

[Norimichi Kawakami](#)

If you prefer you can read the English translation of this article, which was provided by the author.

栃木県宇都宮市 河上宣道

昨今は既成の半完成機(所謂 ARF 機)を組み立ててラジコン飛行を楽しむのが主流ですが、自分で設 計して素材から部品を切り出しそれを組み立てる、というのもラジコン機趣味の醍醐味です。資料を集 めて種々検討しながら納得のいくまで図面を修正し、思わぬ失敗を繰り返しながら何とか自分好みの機 体に仕上げると ARF 機では味わえぬ愛着が湧きます。

子供の頃には工作が楽しくてしょうがなかったのに成長するに従ってその機

会も無くなり、その上最 近では半完成品が手軽に手に入ることから益々工作から遠ざかってしまい、イザ自作と言っても実際に 着手することは躊躇される方も多いと思います。ラジコン技術誌には自作記事が載りますが、自作過程 で起こる幾多の検討事項をどのように処理し、避けて通れぬ失敗をどのように乗り越えて完成に至った のかは殆ど記されないのが普通です。その為、読者は余程工作の得意な人が製作したものと考えて自分 とは遠い存在に思いがちです。

斯く言う私も中学生以来工作から遠ざかること数十年、退職後に始めたラジコン飛行機の趣味で、当初 は ARF 機やバルサキット機を組み立てて楽しんでいましたが、やはりゼロから自分で設計・製作してみ たい気持ちが大きくなりました。そこで数十年ぶりに 2D CAD で図面を描き、カッターや鋸、やすり等を 使って素材から部品を切り出し組み立てることに挑戦しました。設計の段階ではいろいろ検討すること も多く、製作段階でも多くの失敗を繰り返しました。その過程を隠さず報告することで自作に興味がある方の参考になるのでは、と考えてこの文をまとめました。その為少々長文ですが読み物としても楽し んで頂き、少しでも自作に躊躇されている方の背中を押せたら、と願っているところです。 尚、対象は「ラジコン技術」2019 年 11 月号に掲載された 1/3 スケールの三田式 3 型改 1 グライダーです。 翼幅 5.3m 超の大型機で、私が設計・製作した完全自作の 2 番機です。

きっかけ

退職後ラジコン飛行機を趣味として始めました。飛行機にも色々な種類がありますが特にグライダーの優雅な飛行スタイルに魅力を感じています。いろいろなラジコングライダーを製作した中でも、サー マル工房のキットから製作した 1/5 スケール三田式 3 型改 1 が特にお気に入りの一機になっています

下の写真はこのグライダーの初飛行で撮った着陸直前の姿です。この優雅な姿に参ってしまいもう少し 大きな 1/3 サイズの機体が欲しくなりました。キットとして販売されているものは無いので自作するこ とにしました。

画像1 サーマル工房のキットから製作した1/5スケール三田式3型改1

実機調査その1

早 2017 年の年末から三田式 3 型改 1 の実機調査を始めました。ネットでいろいろ調べていると、サーマル工房の 1/5 キットの元になった、東海大学が所有していた JA2103 を所有する方が同じ宇都宮市に お住まいということで、早連絡をとり同年末に御自宅にお邪魔させて頂きました。残念なが

ら現在は 機体を静岡理工大学の航空資料館に寄贈されたとのことで見ることはできませんでした。しかし、所有 されていた時代に撮られた機体各部の貴重な写真を CD に焼いたものを頂き、以後の設計の大きな助けと なりました。

この調査開始と同時に 1/5 三面図を元に、1/3 三面図の原寸製図を CAD で開始しました。これは図面を描 くことで調査に必要な不明点/疑問点を具体的に明らかにするためです。尚、残念ながら私は 3D CAD を 使えないので 2D の AR_CAD というフリーソフトを使用しています。

実機調査その2

年が明けた 2018 年一月、関東地方は稀にみる大雪に見舞われましたが、その 3 日後に静岡空港傍の静岡航空資料館を訪問して実機調査を行いました。さすが静岡、雪はまったくありませんでした。

初めて三田式3型改 1 の実物を目にすることができました。

画像2 静岡航空資料館の実機三田式3型改1JA2103(インターネット航空雑誌ヒコーキ雲から拝借)

初印象は思っていたより小さく華奢だということです。特に胴体に使われている鋼管の太さを勝手に 30 Φ位と想像して図面を描き始めましたが、年末に頂いた CD の写真と見比べてもっと細そうだという感じ を持ちました

が、実際に実機を見てみると一番太い縦通材でも 20Φ、その他は 15、12、10Φ程度だとい うことに驚きました。

忙しい時間を割いて資料館の方が親切に対応して下さったお蔭で、構が良くわからなかった中央翼と 外翼の結合方法や、翼の胴体への取付方、エルロン前縁形状とヒンジ位置などが判り大収穫でした。今 はインターネットでなんでも調べられる時代ですが、やはり何事も実物を観て自分の感覚に訴えること が重要だと改めて感じた次第です。

今後の設計過程で発生する不明点をメールでやり取りして、資料館の方に実物調査をして頂くことを快 く受けて頂き、多いに励まされることになりました。

画像 3 は外翼と中央翼の結合状況です。主翼前縁側から撮りました。両翼は約 10cm 程度の間隔を隔て左 右の主桁から突き出したかなりゴツイ結合金具で結ばれます。結合は桁の上下フランジ高さの位置にあ る2本の剪断ボルトで結ばれます。この写真は上側ボルトが見えています。尚、翼の隙間はプラスチッ クのカバーで覆って塞ぎます。

画像3 実機の中央翼と外翼の結合部

画像 4 は主翼と胴体の結合金具です。前後2か所にありますがこれは前側のものです。主桁ウエブに取 り付けられた2個の金具の先端に穴が開いており、角型胴体フレームから突き出したボルトが貫通し、 それをナットで締め上げます。揚力と抗力およびローリングモーメントを効率良く胴体側に伝えていま す。

画像4 実機の翼胴結合部(前側)

この他にも貴重な写真を何枚も撮影できました。

実機データ

ここで三田式3型改 1 の実機データを纏めると次のようになります。

形式		複座式滑空機
初飛行		1966. 03. 26
生産機数		32
構	胴体	鋼管羽布張り
	翼	木製単桁式羽布張り、中央翼 1 枚と外翼 2 枚の 3 部構成。
主要諸元	翼幅	16m
	全長	7.96m
	全高	1.57m
	自重	300Kg
	全備重量	450Kg
	主翼面積	15.87m²
	アスペクト比	16.3
	外翼上反角	3.45°
	ねじり下げ	外翼部にねじり下げを設けているがその大きさ不明。
	翼型	NACA 633-618
性能	最良滑空比	30.8
	最良滑空 度	78Km/h (単座) 82.7Km/h (複座)
	最少沈下 度	0.72m/sec (全備重量時)
飛行限界	超過禁止 度	180Km/時
	最小シンク速度	62.5Km/時 (複座時)
	制限荷重倍数	+5.0~-2.5
	許容重心範囲	30%MAC~40%MAC (主翼前縁から 312mm ~ 416mm)

これらのデータを参考にして 1/3 模型の諸元を決めていくことになります。

1/3 模型の基本構想

実機の基本調査が完了したので、いよいよ 1/3 模型の基本構想を固める段階です。方針としてはできるだけ実機のイメージを壊さずに必要に応じて省略や簡略化をすることにしました。基本構想として固 めなければならないことには以下の 5 項目があります。

1. 分割をどのようにするか?:搬送は私の愛車スバルフォレスターで行いますが、これに乗せられるよ うに各部をどのように分割するか?

2. 胴体構 をどのようにするか?:サーマル工房製の1/5模型はレーザーカットしたシナベニアの組合 せ構 だが、レーザーカッティング機を持っていないのでどうするか?
3. 中央翼と外翼の結合方式はどのようにするか?:実機の結合方式は前述の通りですが、これを忠実に 模型化するかまたは別方式にするか?
4. 翼型はどうするか?:実機と模型では飛行時のレイノルズ数が異なるので、翼型の揚力や抗力等の空 力特性が変わります。そのため実機そのままの翼型では性能が落ちる懸念があります。
5. 目標重量をどの程度に設定するか?:重量管理の重要な飛行機の開発では目標重量を定めて、設計、 製作の各過程で重量・重心をそれに照らして監視しなければ、重量オーバーで満足な飛行性能が得ら れないことになりがちです。

以上 5 つの基本的な項目を順次以下のように固めました。

基本構想その1 機体の分割

実機は中央翼、外翼(2 つ)、胴体、水平尾翼の合計 5 つに分割することが基本分割です。その他にラダーも比較的簡単にはずれますので胴体長を若干縮めることができます。サーマル工房製の 1/5 模型も 基本的に実機と同じ分割です。但し私の機体では水平尾翼は付けたままで4分割にしています。

さて、1/3 模型のそれぞれの寸法は以下のようになります。

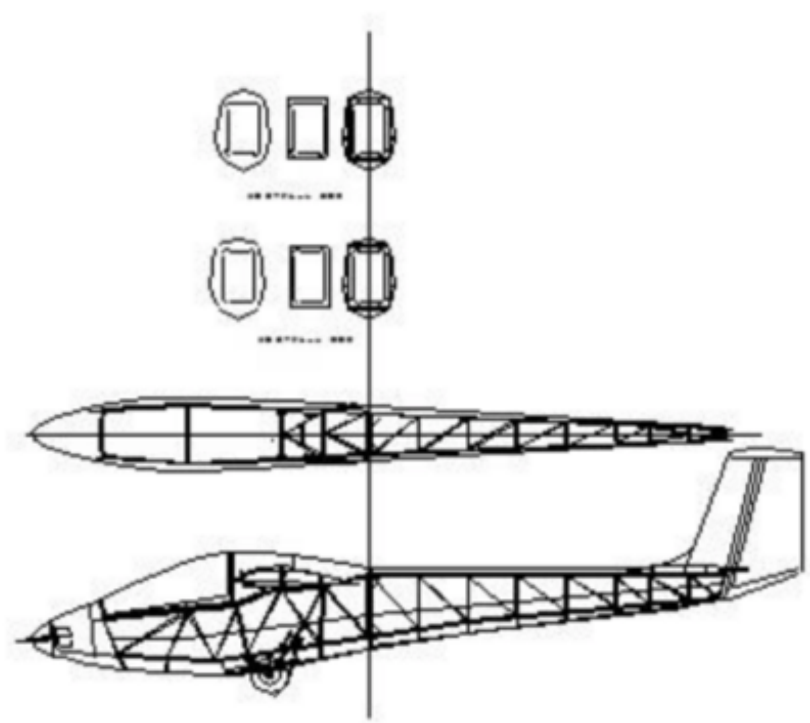
中央翼	2,000mm
外翼	1,670mm
胴体	2,654mm (ラダーを付けた状態)
	2,526mm (ラダーをはずした状態)
	2,394mm (垂直尾翼もはずした状態)
水平尾翼	996mm

一方、私の愛車スバルフォレスターでの長尺物運搬能力は次のような状況です。

後席を倒した状態	1,600mm
同上で運転席と助手席の間の隙間に通す場合	1,700mm
助手席を倒してダッシュボードに突当る場合	2,600mm
同上でフロントガラスに突当る場合	2,800mm

以上の条件で分割方式を検討する訳ですがこれにはいろいろ悩み二転三転しました。外翼は運転席と助 手席の間の隙間から顔を出すことで何とか運べます。問題は中央翼と胴体です。当初は単純に助手席を 倒すことで実機と同じ分割にすることにしました。しかしできれば助手席を倒さないで運ぶことがベス トですので、途中で中央翼と胴体を分割することを計画しました。中央翼は真ん中で2分割すれば見栄 えも悪くなく長さも1m に縮まります。組み立てるには、桁ウエブの前後に 2~3mm 厚のアルミ板を当て がってボルト締めすれば比較的簡単に組めます。

問題は胴体です。垂直尾翼を外れるようにしても未だ長すぎますので、どこかで2分割する必要があり ます。主翼後縁のすぐ後ろあたりで2分割すると前胴が約 1,200mm、後胴が約 1,200~1,300mm 程度にな ります。そのように分割する方法を作図したのが図面 1 です。



図面1 胴体分割案

前胴最後部と後胴最先端にほぼ同形状のフレームをそれぞれ 4mm 厚と 5.5 mm厚のシナベニアで作り、4 隅 の 4 本の M4 ボルトで結合する案です。5.5mm シナベニアが強度を受け持ち、4mm シナベニアは外周形状 を保つ役目です。かなりの間これで進めることに決めていましたが、この方法の最大の欠点は本グライ ダーの美しい羽布張り胴体に分割ラインが明確に生じることです。

更にどんなにシナベニアのフレームを平滑にしても羽布の張力で歪みが生じて、分割ラインに隙間が現 れることが予想されます。これはスケール機には大きな痛手です。また、この分割のために機体後部の 重量が 200g弱増加します。それでなくても重心後退が心配されるのでこれは避けたいという思いがだん だん強くなり、とうとう分割を諦めることにしました。

胴体の分割を諦めることは助手席を倒すことを意味しますので、中央翼も分割しないことにしました。 結局当初の構想に戻り、中央翼、外翼(2枚)、胴体、水平尾翼、垂直安定板、ラダーの 7 分割にするこ とになりました。

基本構想 その2 胴体構

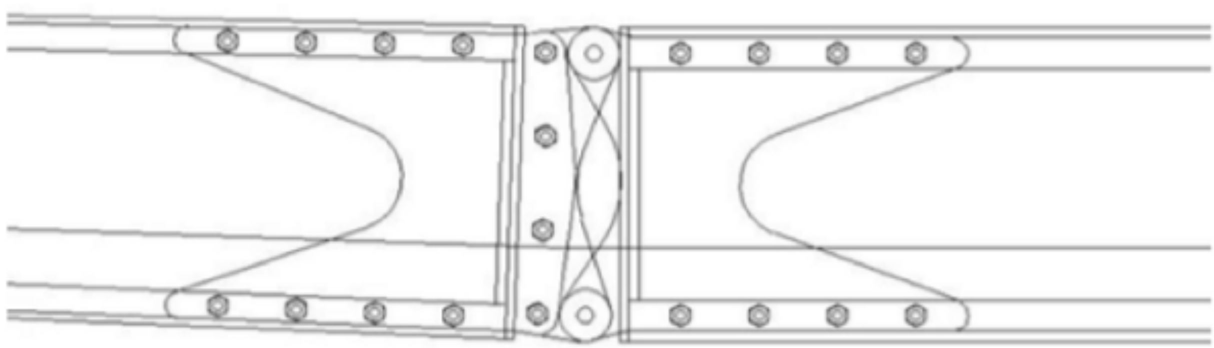
サーマル工房製の 1/5 模型の胴体構 はシナベニアをレーザーカットしたパネルを組み合わせた複雑且つ精巧なものです。重量も軽く剛性も高く優れた構 です。しかし、私はレーザーカッターを所有し ておりませんし時間貸しでカッターを借りるとしても、複雑な構 故に相当の時間がかかりその費用も かなりなものと予想されます。

そこで今回はカーボンパイプを鋼管に見立てて実機と同じようなトラス構にすることにします。当初 はアルミパイプも考えたのですが、カーボンの方が軽く剛性も高く、且つ手ごろな太さのものが入手で きることから選択しました。また、カーボンは瞬間接着剤やエポキシ樹脂で簡単に接着できることもメ リットです。但し、切断がやや困難と思われますが、百均で入手したダイヤモンドカッターをミニルー ターに付けて予備的に実験したところ、割と簡単に切断できることが判りましたこれで実機の鋼管羽布張りのイメージが一層リアルに再現できるのではないかと期待しました。 尚、本機完成後に英国のスケールグライダー同好会(SSUK: Scale Soaring UK)に投稿し

たところ、この カーボンパイプ製胴体構 が目新しく大いに注目を集めました。この方式で着陸荷重等に耐えられるな らば画期的との評価も頂きました。今のところクラックや接着剥がれ等の問題もなく、充分使用に耐え る構 となっています。

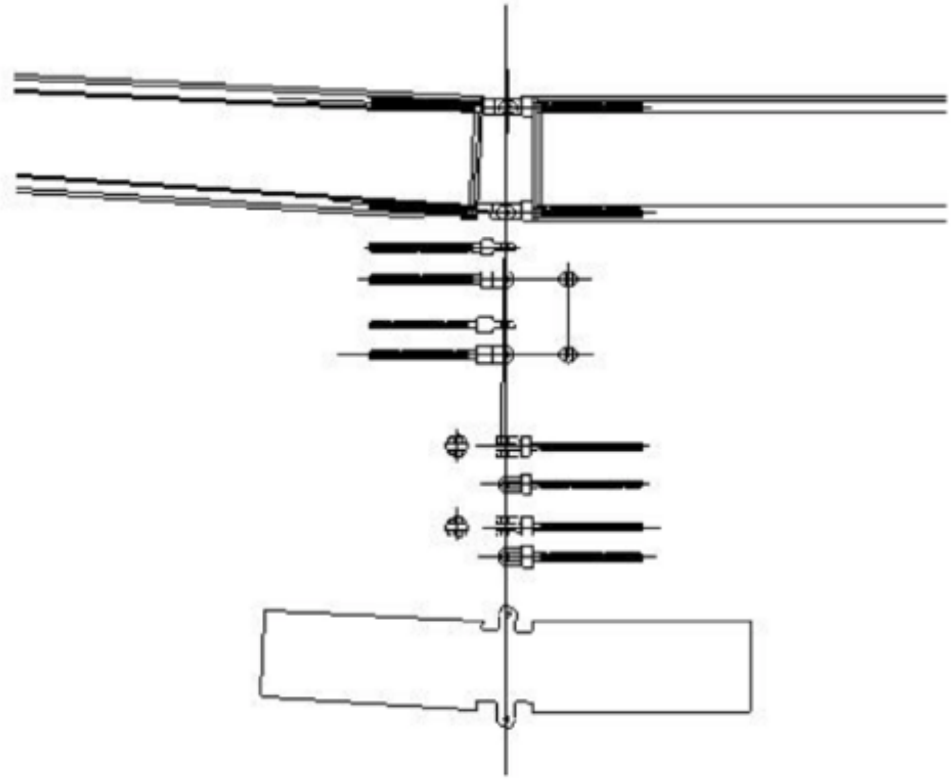
基本構想 その3 外翼と中央翼の結合方法

実機では先に述べたように外翼と中央翼の間は 10cm程度の隙間があり、そこに結合金具が両者の桁から伸びて上下2本の剪断ボルトで締結されています。そこで当初は折角 1/3 もの大型模型を作るのだ からできるだけ実機に似せようと思い、同様の結合方法を考えました。図面 2 はまず最初に考えた実機 もどきの結合方式です。



図面2 当初考えた外翼と中央翼の結合方式

両翼の桁フランジにボルト締めした金具を張り出して2本の結合ボルトで結びます。最も実機らしい結 合方式ですが、この金具の製作にはどうしてもフライス盤が必要になります。ラジコン仲間に金属加工 の得意な方がいらっしゃって、時々特殊金具の製作をお願いするのですが、同氏もミニ旋盤しかお持ち ではありません。金属加工所に製作依頼する手もありますが、結構な金額になると思われます。 そこで、次に考えたのがミニ旋盤だけで作れる金具を用いた図面 3 の結合方式です。



図面3 ミニ旋盤だけで製作可能な外翼と中央翼の結合方式

これは、両翼の桁フランジをカーボン角パイプで作り、そのパイプの中にボルト状の結合金具を上下4 本挿し込んで接着固定するものです。一番下の板状のものは組立時に外翼の上反角を正確に出すための 治具です。この方式ならばボルト頭の平面部を手でヤスル必要がありますが、ミニ旋盤で製作可能です。 実機感も出て面白そうに思え、当初はこの案で進めることを考えました。しかし、問題は隙間を塞ぐプ ラスチックのカバーです。プラスチック部品の製作に経験のない私にとって、前縁部の急カーブにもピ ッタリ馴染んだカバーの製作とその装着方法を考えることは余り得意ではありません。

結局、飛行前後の組立・分解の手間や見栄えを考えて、ラジコン飛行機では常識的なカーボンパイプの カンザシで両翼を繋ぐことにしました。従って、両翼は隙間無くピッタリとあわせます。 しかし、金具結合方式は通常のラジコン模型とは一線を隔した高級感があり、若干の未練が残りました。

基本構想その4 翼型

実機の翼型は米国 NASA の前身 NACA が開発した NACA633–618 です。所謂 NACA 6 シリーズの層流翼型で18%の翼厚です。6 シリーズの命

名法がうろ覚えになっていたのでここで再確認しました。

最初の 6 は 6 シリーズ(層流翼シリーズ)であることを意味します。層流翼シリーズとは翼の最大厚 を比較的後方に置くことで、翼上面の最低圧力の位置を後方にずらします。これによって前縁から最大 厚付近までの空気の流れを加 してその部分の流れを層流(きれいに整った流れ)に保つことで抵抗の 少ない翼型を実現するという狙いで開発された一連の翼型です。次の 3 は最低圧力の位置が前縁から 30% 翼弦長の位置に設定したことを意味します。その次の 3 はこの後の 6 と対になって意味を持ちます。即 ち 4 番目の数字の 6 が設計揚力係数を意味し、その前の 3 はその設計揚力係数の前後±0.3 の範囲で抵抗 が低いと伝えています。つまり本翼型の設計揚力係数は 0.6 で、その前後 0.3 の範囲、即ち 0.3~0.9 の 揚力係数の範囲で抵抗が少ないということです。最後の2桁の 18 は翼厚を意味しますので、本翼型の翼 厚は翼弦長の 18%と言うことです。

さて、一般に翼型の空力性能(最大揚力係数や抵抗係数)は翼弦長が長いほど、飛行 度が いほど 良くなる性質があります。即ち翼弦長と飛行 度の積が大きいほど空力性能が良くなります。この積の 値を表すのにレイノルズ数 Re と言う値があります。Re は翼弦長と飛行 度の積を空気の動粘性係数で割 ったもので、Re=(C*V)/νと記されます。C は翼弦長、V は飛行 度、ν は空気の動粘性係数でその値は 1.50E-05 m2/sec です。レイノルズ数 Re は翼型に及ぼす空気の慣性力と粘性力の比を意味します。つま り Re が大きくなるほど粘性の影響が減って翼型の空力性能が改善されます。

そこで問題になるのは、実機と 1/3 模型のレイノルズ数の相違ですので次にこれを検討しました。実機 の翼弦長 C は中央翼で 1.2m、外翼は 1.2m→0.54m にテーパーしています。このようなテーパー翼の代表 的な翼弦は平均空力翼弦(MAC: Mean Aerodynamic Chord)と言いますが、三田式3型改 1 の場合はその弦 長が 1.04m と計算されます。対して、1/3 模型では当然その 1/3 の 0.347m となります。

次に飛行 度 V ですが、最良滑空 度で考えます。実機の複座状態でその 度は時 82.7km/h、即ち23.0m/sec です。1/3 模型の最良滑空 度は未だわかりませんが、凡その値は次のように推測されます。 滑空中の翼に働く揚力 L

は機体の重量 W と釣り合っています。揚力は L=1/2ρV²*S*CL で与えられます。 ρは空気密度、S は主翼面積、CL は揚力係数です。揚力 L は機体重量 W と釣合っていますから L を W に置 き換えて式を変形すると、
V=2*√(W/S)/(ρ*CL)

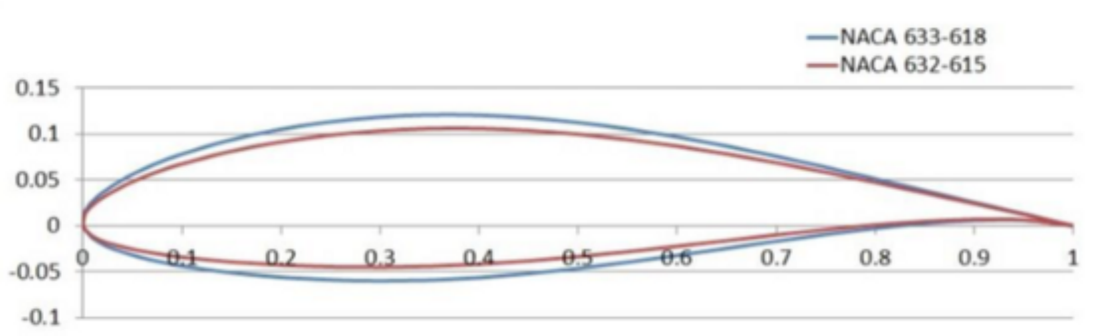
空気密度ρは実機も 1/3 模型も同じです。揚力係数 CL もそれほど異なりません。そうすると、飛行 度 V は W/S 即ち、単位面積当たりの重量(翼面荷重)の平方根に比例することになります。実機の翼面荷重 は W=450Kg、S=15.87m2 から、W/S=28.36 となります。1/3 模型の重量はこの段階ではまだ正確に判りま せんが、次の基本構想その5目標重量で検討するように、10Kg 以下になります。ここでは仮に W=10Kg と 置くと、S=1.76m2 ですから、W/S=5.68 となります。従って、1/3 模型の翼面荷重の平方根は実機のそれ の 0.445 となり、最良滑空 度は実機の凡そ 0.44 倍の 10m/sec 程度に下がることになります。

以上のことから、実機と 1/3 模型のレイノルズ数は凡そ次のようになります。

実機 Re=1.04*23.0/1.50E-05≒1.6E+06=1,600,000

模型 Re=0.347*10/1.50E-05≒2.3E+05=230,000

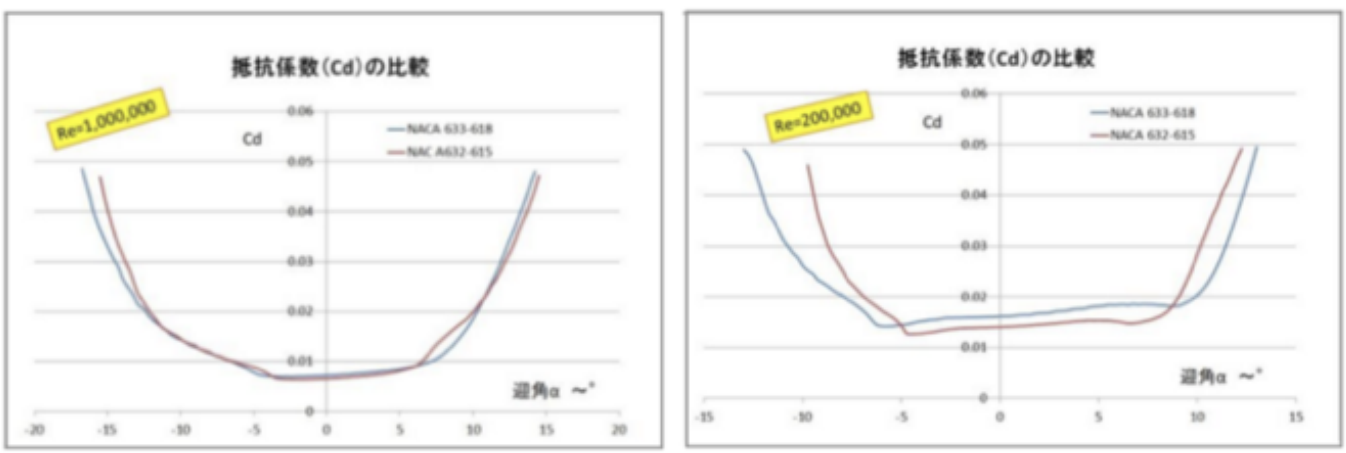
即ち、実機の 160 万に対して、模型は 23 万と実機の 14%程度に落ちますので、翼型の空力性能は実機よ りかなり悪くなってしまうことが予想されます。そこで、模型のレイノルズ数で少しでも空力性能が良 く、尚且つ実機の翼型のシルエットイメージを壊さないものを採用したいと思って探し当てた翼型が同 じ NACA 6 シリーズの 15%翼厚の NACA632–615 です。両翼型の比較図を下に示します。



図面4 翼型比較

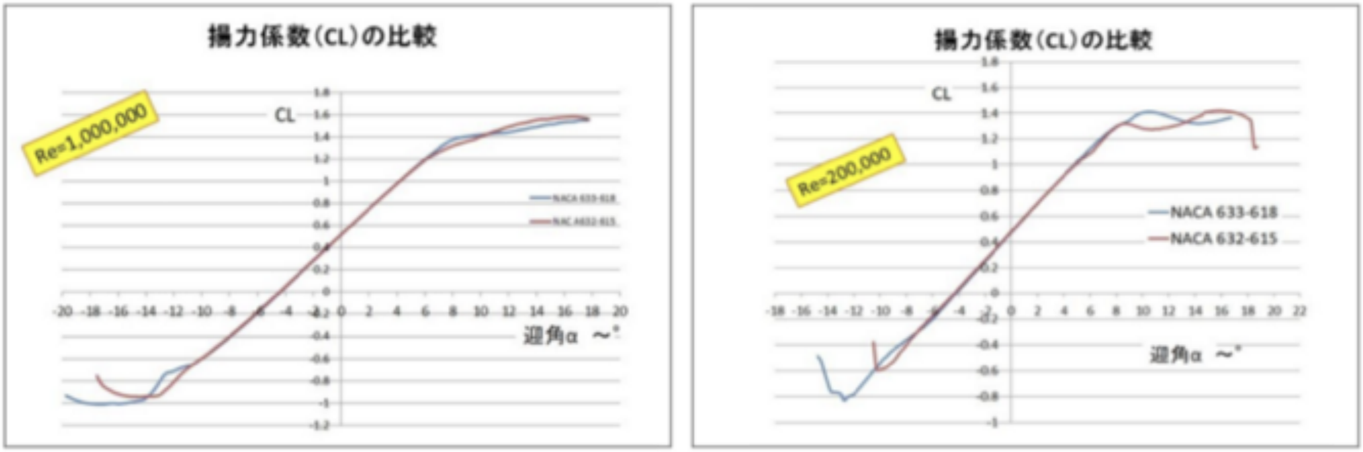
断面が見えない状態ではシルエット的に殆ど違いが判らないと思います。

次に、両翼型の空力性能を比較します。手元にあったデータはレイノルズ数 100 万と 20 万ですので、100 万を実機レイノルズ数、20 万を 1/3 模型レイノルズ数として見ます。まずは抵抗係数の比較です。



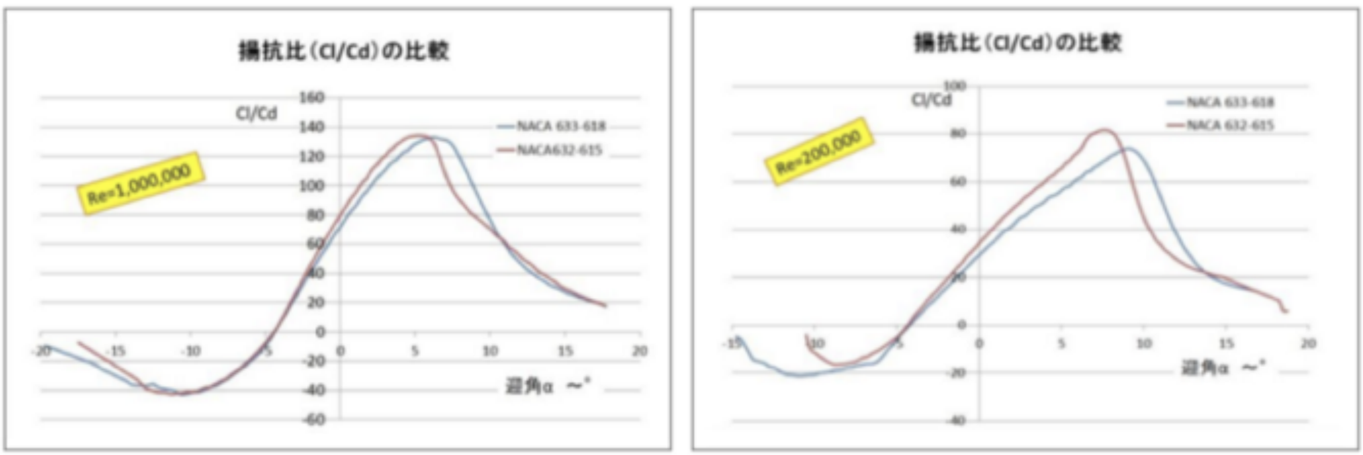
グラフ1 両翼型の抵抗係数比較

レイノルズ数が 100 万の時の両翼型の抵抗係数はほぼ同じで、迎角が-4°~+6°程度の間は Cd=0.007 程 度の非常に小さい値を保ちます。一方模型レイノルズ数の Re=20 万では、実機翼型の 633–618 は抵抗係 数の低い迎角の範囲でもその値は 0.016~0.018 と Re=100 万の場合の倍以上に増えます。一方 632–615 は 0.014~0.015 と倍増で済みます。



グラフ2 両翼型の揚力係数比較

このことからグライダーにとって重要な揚力と抗力の比である揚抗比(CL/Cd)は次のようになります。



グラフ3 両翼型の揚抗係数比較

Re=100 万では両翼型の揚抗比はほぼ同等で、最大揚抗比は 130 超が実現されますが Re=20 万では抵抗係 数の違いから、迎角 7.5°付近の失 角までは明らかに 632–615 の方が優れた特性を示します。最大揚抗 比も 632–615 は 81.6、633–618 は 72.2 と、前者が約 13%程優れます。

以上のことから、実機のレイノルズ数では 18%翼型と 15%翼型の性能に差は殆ど無いことが判りまし た。厚翼にするほど構 的には強度、剛性を確保し易くなりますから、実機が 18%翼型を採用した理由 は良く判ります。一方 1/3 模型では最大揚抗比が実機の 72.2/132=0.55 と激減しますから、少しでも滑 空性能の劣化を食い止めるために、15%翼型を採用することに

しました。

基本構想その5 目標重量

基本構想の最後の項目として目標重量を定めました。方法は実機と手持ちの 1/5 模型の重量データから 1/3 模型の重量を推測して設定することにしました。

二乗三乗則

実機の世界では新規の機体を開発する場合、まだ色々なことが決まっていない計画の極初期段階でその 重量を予測するのに、「二乗三乗則」と言う法則を用いて推測することがあります。これは、重量が既知 の似たような形状の機体のデータから新規の機体の重量を推算するのに当たり、面積は大きさの比(寸 法比)の二乗に、重量は三乗に比例するとして推測する方法です。例えば似たような機体の半分の大き さの機体の翼面積は 1/2×1/2=1/4 に、重量は 1/2×1/2×1/2=1/8 になるということです。

面積が 1/4 になることは当然ですが、重量が 1/8 になるということは次のように仮定していることにな ります。即ち、重量は体積に材料密度を掛けたものですが、半分の 1/2 に小さくした機体の全ての構 や搭載物は同じ材料と構 様式で作られ材料密度も変わらない。ただ寸法(長さ、幅、厚さ)はそれぞ れ半分で、体積が 1/2×1/2×1/2=1/8 に小さくなる、と想定している訳です。

最初はこの二乗三乗則を出発点にして必要な修正を加えて、1/3 模型の重量を予測しました。

グライダーの重量推測の留意点

普通のプロペラ機模型の重量推算では空虚重量を推算すれば済みますが、スケールグライダーの場合は事情が異なります。三田式三型改 1 の空虚重量は 300Kg ですが、搭乗員の乗っていない空虚重量状態 では重心が後方過ぎで、当然そのままでは RC 装置を搭載した無人機としても飛行できません。2 人搭乗 した最大全備重量は 450Kg ですから、実に空虚重量の半分もの重

量(ペイロード)を搭載して重心が合 うという状況です。従って、模型グライダーの重量を推算するには空虚重量とペイロードの両者を考え る必要があります。

私の作る模型グライダーは全て機首にモーターと折りペラを装着します。これは平地でも気軽に飛行を 楽しむためです。当然実機に無いこのような装置の重量はペイロード扱いです。そこで模型グライダー に搭載する装備品の重量区分を以下のように考えました。

ペイロード扱い	モーター、折りペラ&ハブ、動力用LiPo、アンプ、受信機、受信機用電源&S/W
空虚重量扱い	サーボ、サーボ用延長コード

サーボと延長コードを空虚重量扱いにしたのは実機でも操縦系統のリンクやケーブルが空虚重量に含ま れるからです。

実機と 1/5 模型の重量データ

因みに実機と手元にある 1/5 模型の空虚重量とペイロード重量を比較すると次のようになります。

	実機	1/5 模型
空虚重量	300Kg	2.10Kg
ペイロード	最大 150Kg	0.665Kg
飛行重量	最大 450Kg	2.77Kg

実機と 1/5 模型では材料も構 様式も異なりますが、強引に実機に二乗三乗則を適用してみますと、

1/5 模型予測空虚重量=300×1/5×1/5×1/5=2.40Kg

最大ペイロード=150×1/5×1/5×1/5=1.20Kg

強引な法則適用ではありますが、空虚重量は意外なほど実測重量の 2.10Kg に近いのに驚かされます。実 際の模型の空虚重量は予測値の

2.10/2.40×100=87.5%で仕上がっています。ペイロードが最大ペイロ ード予測値の半分強で済んでいるのは重たいモーターが機首に搭載されているためです。この状態で追 加おもり無しで重心が合います。

1/3 模型の予想重量(当初)

当初この二乗三乗則を用いて 1/3 模型の重量を次のように予想しました。

1. 空虚重量

実機データから予想すると	300Kg×1/3×1/3×1/3=11.11Kg
実機と模型の構 や材料の違いを考えて 1/5 模型の実績に合わせて上の予想値の 87.5%とすると、	11.11×0.875=9.72Kg
1/5 模型から予想すると	2.10Kg×5/3×5/3×5/3=9.72Kg
当然両推定値は同じ値になります。	

2. ペイロード

錘が無い状態のペイロードは 1/5 模型の実績値から推定して 0.665Kg×5/3×5/3×5/3=3.08Kg

最大ペイロードは実機と同じように空虚重量の半分とすると、9.72Kg×0.5=4.86Kg

以上から飛行重量は次のようになります。

錘のないノーマル飛行時	9.72+3.08=12.80Kg
錘を積んだ最大全	9.72+4.86=14.58Kg

1/3 模型の修正予想重量(目標重量)

当初は上のように重量予測して設計を進めていましたがその過程で次のことに気が付きました。翼の図面を書き進めると 1/3 模型と 1/5 模型で材料の板厚は左程違いを付ける必要がありません。リブやプ ランク等 1/5 模型とほぼ同じ 2 乃至 3mm 厚のバルサ材で済みます。比較的重量を食う被覆材も 1/5 模型 と同じオラテックスにする予定ですので、厚さは同じです。つまり、これらの重量は寸法の三乗では無 く二乗で増えます。

また桁は 1/5 模型ではヒノキ角材ですが、1/3 模型ではカーボン角柱にする計画にしましたので軽くなります。更に 1/5 模型のシナベニア組立に対してカーボンチューブ組立とします 1/3 模型の胴体構 も、 どうも三乗則程重量は増えないと思われます。

以上のことから 1/3 模型の重量は 1/5 模型にスケール比の二乗を乗じて推定することに修正しました。 1/5 模型の主要構成部の重量データがありますので、これを用いて 1/3 模型の主要構成部の重量を二乗則 で推定したのが下の値です。

	1/5 実績重量	1/3 推定重量
左外翼(エルロンサーボ込)	242g	672g
右外翼(同上)	244g	678g
中央翼(スポイラーサーボ込)	585g	1,625g
胴体(尾翼&それ用サーボ込)	1,029g	2,858g
合計(空虚重量)	2,100g	5,833g
ペイロード(モーター、LiPo 等)	665g	1,847g
再計(ノーマル飛行重量)	2,765g	7,680g
最大全備重量(空虚重量×1.5)		8,750g

端数処理をして 1/3 三田式三型改 1 の目標重量を次のように定めました。

	目標重量
左外翼	700g
右外翼	700g
中央翼	1,600g
胴体	2,800g
空虚重量	5,800g
ペイロード	1,800g
ノーマル飛行重量	7,600g
最大全備重量	8,700g

> *失敗1 後で示しますように残念ながら完成重量は約10Kgに達してしまいました。1/5模型には無か った主翼補助桁の設置や装備品(脚ダンパー、計器盤、座席、曳航索リリース機構、エルロンフラッ ター防止錘、翼端車輪等)の装着、材料変更(桁ウエブのシナベニア化等)等が原因です。*

> *この手痛い失敗から、3面図程度の情報しか得られない初期段階で精度良く模型飛行機の出来上がり 重量を推定する方法の開発が必要と痛感しました。*
>
> *その後手持ちの機体十数機のデータを用いて、RC 飛行機の重量推定式を下記のように開発しました。*

$$W=2,151L^{-0.11400}b^{-0.76204}S^{1.75388}$$

ここに、

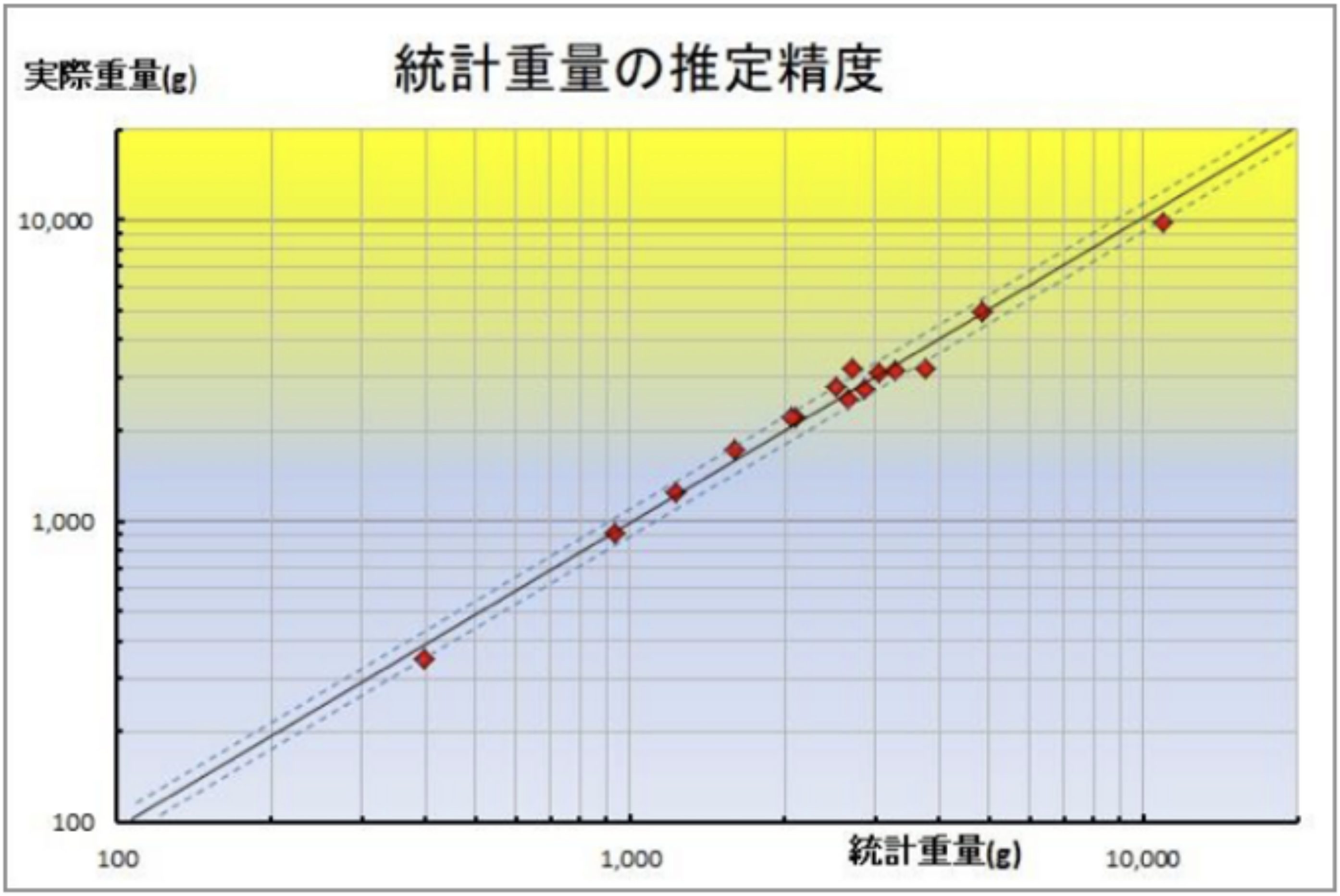
L：胴体長(mm)

b：翼幅(mm)

S：主翼面積(dm^2)

W：全備重量(g)

> *この統計式はラジコン飛行機の全備重量(動力用 LiPo を含む飛行重量)を平均誤差 8.7%で推定します。*

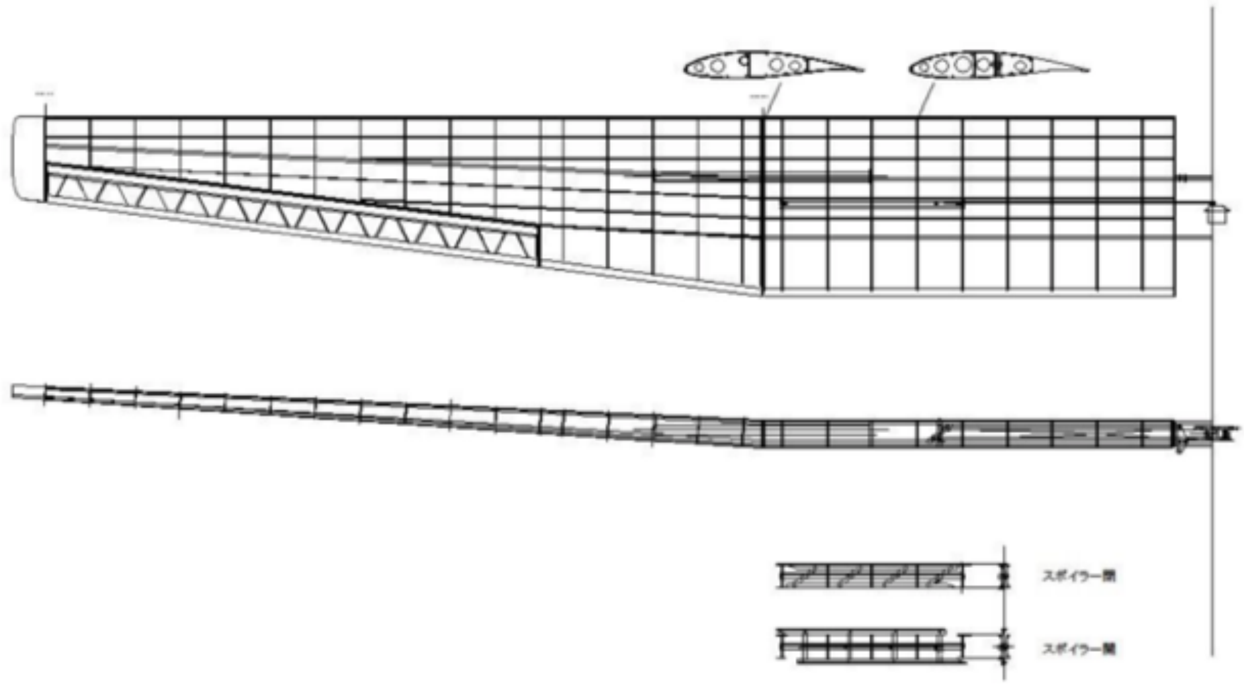


設計製作開始

基本構想も固まっていよいよ実際の詳細設計と製作段階です。

主翼の構造

図面 5 が設計した 1/3 模型の主翼構 造図です。



図面5 主翼構造図面

主翼は中央翼と外翼で構成され、両者は外径 20Φ、内径 16Φ、長さ 480 mmのカーボンパイプ製カンザシ で結ばれます。両翼のカンザシ受けは肉厚 0.5 mmの薄いアルミチューブです。当初、アルミチューブは 1 mm肉厚のものしか見つからずそれを購入して作業を進めていましたが、私の工作室を見回していたらラ ジコンヘリのテールブームの予備部品が目につきました。内径を図ってみたらピッタリ 20Φ!。おまけ に肉厚も 0.5 mmで、カンザシ受けに最適です。これで重量が半分になりました。

主桁は前縁から約 35%の一番翼厚の厚いところに通します。中央翼は 6×4(外径 6 mm角で内側にΦ4mm の空洞)のカーボン角パイプをフランジとし、1.6tのシナベニアのウエブで作る桁で、外翼はフランジ を 5×4 のカーボン角パイプとしました。この桁が曲げ荷重の大半を受け持ちます。強度計算(P22)で はもっと細いカーボンパイプでも持つことが判ったのですが、剛性を確保するために若干太めのパイプ を採用しました。

前縁から約 67%翼弦長の位置には補助桁が走ります。構 は主桁と同じですが、フランジを若干細くし て中央翼で 5×4、外翼で 4×2.8 のカーボン角パイプです。この補助桁は主桁と対になって主翼のねじり 荷重を胴体に伝えます。補助桁より前方部分は 2tバルサで全面プランクしてねじり剛性を確保し

ます。

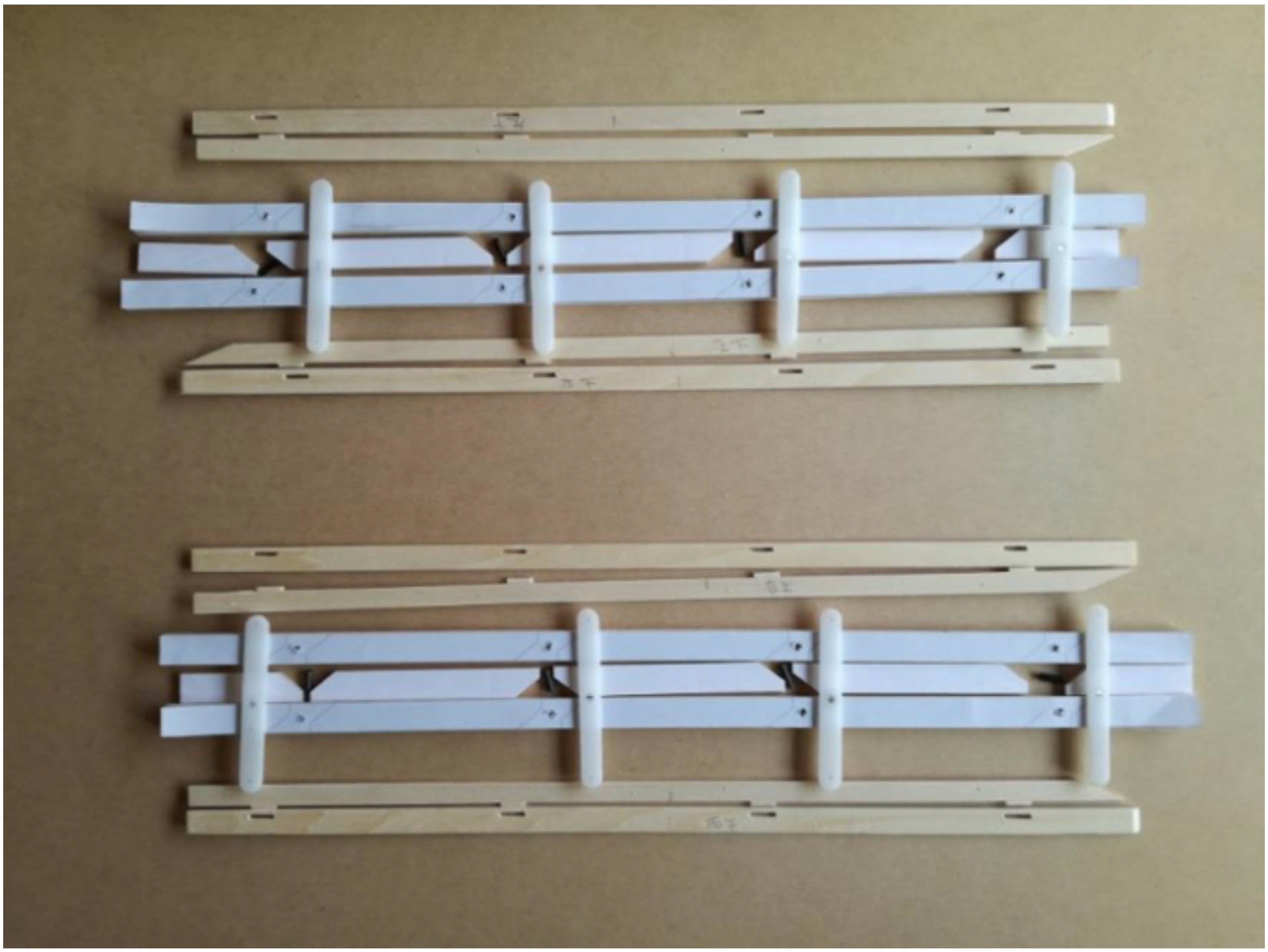
リブ間隔が 100 mmとやや広いのでプランク材のペコ対策として、前縁から主桁の間に上面 2 本、下面 2 本の計 4 本、主桁と補助桁の間に同じく計 4 本のストリンガーを通して、プランク材の剛性を上げてい ます。ストリンガーは 2×5 のバルサ角材です。実機ではストリンガーでは無く、前縁と主桁の間のリブ 間に補助リブを配置して、前縁付近の重要な翼形状を保っています。私がこの方法を採用しなかった理由は以前製作した機体で補助リブを付けたことがあるのですが、主桁と前縁の短い距離の中で正確に補 助リブの位置決めをすることが難しく、主リブとの翼上面の並行度の確保に苦労したことがあるからで す。位置決め治具を設けない限り正確に補助リブを配置することは難しいです。リブは中央翼の大半が 3 tのバルサ、外翼は 3tと 2.5tのバルサ製です。両翼の合わせ面には 2tのハードバルサ製、中央翼最内側のリブには 1.6tのシナベニア製保護リブを貼りつけます。

外翼はテーパーしているためリブは外に行くほど小さくなります。当初 CAD だからこれは簡単に比例作 図できるとたかをくくっていましたが、いざ実際に作図すると面倒なことに気が付きました。理論翼型 は後縁が尖っていますが、そのままでは模型をぶつけたら簡単に凹んでしまいますので、2mm 程の厚みを 持たせる必要があります。この厚さは、テーパーに関係せず一定でなければなりません。つまり、翼型 の修正はリブ一枚一枚に施す必要があります。

更に、外翼には1°の捩じり下げを設けました。実機の捩じり下げの大きさが不明なので取り敢えず設 定した角度です。リブの配置をこの捩じり下げに従って徐々に捩じっていかなければなりませんが、厄 介なのは桁です。桁をリブと同時に捩じってしまうとカーボンパイプ製のフランジが捩じられることに なります。カーボンパイプは捩じり剛性が高いので、これでは組立完了後に治具から外すと、捩じり戻 って翼が歪んでしまうことが予想されます。それを避ける為にリブ本体は徐々に捩じって配置しますが、 桁は捩じらない配置に設計する必要があり、結構な手間を求められました。何事も甘く見てはいけない と、反省しきりです。

製作その 1:スポイラー

2018 年 3 月末から図面が出来た部分から製作を開始しました。最初に製作に着手したのは中央翼です。これはテーパーの無い一定翼弦長なので製作が容易なことと、翼弦長 400mm、スパン 2,000mm という中央 翼が実際どのくらい大きいものか、実物で見てみたいと思ったからです。中央翼にはスポイラーが組み 込まれますので、まずスポイラーから製作を開始しました。下の写真は組立前のスポイラー部品です。



画像5 最初に製作に着手したスポイラー

スポイラーは中央翼の上下翼面に飛び出します。2mm 厚のアクリル製ステーの上下に 1.6mm シナベニアを T 型に組んだ抵抗板を取付け、ステーの中央を 4mm バルサ 2 本で挟んで全体をリンク式に動くようにしま した。上下各 2 本のシナベニアには切り込みと張り出しを設けて、T 型形状を作りやすくしています。2 本の 4mm バルサ棒の間にある斜めにカットした

短い棒は、4mm バルサ棒に挟んで接着し、スポイラーの作 動範囲を規定するものです。尚、このスポイラーは 2 本の両引きワイヤーを一番内側のステーに取り付 けてサーボで作動することにしました。

> *失敗2 実は簡単な構造 なので甘く見て早 速失敗しました。組み上がったスポイラーを手で動かしてみ たのですが、キチット設計通りの高さに収納されません。このままでは収納状態でも翼の上下面に若 干とび出してしまいます。修正しようにも構 造上手が入りません。*

不具合の原因を当たっているうちに気が着きました。アクリルステーの製作過程でその幅の寸法精度が コンマ数ミリ甘かったのです。このスポイラーの作動範囲は斜めにカットしたバルサの短い棒とアクリ ルステーとの接触によって決まります。バルサ短棒は正確に一発で切出せましたが、アクリルステーは 材料の性質上少し大きめに切出してからやすりで削って寸法を整えることになります。このやすりで削 る段階で図面寸法より若干大き目で終了した為に、図面より少ない角度で斜めにカットしたバルサ短棒 に接触してしまい、キチット収納できないことになったのです。

自分で図面を書いていながらお恥ずかし不始末でした。結局スポイラーは作り直しました。

> *失敗3 尚、このスポイラーの設計が本機開発で最大の失敗であったことが完成後の飛行試験で判明し ました。それはスポイラーの飛び出し量が不足したのです。*

私はスポイラーが翼表面から少しでも飛び出せば、空気の流れが乱されて主翼の抵抗が大幅に増加し、 スポイラー効果が発揮できるものと考えていました。その為飛び出し量を余り気にせず、実機の飛び出 し量を測定することもしないで、適当に決めた 12 mm弱の飛び出し量で設計してしまいました。 実はスポイラーは主翼の抵抗を増すだけではなく、自身も抵抗版となってブレーキ効果を発揮して機 を減 させる機能があることを後で知ったのです。その為にはスポイラーを翼面から大きく飛び出して 境界層の外に出す必要があります。私の設計したスポイラーは主翼の抵抗増加で降下角調整には良く効 きますが、飛び出し量不足のためにブレーキ効果が悪く、着陸

度のコントロール能力が不足と判明し ました。

本機の完成後に実機を所有されていた K 氏にお披露目した際にも早 スポイラー飛び出し量の不足を指 摘されました。倍程度の飛び出しにすべきであったと後悔していますが後の祭りです。

> *教訓1 自己の思い込みを排除して、知識不足の場合は調査を徹底すること。*

Contour Gauge

The shape of things to come?

Tom Broeski

Assembled contour gauge ready to use.

I needed a contour gauge a bit deeper than what is available (for a reasonable price) at Home Depot, Walmart or Harbor Freight. Most have a measuring depth of around 2". Soooo...I made exactly what I needed.

Photos 1 and 2: The part required and the configuration of the strips used to hold the sticks.

Materials

- A bunch of sticks.
- (2) 1 inch to 1.5 inch x 1/4 inch strips. Whatever length you want the gauge to be.
- (2) Machine screws with nuts.
- (2) Plastic tubing cut to width of sticks. These slip over the screws, but are not needed for skewers or small sticks.

Photos 4 and 5: Just one potential use of the finished contour gauge in use.

You can use skewers, popsicle sticks, stirring sticks, tongue depressors, etc. I found that tongue depressors are thinner than popsicle sticks, so decided they would be best for my application. I use it mostly for woodturning, but figured it would come in handy for copying other profiles.

Just cut your strips to length, drill holes for the screws, add the tubes and screw together. Then you can stack your sticks in and adjust the tightness. You want it loose enough that the sticks will move, but not so loose that they fall out.

Photo 6: That wing saddle is going to fit absolutely perfectly.

Need to get the airfoil shape for a specific part of a wing? Not many other ways to do it. The thinner the sticks, the smoother the contour. Really nice if you need to get the shape of a rib for a built up plane when you don't want to rip the wing apart or don't have the plans.

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

A Torrey Pines Puzzle

Never miss an opportunity to ask your folks a question.

[Terence C. Gannon]

One of the four tantalizing clues that Dad left behind. (image: Dr. R. Patrick Gannon)

My father was an institutional physician, which is to say that while our family never lacked for any necessity, we were in no way wealthy. Dad prized time with his family above all else and he was going to be damned if some high paying, private practice position was going to keep him from that. He made professional choices in the 1950s which would look positively modern in the 2020s. I'm eternally grateful to Dad for that because it meant that I, along with my mother, brother and sister, got the lion's share of Dad's attention over the decades we shared here on this planet.

“the magnificent Torrey Pines bluff which tumbles down to the sea” (image: Dr. R. Patrick Gannon)

The one exception to Dad’s ‘family first, everything else tied for last’ life philosophy was the very occasional professional requirement to attend medical conferences. Remember those? When a bunch of people got together in the same room at the same time separated by way less than the now normal two metres? Yep, Dad would head off on his own to some exotic location for a couple of days to attend what we call today a face-to-face. He would complain about it a lot before he left, but I have a suspicion that he actually enjoyed those trips, particularly when the destination was somewhere he really wanted to go.

Dad wound up in San Diego at one of these conferences in the early 1970s — that is, judging from the mud-brown Pinto he rented. Undoubtedly inspired by its cameo in Disney's *The Boy Who Flew With Condors*, he must have ditched one of the scintillating but undoubtedly stuffy seminars on noise-induced hearing loss (yes, that was his specialty). In his suddenly free afternoon, he must have then sneaked out to Torrey Pines to indulge his intrinsic passion for all things that fly — particularly those without a motor. How do I know that, for absolutely sure? In a recently resurfaced family photo album, four tantalizing clues emerged: four pictures Dad had obviously taken when he was there.

If you look closely, you can clearly see the cylinder of the engine, but no prop. (image: Dr. R. Patrick Gannon)

Looking at the photos, I began to remember him telling the story of the sole occupant above the magnificent Torrey Pines bluff which tumbles down to the sea. It was an old timer, a description which applied equally and aptly to both the pilot and the plane. Dad, who loved to chat with people he found interesting, most certainly would have struck up a conversation with the gentleman while he improbably removed the prop from his gas-powered model. Yes, it turns out the old guy's plan was that lacking a true glider, he was prepared to turn the one plane he had on hand into one. There is photographic evidence to indicate that the 'glider' must have done pretty well.

"photographic evidence to indicate that the 'glider' must have done pretty well" (image: Dr. R. Patrick Gannon)

If you have made it this far, there's a question I want to ask you, dear reader, particular if you are local to Torrey Pines: do you remember this elderly gentleman and his equally elderly model? If so, is there anything you can tell me about him? I would love to know. I'm pretty sure Dad would have extracted all of those details at the time but, sadly, with Dad's passing a couple of years ago, I'll never know for sure. For reasons I am not able to fully explain — which is to say, I don't understand why it matters but it does — I would really like to know.

I know somewhere Dad is looking down from that amazing thermal he caught on his way out of here, and laughing a little at the little puzzle he left behind, and shaking his head a little that I didn't think to ask when he was still here.

Miss ya', Dad.

Know something about the elderly gentleman and his plane? Write a response to this article and let the world know! Or, maybe considering writing a brand new followup article. Or, if you prefer read the ***next article*** *in this issue, return to the* ***previous article*** *or go to the* ***table of contents***.

Thanks to Hedy Lamarr

Inspiration and innovation in the Golden Age of Hollywood.

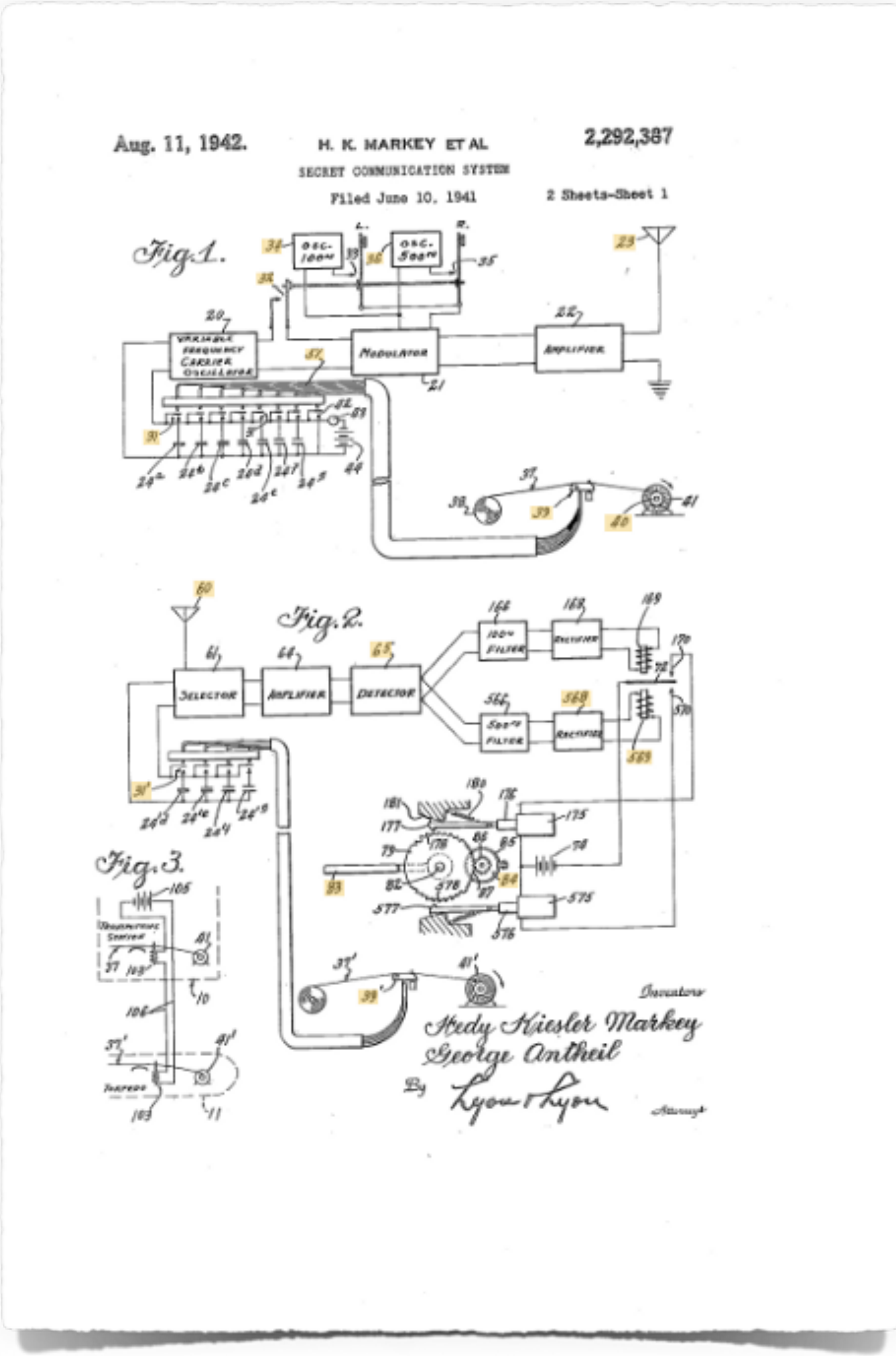
Peter Scott

Promotional photo of Hedy Lamarr from the 1944 MGM film '*The Heavenly Body*'. (image:)

On my transmitter I have put a printed strip saying 'Thanks to Hedy Lamarr'. For those who don't know the reason I thought it would be good to describe this remarkable woman.

Born Hedwig Keisler in Vienna in 1914, she made a name as a beautiful and talented film and stage actor. In the late 1930s, she fled an oppressive husband and, having a Jewish background, the Nazis, ending in the US.

But that isn't why her name is on my transmitter. She was also an inventor. She worked with Howard Hughes and suggested he change the shape of his aircraft from square to a more rounded streamline shape. However it isn't aviation that put her on my transmitter either.



Hughes was so impressed by her talent that he gave her a team of scientists and engineers and free rein to do what she wanted. During World War Two a new generation of radio controlled torpedoes was being developed, but the Germans found that they could jam the signals. Lamarr devised a system for changing transmitter frequencies using a device based on a piano roll player that she patented in 1942 (US Patent 2,292,387). The system became known as frequency hopping.

As is so often the case, establishments, in this case the US Navy, are resistant to ideas from outside and did not take it up until the early 1960's. Her achievement was eventually recognised in 2014 when she was inducted, after her death, into the US National Inventors Hall of Fame.

Frequency hopping allows transmitter and receiver to switch frequencies when connection is lost due to interference or a block. This is why we never worry about switching our transmitters on when others are flying. Ours will simply not connect using frequencies currently in use.

For those who have never used 27, 35, 53 and 72 MHz equipment, the large frequency channel board sometimes found on a flying field will be a mystery. Switching on your transmitter without checking whether someone else was already on your frequency was the greatest crime. Transmitters were often kept in a pound. Each frequency had a colour. You put a coloured ribbon on your transmitter aerial and had to register that you were using that frequency on the board. You could change frequency by changing crystals in the transmitter and the receiver.

Want to hear Hedy Lemarr in her own words? Here's the trailer for Zeitgeist Films' 2017 film 'Bombshell: The Hedy Lamarr Story'

Frequency hopping goes by a number of names depending on the manufacturer, most centring on FHSS (Frequency Hopping Spread Spectrum). FrSky calls its version ACCST (Advanced Continuous Channel Shifting Technology). Hitec is AFHSS (Advanced FHSS). Futaba has FAAST (Futaba Advanced Spread Spectrum Technology). Multiplex has M-LINK which is FHSS. In the European Union all systems must also check for a clear frequency before transmitting using LBT (Listen Before Talk/Transmit). The technology is also found in Bluetooth connections and many other radio-based wireless networks.

And all ‘Thanks to Hedy Lamarr’.

Read the **next article** in this issue, return to the **previous article** or go to the **table of contents**.

The Trailing Edge

Some timely thoughts as March turns into April.

The NEW RC Soaring Digest Staff

1/4.5 scale, 4m wingspan ASH26 from F. Deffner in Germany. It's perched on a slope in the Lavaux area above Lake Geneva. (image: Alexandre Mittaz)

We strive very hard to keep RCSD a COVID free zone. Don't get us wrong — it's one of the defining moments of our collective lifetimes — but we're also quite sure that you're getting all the information you need from sources much better than us. So that's the last we'll mention it. That is, other than with at least some vaccine-enabled relief in site, the various restrictions which have been in place around the world are either beginning to ease off, or will be in the predictable future. Without for a moment forgetting the tragedy which has befallen so many and the attendant, incalculable loss to their friends and family, the end finally being in sight is wonderful news for all of us. It also means...**time to get outside and fly!**

This one minute video shows how to make RCSD available for offline reading — yes, you can still enjoy RCSD even when travelling where the internet **isn't**.

More than ever, some fresh air and camaraderie is just what the doctor ordered and we're fortunate to participate in an activity which promises both. The slope or field awaits. But that doesn't mean you have to leave RCSD behind in the shop. Did you know you can take it with you and enjoy RCSD offline as this short video illustrates?

The beautiful image for *The Trailing Edge* this month is provided by Alexandre Mittaz. If that name rings a bell it's because Alexandre also provided the magnificent 'Springtime in Switzerland' photo which graced our March cover. We'll let Alexandre tell the rest of the story:

"*The picture was taken on Sunday the 7th of February, 2021 a few moments before sunset. The slope is located in the Lavaux area, above Lake Geneva (or Lac Léman as we say it in French). The model is a 1/4.5 scale, 4m wingspan ASH26 from F. Deffner in Germany. Deffner is well known for his 6m DuoDiscus, now produced by RC Flight Academy. He makes these from his private molds. Flying weight is about 4.7kg unballasted, around 6kg* *ballasted with a steel joiner. Airfoil is HQ DS, layup full carbon Hardshell wings. Great model, very fast in high dives, a pleasure to pilot and to watch."* Thanks, Alexandre, it's a great photo and an inspiring story to go with it.

Heartfelt thanks all the contributors to this month's issue. Readers, please don't forget to add a few *Claps* for those stories you really enjoyed. Writing *Responses* to articles is also a great way to interact with the authors. And please consider contributing a story of your own — everybody has a least one ripping yarn to share, right? The May deadline is **2021–05–16** and it will be here before you know it.

Our Managing Editor Terence C. Gannon kicked off this issue talking about his aspiration to grow a global audience for RCSD. Another way of doing that is our *Events* page. You can find it right up there on the menu bar. Please add your event no matter where it might be here on Planet Earth. Just send us your details and we'll make sure your listing goes up promptly. We support new listings with our social platforms, so it will really help get the word out.

The RCSD Cover Photo T-Shirt for March is now available in the RCSD Store.

As always, we are obliged to peddle a little merch — it's one of the ways we use to help keep RCSD free for all. We have *RCSD Cover Photo T-Shirts* for January, February and now March on sale. The latter has that beautiful

‘Spring in Switzerland’ photo by Alexandre Mittaz mentioned above. All proceeds support the operating costs of RCSD. Don’t like black t-shirts? Let us know and we’ll create one you want in one of a range of colours almost bound to include your favourite.

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

That’s it for now — 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**.*