
Radio C■ntrolled
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The New RC Soaring Digest

June, 2023
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In the end, this is what it's all about: sand, surf, a sunny day, a steady breeze and a slope. This is my favourite place on Planet Earth. (credit: Michelle Klement)

In The Air

All (good?) things must come to an end.

Terence C. Gannon · Follow

Published in The New RC Soaring Digest

7 min read · 4 days ago

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It is with a mixture of regret and relief that after 30 issues of the New RC Soaring Digest, I announce this will be my last. I anticipate for the vast majority of you who truly enjoyed the monthly dose of commercial-free RC soaring journalism from around the globe, this will be disappointing news.

To anticipate and answer the question of “why now?” the most candid answer I can provide is that I actually intended to wind things up after a nice-and-tidy two years. But as a few trends seem to foreshadow better times ahead at that anniversary, I decided to extend my tenure on a month-to-month basis. As the subsequent issues rolled out, however, I began to realise the positive swings in the outlook were nothing more than statistical aberrations. Two-and-a-half years, therefore, overachieves on my original commitment I made to myself and my family of growing the then-nascent RCSD opportunity into something which pays something. *Anything.*

Alas, it has not. The sole revenue stream for the publication was The RCSD Shop. Instead of generating what even amounts to a slight offset in expenses, lack of sales meant the Shop actually lost money. Perhaps when I obliquely wrote — *ad nauseam* — about the need to make the New RCSD ‘sustainable’, I should have been a bit more on-the-nose. My work on the New RCSD needed to eventually pay.

There seems to be a sustained and widely held belief that everything on the internet should be free. And much of it *is* free and worth exactly what you paid for it — maybe less. That said, while the New RCSD is free to consume I can assure you that it’s not free to produce. I have 3,427.7 hours invested in the New RCSD to date which are a stark testimony to that fact. Plug in whatever number you think is fair pay for each hour and *that* is what the New RCSD cost to produce. Not free. Not even close.

Moreover, this doesn’t take into account the extensive time and effort of the many excellent contributors to the New RCSD. Neither is their time free and simply expecting them to do the work *pro bono* isn’t right or reasonable, either.

To say the New RCSD was a labour of love actually mischaracterises my involvement with the publication. While I certainly love reading, editing and writing about RC soaring I could not, when I started, and can’t now justify a project which demands so much time and yet for which there is no prospect of monetary compensation. I am not independently wealthy and even at 62 I feel I have some good earning years left in me. As the only income in our household, I need to get back to paying work to set our family up for true retirement which is still realistically too-many-to-contemplate years in the future.

Unfinished Business

In preparing this final issue I tried as much as possible to put the blinders on and think of it like any other issue. That is, other than this article and *The Trailing Edge* which winds things up — the last article ever.

What sharp-eyed readers will notice is that there are at least two excellent series — Tiberiu Atudorei's *Project ALTius* and Mike Goulette's *The History of Electric Flight* which are seemingly being abandoned in the middle of their respective runs. Although the final call will be up to Tiberiu and Mike — they're the ones doing most of the work — I pledge that if they write their articles I will make sure they get the same treatment they always have and I will get them out to those who express a desire to read them. This only seems right.

To some degree the same could be said of Scott Manley's *Condor Corner*. However in this latter case, the original versions of these articles ran in the SSA's *Soaring* magazine just last year, and readers who are keen to finish Scott's series can continue with it using that publication's archives.

What the Future Holds

There are really two answers to this question. The first, of course, is what the future holds for the *RC Soaring Digest*. Frankly, I don't know. If somebody out there wants to pick up the mantle and run with it, that would be great. However at this time no such individual has been sought out and no one has stepped forward. If and when this occurs, then it stands to reason the publication of the new *New RC Soaring Digest* would re-commence at some indefinite point down the road. Any takers out there?

So far as the future for me? I also don't know. As I mentioned above, the priority has to be replacing non-paying hours with paying ones as fast as reasonably possible. But 'writers gotta write' so I suspect while that search is ongoing, I'll put pen-to-paper on whatever is on my mind at a given moment: aviation history and NBA basketball are subjects which are easy and fun. I also figure I have a screenplay or two in me and I might use whatever time is left over to scratch away at these. If anybody has a connection to Tom Hanks, by all means please hook me up — these stories would be right up his alley.

Finally, if I were ever to dip my toe into the monthly publication waters again — that's not *impossible* — it would come with non-negotiable rules forged in the fires of my recent experience: it would be a subscription-based publication and it would cater to a broader, more diverse audience. The latter is not some sort of nod to political correctness. Rather, it's motivated by pure economics. Publications need a certain critical mass to be sustainable — or, more on-the-nose — they must *pay* those who contribute to them. My subjective sense is that the RC soaring community alone simply does not have what it takes for such a publication.

Finally, Thanks

It's tempting to start naming names of those who have really gone above and beyond in their support of the New RCSD. But this runs the risk of missing somebody out and that I want to avoid at all cost. Suffice to say for all those who contributed stories, pictures, letters to the editor, insightful comments, likes and reposts on social and to all those who purchased something from the Shop, my heartfelt and humble thank you. The New RCSD simply would not have existed as long as it did without you. I truly hope we cross paths at some point down the road so I can thank you with a firm handshake and a pat on the shoulder.

Finally, I want to thank my wife Michelle from the bottom or my heart. You let me quixotically tilt at *yet another* windmill, patiently weathered the excruciating highs and lows of monthly deadlines and just generally put up with my shit through these last two-and-half-years. For this and so much more, I love you, always.

Fair winds and blue skies to each and every one of you.

Cover Photo

We end where we began. This month's cover was taken by Bob Hirsch in April of this year, who caught Aaron Smith Wallace and his classic *Aquila Grande* amongst the wild flowers atop everybody's bucket list soaring site, Torrey Pines. Aaron comments:

> *"So much rain this season brought out this huge bloom of flowers. Could not resist the chance to catch all the bright colors. We usually get some flowers at Torrey in the Spring but that was exceptional."*

Exceptional, indeed — and we're truly grateful California is finally getting some rain! Thanks for the opportunity to feature your great photo, Bob and Aaron.

You are welcome to download the June 2023 cover in a resolution suitable for computer monitor wallpaper. (**2560x1440**).

Disclaimer: *While all reasonable care is taken in the preparation of the contents of the New RC Soaring Digest, the publishers are not legally responsible for errors in its contents or for any loss arising from such errors, including loss resulting from the negligence of our staff or any of its contributors. Reliance placed upon the contents of the New RC Soaring Digest is solely at the readers' own risk.*

Here's the ***first article*** *in the June, 2023 issue. Or go to the* ***table of contents*** *for all the other great articles. A PDF version of this edition of* In The Air*, or the entire issue, is available* ***upon request****.*

The legendary New RC Soaring Digest glider stamp montage. Can you spot the new stamp added this month?

Letters to the Editor

An exciting new aircraft takes to the skies for the first time.

The New RC Soaring Digest Staff
Published in The New RC Soaring Digest
2 min read · 4 days ago

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I wanted to share a project that I have just maidened. This is a SZD-9 *Bocian* with a 4.5m wingspan which is very special, because it is dedicated to slope aerobatics. It is equipped with some unusual features to be able to perform both old-timer-slow-and-smooth trajectories and more aggressive tricks. It is an entirely wooden structure and I started working on it in 2019.

After the first flight, I still have some aspects to set up and more test flights. I would be very happy to share about all the passionate work I put into this project, in an upcoming issue of the New RCSD.

Stéphane Combet
France

She looks gorgeous, Stéphane, thanks so much for sending news of her first flight in to us. Good luck with the rest of the flight test program! — Ed.

*Read the **next article** in this issue, return to the **previous article** in this issue or go to the **table of contents**. A PDF version of this article, or the entire issue, is available **upon request**.*

The finished Gull airframe, ready for covering and finish.

The Kirby Gull

Fred Slingsby's gorgeous gull-wing at 1:3.9-scale.

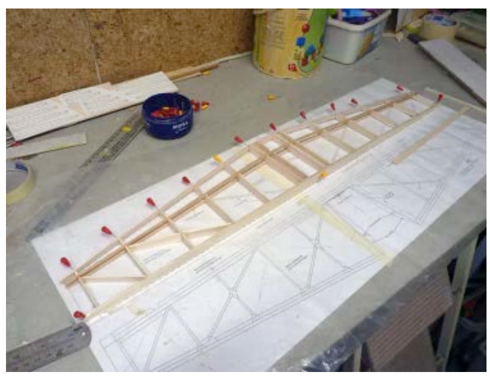
Chris Williams · Follow
Published in The New RC Soaring Digest
4 min read · May 25

This is my second foray into the world of the Slingsby *Gull*, the previous being a much larger version of the *Gull 4* replica. I've kept pretty much to scale, other that the fact that the blue of the full-size is lighter than I have used, due to the fact that the film that covers the flying surfaces is available only in a limited range of colours.



Left: The basic structure of the first of the fuselage half-shells is where it begins. | **Centre**: The front half of the fuselage is planked with 1.5mm ply: tedious but strong! | **Right**: The second half is built over the first, making sure to keep it all straight.

Construction is Williams-conventional, with the fuselage being built in two halves before being clad in plywood.


Left: View of the tailplane mount. | **Centre**: Basic tailplane assembly. | **Right**: Inner fuselage structure completed, now for all the plywood skinning The temporary formers have yet to be removed.

The wings are built with my current format of using a relatively small main spar, which is tied together at the front with ply web plates, and then reinforced for a good part of the wing by dropping in an equally size sub spar, thus to form a very strong I-beam.

Left: The nose block is made up from polyester filler. | **Centre**: The front end complete and smoothed with filler The temporary formers will be removed and the interior glassed with wing joiner tape and polyester resin. | **Right**: The components of the joiner box for the fuselage.

The wings are in one piece, with the gull break being achieved by bending the 5mm by 5mm spruce spars over a simple jig.

Left: Tailplane complete. | **Centre**: First stages of the fin construction. | **Right**: Setting up the rudder cable guides before sheeting the rear of the fuselage.

The wing joiner box in the fuselage allows the 15mm steel bars to overlap each other to give the maximum depth and strength.

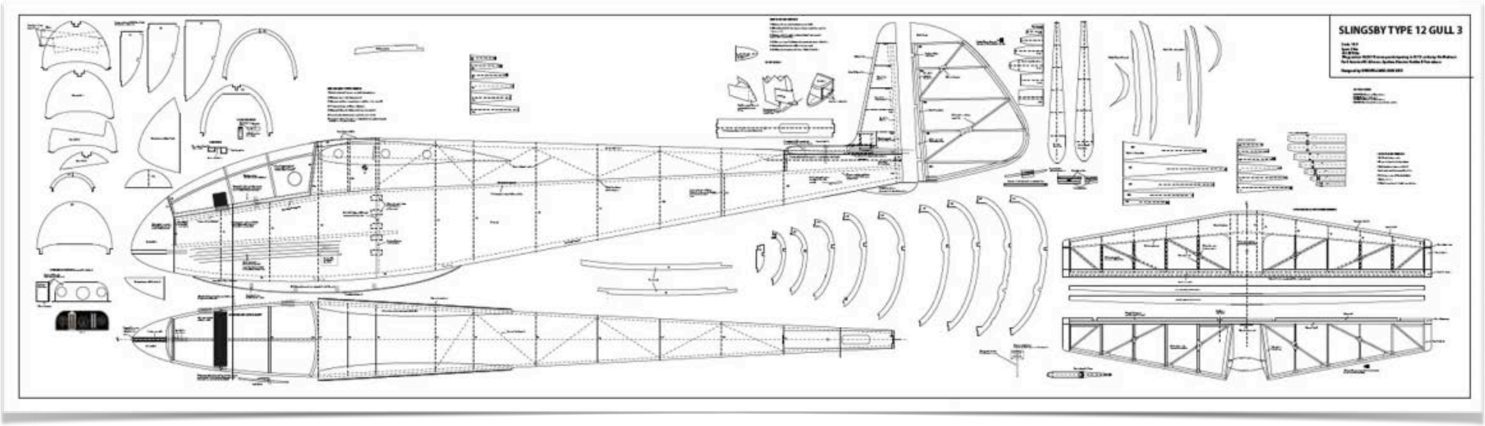
Left: he lower canopy frames are laminated against the fuselage sides to induce the necessary curve. | **Centre**: “Canopy frame completed. | **Right**: First stage of wing construction: the 5mm square main spar is bent over a jig to induce the gull shape.

The airfoil section is my standard HQ35/14 for the inner panel, transitioning to HQ35/12 out to the tip.

Left: Sixteen millimetre brass wing joiner boxes between the sub spars: on the other wing they are between the main spars to allow for the staggering of the joiner blades. | **Centre**: Sub spars added and the wing ready for sheeting. | **Right**: Setting up the wings to the fuselage.

Thanks very much for reading and if you have any questions, please don’t hesitate to leave then in the *Responses* section which you can access by clicking the little 💬 below.

Left: Smoothing the joins between wing and fuselage. | **Centre**: Job done! | **Right**: View of the completed tail group.



Good luck with your project and see you next time.

Resources

- ***Airborne with the Gull Replica*** on YouTube. — First flights with the *Kirby Gull* replica featured in this article.
- ***The Williams Anthology*** — The collected works of Chris Williams as found in the pages of the New RC Soaring Digest.

All images and videos by the author. Read the ***next article*** *in this issue, return to the* ***previous article*** *in this issue or go to the* ***table of contents****. A PDF version of this article, or the entire issue, is available* ***upon request****.*

June 2023 | Gliders | Model Aircraft | Hobbies And Interests | Scale Models

(credit: Sverrir Gunnlaugsson)

Iceland Open F3F 2023

Challenging, chilly conditions lead to a top five sweep by the British contingent.

Sverrir Gunnlaugsson · Follow

Published in The New RC Soaring Digest

5 min read · May 25

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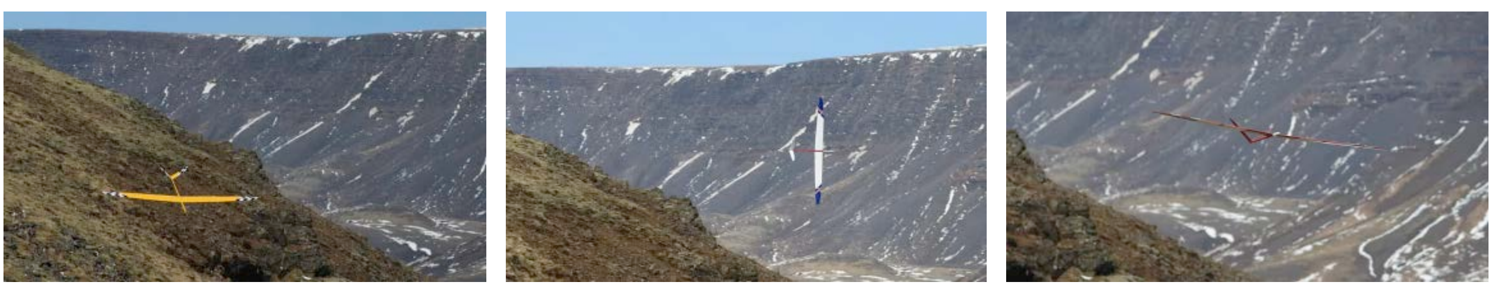
Saturday April 29, 2023 started off bright and early with blue skies and temperatures getting close to freezing but with the wind blowing straight on the slope in Helgafell. We were bothered in the beginning by a faulty audio jack on the CD's (contest director) computer but after finding out what the problem was we managed to 'hot fix' it so the rest of the day went by without too much trouble.

(credit: Magnús Kristinsson)

Due to that problem the first round took some time to finish with re-flights but later rounds were done much more quickly. We got two flights under 40 seconds with the fastest time of the day 38.41s — and the entire competition as it turns out— flown by Andy Burgoyne in Round 3. In the end we managed to fly seven rounds before the cutoff at 1700 hours. The evening was well spent fixing the audio jack on the CD computer.



(credit: Magnús Kristinsson)

Sunday the 30th also started off bright and blue but quite a bit warmer with temperatures around 5C. The wind was going strong on the slope and the first rounds went quite well. The fix to the audio jack worked very well and gave us no further problems. Rounds 8 and 9 went by quickly but as Round 10 progressed we started to see lower wind speeds and the flight times climbing up but thermals came by quite often. However, we managed to finish the round and after a briefing we moved up the lunchtime and waited to see if the wind would steady again.

(credit: Magnús Kristinsson)

After lunch it looked like the wind was picking up so Peter Gunning was sent off to start Round 11. As he was launched off the edge though, the wind died down and you could see him go down, down and down some more. Thanks to some good piloting on Peter's behalf he managed to stay up, finding a thermal and getting back to land after about four minutes. As the weather didn't seem to be picking up in the next hour we had a briefing and called it a day around 1400.

(credit: Sverrir Gunnlaugsson)

The forecast for Monday was highly variable with no wind from all directions — thanks Erik! — so early on in the morning we drove to Helgafell as that was the most likely spot based on the current measurements of the weather.

(credit: Sverrir Gunnlaugsson)

Lo and behold when we got there the wind was blowing straight on to the slope so our spirits were lifted quite literally by that. While setting up the course the pilots started showing up but the wind started shifting and dying down with lots of thermal activity. After waiting to see if it would pick up the CD decided to call it a day.

(credit: Sverrir Gunnlaugsson)

The awards were handed out at the bottom of the slope with the first place trophy going to England with John Phillips.

The globetrotters of this event were Tomas (Shao Yuan) Liu and Lu Hung Jen from Taiwan and Masanori Ichikawa from Japan — they endured a 40 hour trip to get halfway across the globe to fly with us!

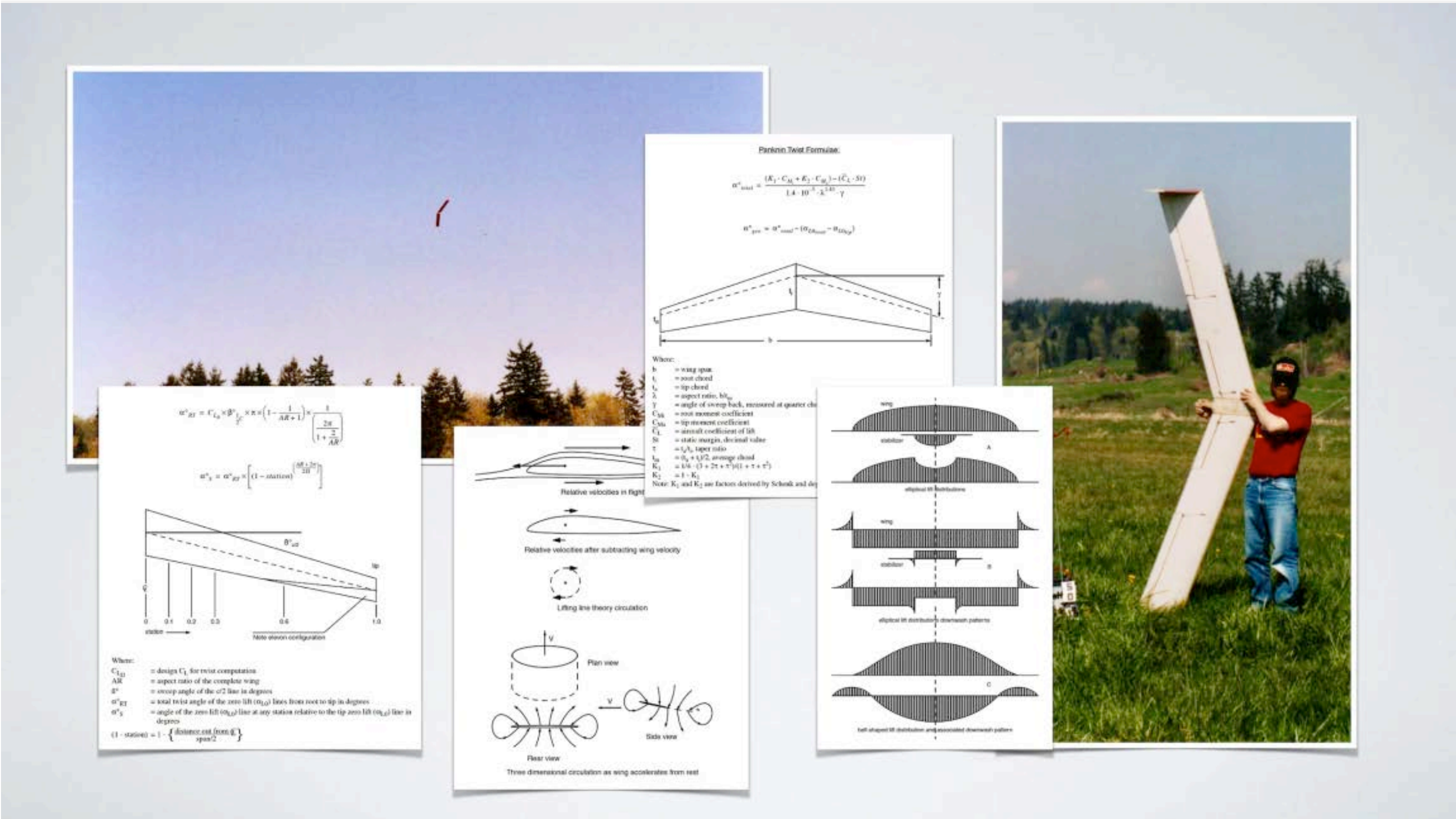
Thanks to all who attended the event in 2023 and hope to see you on an Icelandic slope in 2025!

(credit: Magnús Kristinsson)

Resources

- ***Iceland Open F3F 2023*** organizers official website. — This event is organised in conjunction with the *Flugmódelfélagið Þytur* (Tytur Aviation Model Association).
- ***Iceland Open F3F 2023*** on Facebook.
- ***Complete Competition Results*** as reported on *F3XVault*.
- ***Iceland Open F3F 2023 — The Slideshow*** on YouTube. — Lots more photos of the event plus a great soundtrack for your viewing pleasure!

*Read the **next article** in this issue, return to the **previous article** in this issue or go to the **table of contents**. A PDF version of this article, or the entire issue, is available **upon request**.*



Twist Distributions for Swept Wings

Part 5: A comparative look at the twist distributions formulated by Irv Culver and Walter Panknin along with a few final conclusions.

Bill Kuhlman · Follow

Published in The New RC Soaring Digest

11 min read · May 26

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Readers who have not already done so may want to read ***Parts 1 through 4*** *of this series before proceeding with this final part. — Ed.*

The "Middle Effect"

First, a small digression is necessary in order to understand one remaining concept, the “middle effect.” The Hortens’ later designs included geometric modifications aimed at reducing or eliminating the “middle effect.” Irv Culver’s twist distribution is specifically formulated to eliminate the reduction in lift near the center of a swept back wing. Interestingly, the Hortens and Culver are trying to counter two different phenomena.

As the wing moves through the air, the air coming off the trailing edge is deflected downward. This is called the downwash. As the air approaches the wing, it moves up slightly to meet the wing. This is called the upwash. We’ve already illustrated these two properties in previous portions of this article series, pointing out the angle of attack is directly related to the position of the stagnation point.

If you look at an airfoil traveling through the air, you’ll see that the air moving over the upper surface is moving faster than the wing is moving through the air. So too, the air along the lower surface is moving slower than the wing is moving through the air. From a vector mathematics perspective, if you subtract the velocity of the wing from the two air flows, the air over the upper surface is still moving from leading to trailing edge, but the air along the bottom of the wing is moving backward toward the leading edge. From this perspective, the air ‘circulates’ around the airfoil in a clockwise direction as a wing producing lift moves right to left. The coefficient of lift is directly proportional to this circulation. See Figure 1.

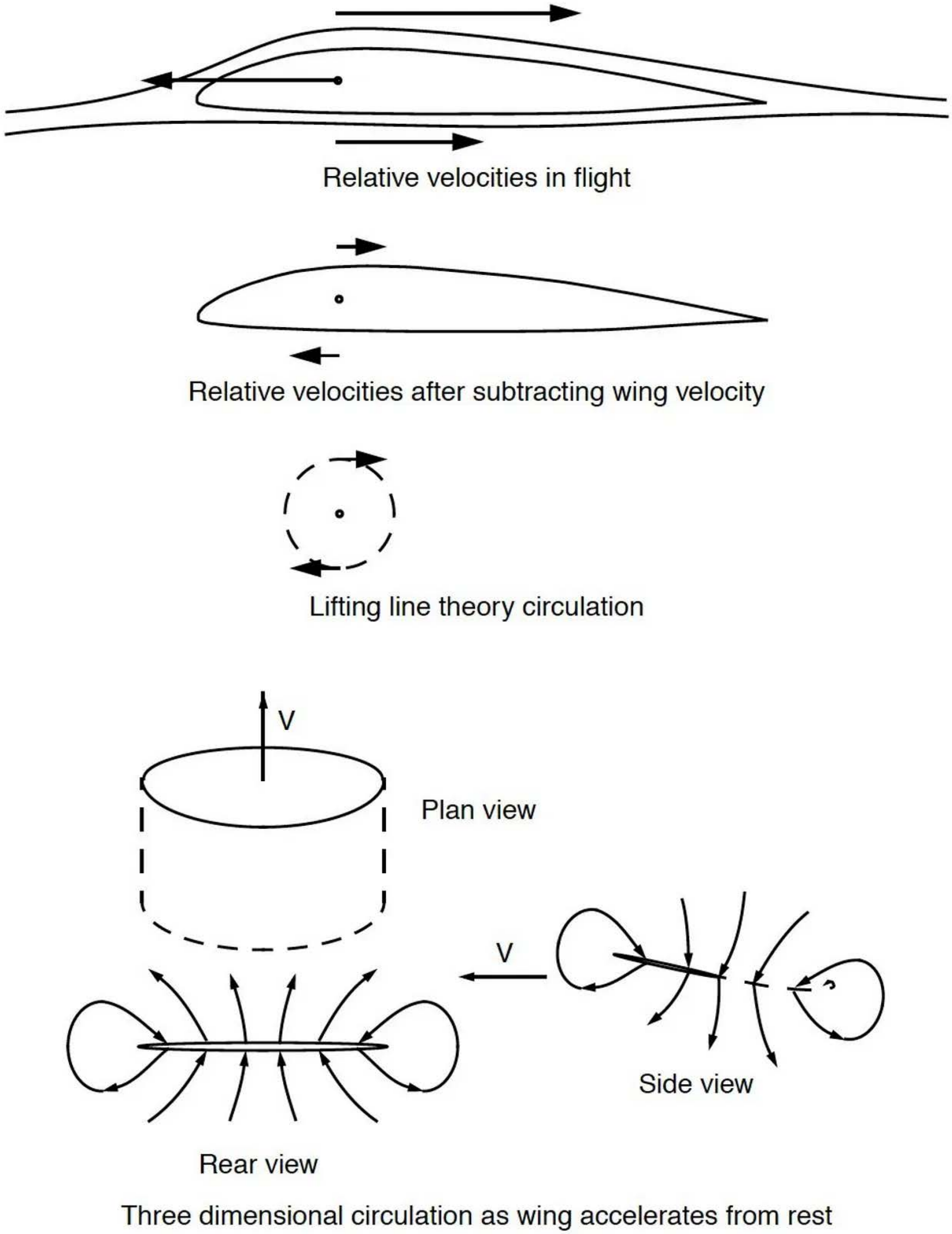

Relative velocities in flight
Relative velocities after subtracting wing velocity
Lifting line theory circulation
V
Plan view
V
Side view
Rear view
Three dimensional circulation as wing accelerates from rest

Figure 1

According to Prandtl's lifting line theory, you can visualize a wing moving through the air as simply a line connecting the two wing tips along the quarter chord line with horseshoe shaped vortices coming from it and extending back to infinity. In this model, both downwash and upwash are accounted for: the air inside the vortices is being deflected downward, and the air outside the vortices is being deflected upward. The actual lifting line calculations, however, are both complex and extensive. Schrenk expanded Prandtl's lifting line theory to include taper, twist and control deflections, but not sweep. Multhopp expanded this theoretical framework further, but still did not fully account for the effects of sweep.

A swept wing can be viewed as a series of connected small wings, the leading edge of each slightly behind the leading edge of its inboard partner and in front of the leading edge of its outboard partner. Each small wing has an effect on the air flow of both its inboard and outboard partner, but the effect on the outboard partner is very much greater than the effect on the inboard partner. The upwash is not equal along the span but rather tends to progressively increase over the more outboard segments. We've illustrated this concept in previous portions of this article series.

Schrenk's approximation does not accurately portray a swept wing, and therefore does not account for the loss of circulation and associated loss of lift at the root and the increase of circulation and associated increase of lift at the wing tips.

Multhopp's method of determining the lift distribution, which involves established "control points" based on "central difference angles," does not account for sweep either, but was used by the Hortens as the best available model at the time. The *H.II* was the first of the Horten aircraft to use a bell-shaped, $\sin^x$, lift distribution, an outgrowth of the Multhopp paradigm.

The "middle effect" which is so often talked about regarding the Horten designs is simply an artifact of this inability to accurately predict the sweep induced changes in circulation, specifically a loss of lift at the center. This middle effect is strictly an artifact of the computation methods and is an error in analysis. The "middle effect" is not the loss of lift in the center area of the wing, it's the unanticipated loss of lift in the center area of the wing.

Horten

The Hortens, in an effort to coordinate stalling behavior and center of gravity with other planform parameters, performed the necessary mathematical computations, but always found errors in their results. The aircraft did not behave exactly as predicted because the center of pressure was not at the location predicted. The Hortens believed the problem to be related to the intersection of the two quarter chord lines at the centerline, and envisioned colliding vortices. They constructed "bat tails" which substantially increased the root chord. Their intent in using the bat tail was to reorient the quarter chord lines of the two wings and eliminate the colliding vortices. On the *H.IV*, the quarter chord lines meet at right angles to the centerline, while on the *H.VI* the quarter chord lines actually bend backward. Despite these changes to the quarter chord line, the "middle effect" remained. Al Bowers has suggested that the Hortens might have realized they were looking in the wrong direction had they actually flown their Parabola design.

Despite their problems getting a handle on the "middle effect," the Horten twist distribution has the potential to reduce induced drag and allow turns to be accomplished without adverse yaw. But aircraft will operate as Dr. Horten envisioned only when all of the design parameters are utilized: moderate sweep angle, large taper ratio, carefully chosen airfoils (pitching moment), strong nonlinear twist distribution, bell-shaped span load (lift distribution), and outboard ailerons of defined size and configuration.

The Horten twist distribution is such that the wing twist is concentrated over the outer portion of the wing, in the area where the sweep generated upwash is greatest. Computing the twist distribution is a rather complicated affair, and we've been so far unable to obtain formulae of use to modelers. Mathematically inclined readers may be interested in Reinhold Stadler's paper, *Solutions for the Bell-Shaped Lift Distribution*.

Culver

Unfortunately, Irv Culver did not write a comprehensive treatise on his twist formula. Rather, his description of its use is sparse, and its derivation not explained in any detail. Still, it is possible to understand the general thoughts behind Culver's paradigm.

Although Culver did not specifically mention the "middle effect," he did realize that lift of a swept wing is depressed in the area of the root. To compensate, some amount of up trim is required of the outboard elevons, depressing the lift generated by that area of the wing as well. Performance is substantially reduced as a result. In Culver's view, the ideal is to make the center portion of the wing produce more lift and thereby allow the wing tips to create more lift. At the design coefficient of lift, the lift distribution is near elliptical.

Another digression: the most simple method of creating a twisted wing is to use a single foam core and root and tip templates. Twist is then imparted by setting the two templates at the appropriate angles relative to each other. Cutting with a tensioned hot wire always creates a wing with straight leading and trailing edges. This is quick and simple, but the angle of twist does not change consistently across the semi-span. Rather, the angle changes at a more rapid rate near the root for wings with no taper, and near the wing tip if the wing is moderately tapered. As Culver uses wings with moderate taper in an effort to better achieve an elliptical lift distribution, it is the latter situation which Culver wants to avoid.

In an effort to compensate for the loss of lift in the center area of a swept back wing, Culver proposes placing most of the twist in the inboard 30% of the semi-span, say eight degrees. Three more degrees of twist are then imparted in the outer 70% of the semi-span for a total of eleven degrees. The increased angle of attack at the root increases the lift in that area. This allows the up trim of the elevons to be reduced, increasing the lift in that area as well. The Culver twist therefore requires constructing the semi-span of a foam wing in two parts rather than as a single panel. As the sweep angle is increased, the Culver twist distribution calls for more twist. As the Culver twist distribution is aimed at maintaining an elliptical lift distribution at the design coefficient of lift, this is in keeping with the increased upwash which is anticipated will occur over the outer portion of the wing.

In flight, specially designed elevons are used to trim for low coefficients of lift. As the aircraft approaches a stall attitude, the root will stall first while the wing tips remain well below their stall angle. This makes a full stall across the entire span very unlikely.

There are a few limitations to the Culver twist distribution: it is accurate only for wings of modest sweep and taper, and the recommended design lift coefficient is very high compared with other methodologies, particularly that of Dr. Walter Panknin. Since the Culver twist distribution is based on maintaining a near elliptical lift distribution, adverse yaw may be noticeable, particularly around the design coefficient of lift.

There are reports stating that swept wing aircraft utilizing the Culver twist distribution are both spin-proof and tumble-proof, and there is also at least one report stating the Culver twist distribution was incorporated into the wings of a number of Boeing commercial aircraft. These reports have not been corroborated by secondary sources, and it should be noted that Boeing commercial aircraft are of conventional tailed configuration and utilize both roll spoilers and rudder to counter adverse yaw.

A six meter (236 inch) span swept wing model using an approximation of the Culver twist distribution was constructed in Germany in 1987. The Stromburg wing utilized the Eppler 220 for the outboard portion of the wing and the Eppler 210 at the root, and had a sweep angle of 28.5 degrees. The twist angle at the root was 11.5 degrees, going to zero degrees at station .167 and remaining at zero degrees to the wing tip. Elevons consisted of “Junkers Flaps” from station .833 outboard. This model performed extremely well, and was large enough to have a movie camera mounted at the CG and directed at the center section. Films taken during flight showed no air flow separation at the root during cruise, turning, high speed flight, or landing.

Panknin

Dr. Panknin derived his twist paradigm from a paper by Helmut Schenk. Using airfoil zero lift angles and pitching moments, span and chords, sweep angle and static margin, a pitch stable tailless aircraft can be assured. The method relies heavily on Multhopp's approximation of the lift distribution, but includes a correction by D. Kuechemann so that it has good accuracy for sweep values for zero to beyond 30 degrees. Schenk states the "middle effect" still exists using these calculations.

The Panknin methodology provides only the total twist required for longitudinal stability for a given monolithic wing with straight leading and trailing edges and a predetermined static margin. The computed twist values have been proven in practice to be extremely accurate for sweep angles of up to 30 degrees, tapered or constant chord wing.

Like the Culver formulae, the Panknin method lends itself quite easily to both custom written computer programs and commercially available spreadsheet software. In fact, a scientific calculator is sufficient when there are no time constraints. The defined twist angle can be used on a moderately tapered wing using the foam core construction method described previously, with straight leading and trailing edges from root to tip. Successful applications, however, include planforms with constant chord in which the twist begins at station 0.5, half the semi-span, placing more of the twist over the outboard portion of the wing.

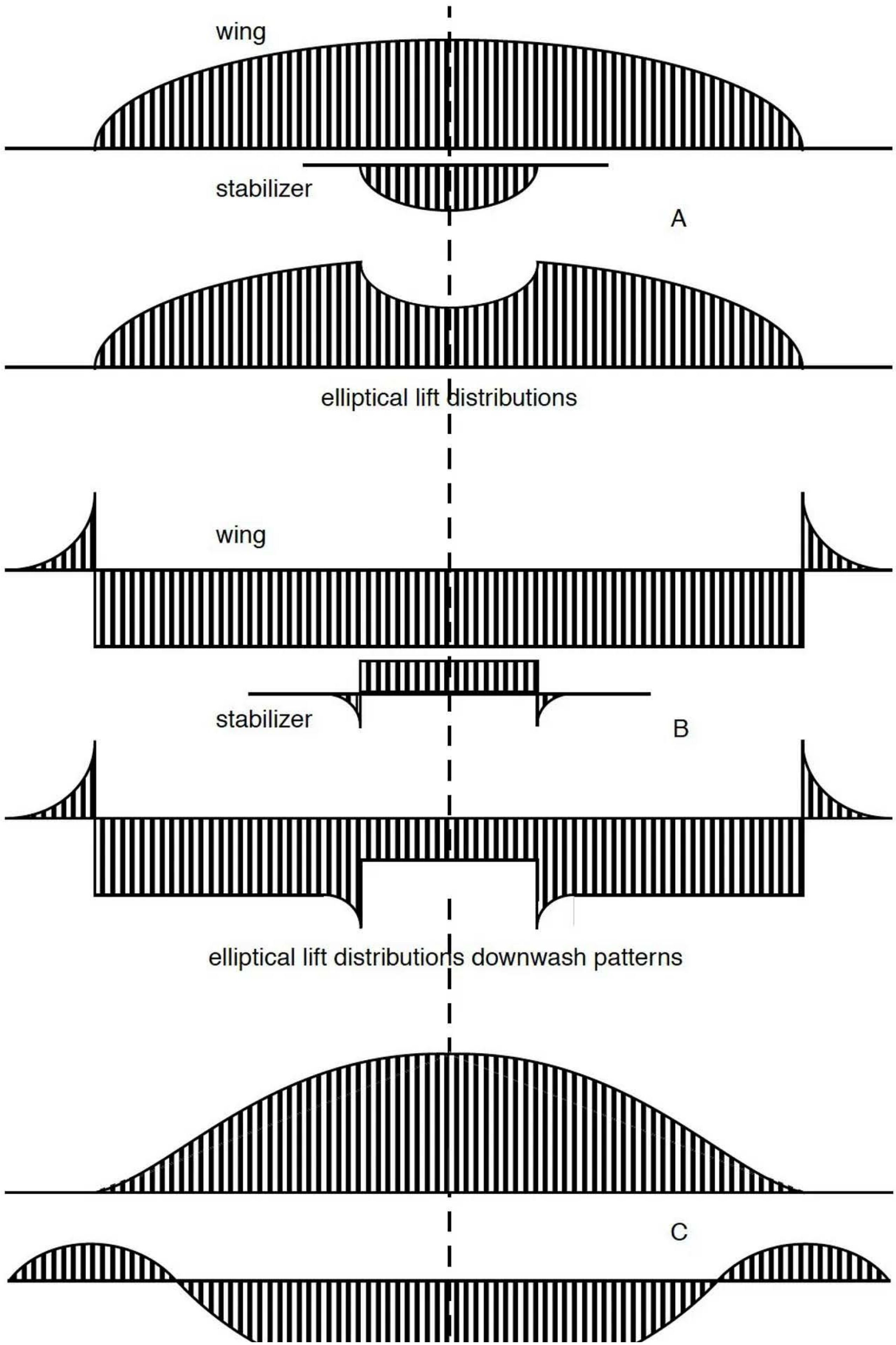
All of Dr. Panknin's designs, and our own designs based on Dr. Panknin's paradigm, incorporate winglets. These vertical surfaces assist in reducing oscillations in yaw in straight and level flight and act to reduce adverse yaw at the expense of some increase in drag. As we've stated in previous columns, thermal machines seem to climb better with winglets, racers track better with a single vertical fin mounted on the centerline.

Conclusions

All three twist distributions have both positive and negative aspects:

- The Horten twist distribution is based on the work of Prandtl and others, and has been supported by the more recent works of R.T. Jones, Klein and Viswanathan. The Horten paradigm has the potential to reduce induced drag and eliminate adverse yaw, but is computationally intensive and the twist distribution itself must be used in combination with a number of additional planform attributes.

- The Culver twist distribution is centered on the elliptical lift distribution. This is a conservative approach which provides relatively low drag and good efficiency within a confined design point, but may be prone to adverse yaw, particularly when operating at the design coefficient of lift.
- The Panknin twist distribution has proven itself over a nearly two decade period to be an accurate determiner of both required wing twist and center of gravity location. It has been used with great success by a very large number of international designers. Its major limitation is that it calculates only the twist required for pitch stability, but it can be used as a fundamental method of determining the approximate minimum twist required for a preliminary design.


wing
stabilizer
A
elliptical lift distributions
wing
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B
elliptical lift distributions downwash patterns
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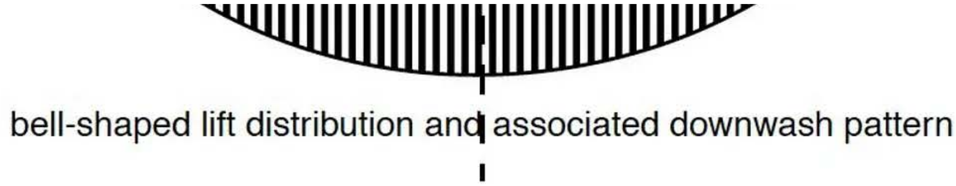

Figure 2

aerodynamic loads of the tail.

These factors, taken in combination, paint a picture of a relatively heavy aircraft with substantial surface and interference drag. Additionally, there is the surface and induced drag of the separate relatively low aspect ratio horizontal and vertical stabilizers. In flight, large amounts of drag are created in an effort to make coordinated turns. Given this perspective, the possibility of more efficient aerodynamics, as seen in Figure 2C, is obvious.

While a specially tailored single surface wing may be necessary to achieve this goal, a well integrated design approach for tailless aircraft is certainly very close, as demonstrated by the recent articles by Katherine Diaz in P*ilot Journal* and Carl Hoffman in *Popular Science*. It is only a matter of time before such design paradigms and appropriate construction technologies are available to modelers.

When designing a tailless planform, the type of twist distribution to be used should be one of the first decisions to be considered, and always relative to other aspects of the design such as prescribed task, design lift coefficient, and planform. There are a number of design flowcharts available to assist the novice designer, and we very much encourage readers to investigate their usefulness. The information presented in this series can be used to augment these resources and assist in developing viable, and perhaps cutting edge, designs.

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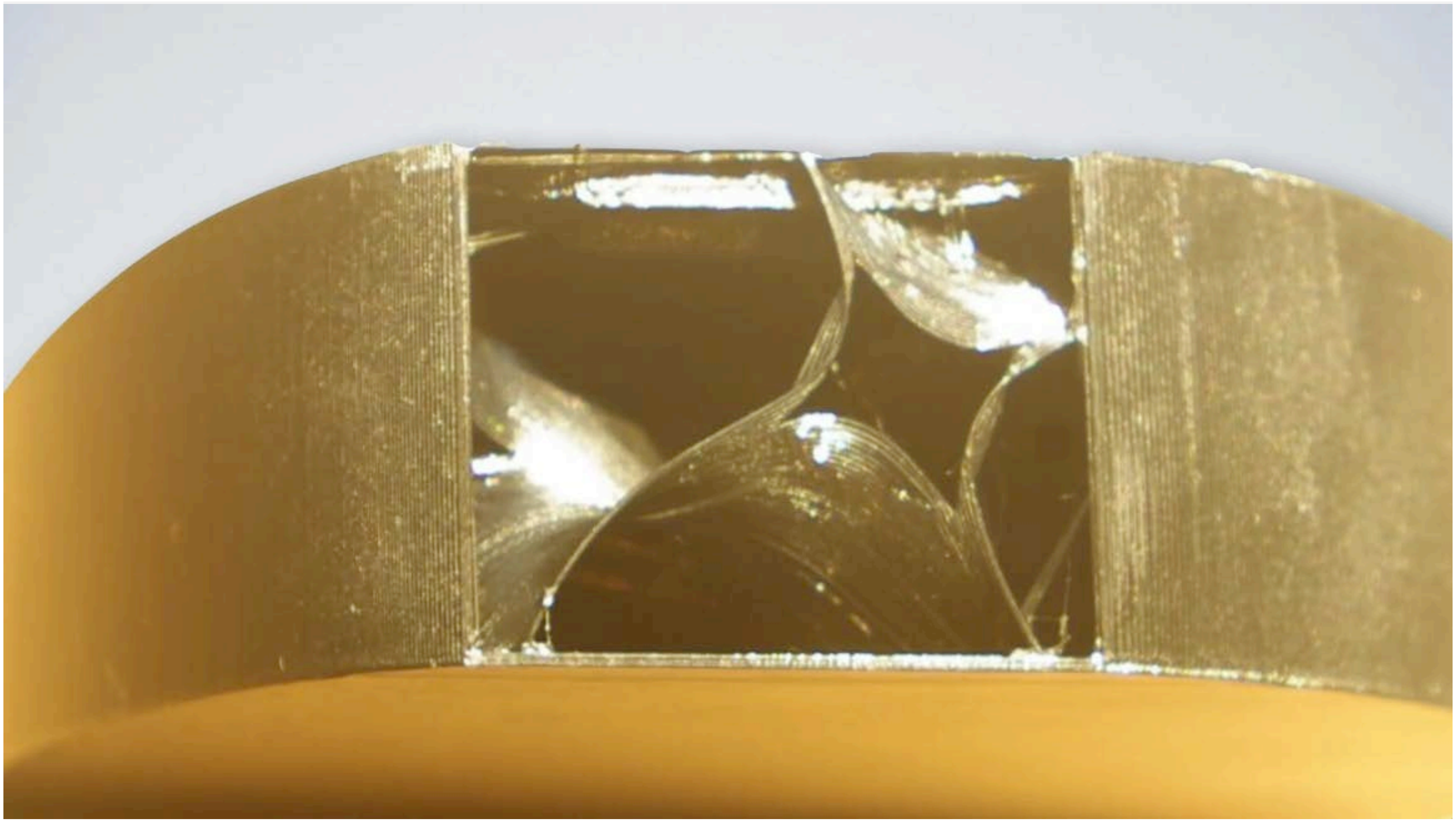


The latest exotic wristwatch from Piaget or Patek Philippe? No it's actually an early, failed attempt at 3D-printing the mold for a wingtip. The 'face' of the watch is the exposed gyroid infill.

Project ALTius

Part V: Practical experiments in FDM 3D-printing.

Tiberiu Atudorei · Follow

Published in The New RC Soaring Digest

16 min read · 6 days ago

For those who have not already done so, you will likely want to read or at least familiarise yourself with the ***first four parts of this series****. — Ed.*

Last time I concluded with "next month, it's back to the nuts-and-bolts": I hope you didn't take that literally. Instead of "nuts-and-bolts" you will have to settle for some "nozzle-and-plastic". That's right: time to do some old-fashioned FDM (fused deposition modelling) 3D-printing! Don't worry, we will have several parts in the future with hardware laser cutters and 3D-printers to help prepare you for the building season which will be upon us by then.

Five Reasons for FDM

The first reason is quite simple: in our journey between the start point of 'what' — that is, the 3D models prepared with SAD/CAD — and the destination point of 'where' — the magical 3D resin printer — we definitely need to do a 'how' pit stop. In other words we need to get you familiar with a very important tool: the slicer — used for 3D-printing — and its relative the 'g-code generator' used with a laser cutter. The purpose of these software tools is very simple: to translate the 3D model or the drawing to the G-code language accepted by 3D-printers and laser cutters. Both are in fact some variants of CNCs with specialised tools.

The second reason is that we need to re-evaluate somehow the FDM printing with the 3D-printers, software and materials available today.

The third reason is more practical: previously we have considered two types of building:

- Balsa geodetic ribs covered in composite — 'low-tech ALTius'
- 3D-printed core covered in composite — 'hi-tech ALTius'

In fact there are three additional variations:

- Fully 3D-printed with plastic
- Resin 3D-printed core covered with composite
- Fully 3D-printed with resin

That's right, for rapid prototyping we need to consider also a quick and cheap build without composites at all. Of the five variations we can consider FDM 3D-printing in at least three.

And the fourth and perhaps most important reason: we need to validate the use of theoretical recipes derived from quick W1 and W2 weight estimations with practical results. In other words, weight and printing time estimations from the slicer software as compared to the actual, measured weight and time for printing. We also need to evaluate the structural integrity of the printed wing and to extrapolate the findings from FDM printing to resin printing.

And maybe a fifth reason: you may already have an FDM printer and you want to put it to good use before starting to build and/or saving up to buy a resin 3D-printer.

Once again using the car analogy from previous instalments of this series, here is a side-by-side comparison of a Dacia—the USD$100 Tarantula Pro—and a Porsche, which is the Bambu Lab P1P that I upgraded to bring its price tag to over €1000.

An Addiction in All but Name?

After a couple of early DIY attempts of my own, my collection of commercial 3D-printers has steadily grown over the years:

- In 2019 I bought a USD$200 Anet *A8 Plus* for bigger, 300mm x 300mm x 350mm printing volume. I also upgraded it from GT2 belt transmission to T8 lead screws for a slow but precise printing of molds.
- In 2020 I then bought a USD$300 TwoTrees *Sapphire Pro* CoreXY type 3D-printer. It, too, has now been upgraded on the Z-axis with two SFU1204 ball screws with 1000mm active travel so I can print 1m molds and wings.
- In 2021 I added to my collection once again with a USD$400 TwoTrees *Sapphire Plus* which has a little bit bigger printing volume.
- Then, in 2022, I bought a USD$100 Tevo *Tarantula Pro*. Admittedly this was an impulse buy: I wanted to know how good a 3D-printer is when the parts cost more than the kit. The answer is "actually quite good"—definitely better than my first DIY 3D-printer.
- Finally, this year, I bought an €800 Bambu Lab *P1P*. It's now worth €1000 with upgrades which include different nozzles and an enclosure. Incidentally, the grey 3D-printed pieces you may have seen in previous parts of this series were for the enclosure for this printer—that's a

requirement for printing ABS.

But wait there’s more: a new Creality *K1* and Kingroon *KLP1* which have been pre-ordered. Then there’s the eight (!) *VORON2.4* and four (!) BLV *mgn Cubes* waiting to be built. There are also three commercial resin 3D-printers — Anycubic *Photon*, Creality *LD-002H* and an Anycubic *Photon Mono X* and seven (!) DIY resin printers.

If you wonder why so many printers: yes, I am addicted to 3D-printing and yes, I’m a technology hoarder. However I can assure you there is a specific, valid reason behind this madness and it’s related of course to projects ALTius and ALTius2. Stay tuned!

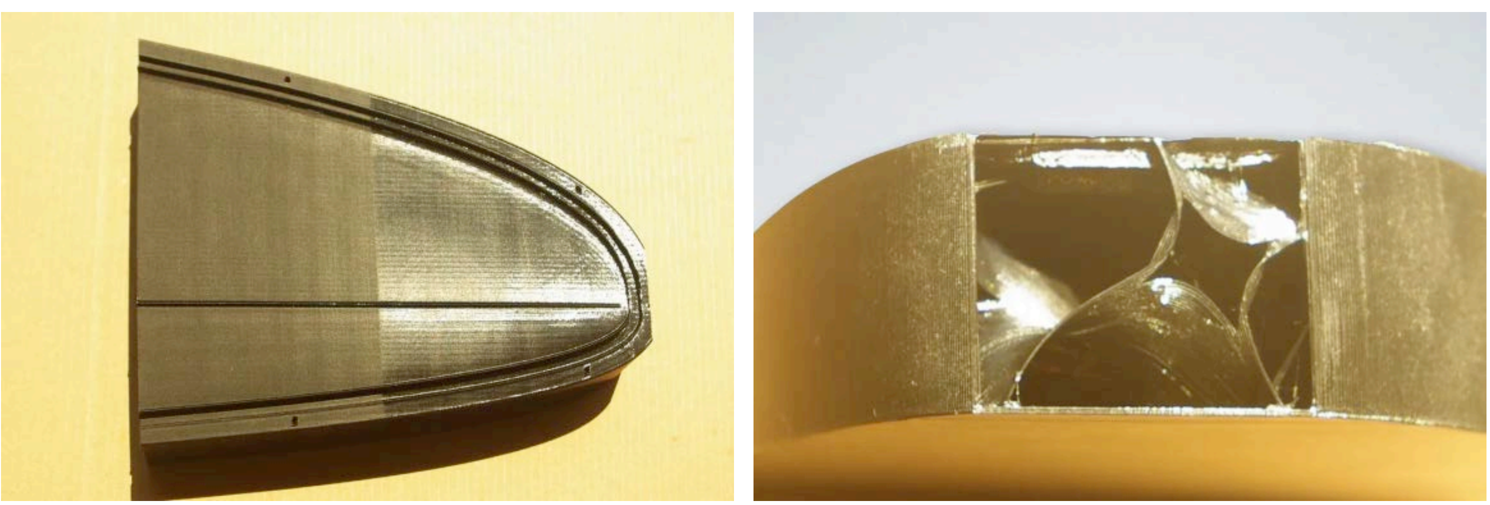
Note also I tried to provide links to all of the above—or the current equivalent—in the *Resources* section below.

are made”.† However, we definitely need to know how to make good ‘sausages’ so it’s time to do some printing.

†Don’t laugh, sausages are big business in Germany and these words may be attributed to Bismarck comparing laws and sausages.

3D-Printing Plugs and Molds

I’ll start with a 0.4mm nozzle and PLA on the standard *P1P* configuration — just the 0.4 mm nozzle and no enclosure. I will print a mold of the tip — not the full segment, of course, but just the last quarter. This first test is a failure.



Mold of the wing tip printed with two different speeds.

In fact, despite appearances, it's actually quite good. It's a failure because I used the rest of an several-years-old PLA roll and the filament was not enough to finish the part — the tip is not closed. Then again, you *can* see the cool-looking gyroid infill. The mold has some elements not suitable for 3D-printed molds: the wall is a very small structure designed to protect the leading and trailing edges when you polish the mold / plug. It's almost of no use in 3D-printed molds and plugs. I left it there just to see how my new printer is coping with very small details and fast direction changes. All we can see in the surface are some vertical lines — 2mm apart — that are correlated with the GT2 belts. I probably need to adjust the belts tension — after all, this is a brand new printer. Definitely usable if between this printed mold and the carbon/resin we use a FEP release film to 'smooth' the surface. All we need to do is to use an offset in the design of the model to compensate for this FEP film and probably use ABS for printing in order to do some thermal curing of the resin . This way we can use also some prepregs. OK, we can use an FDM 3D-printer for molds and plugs — what about wings?

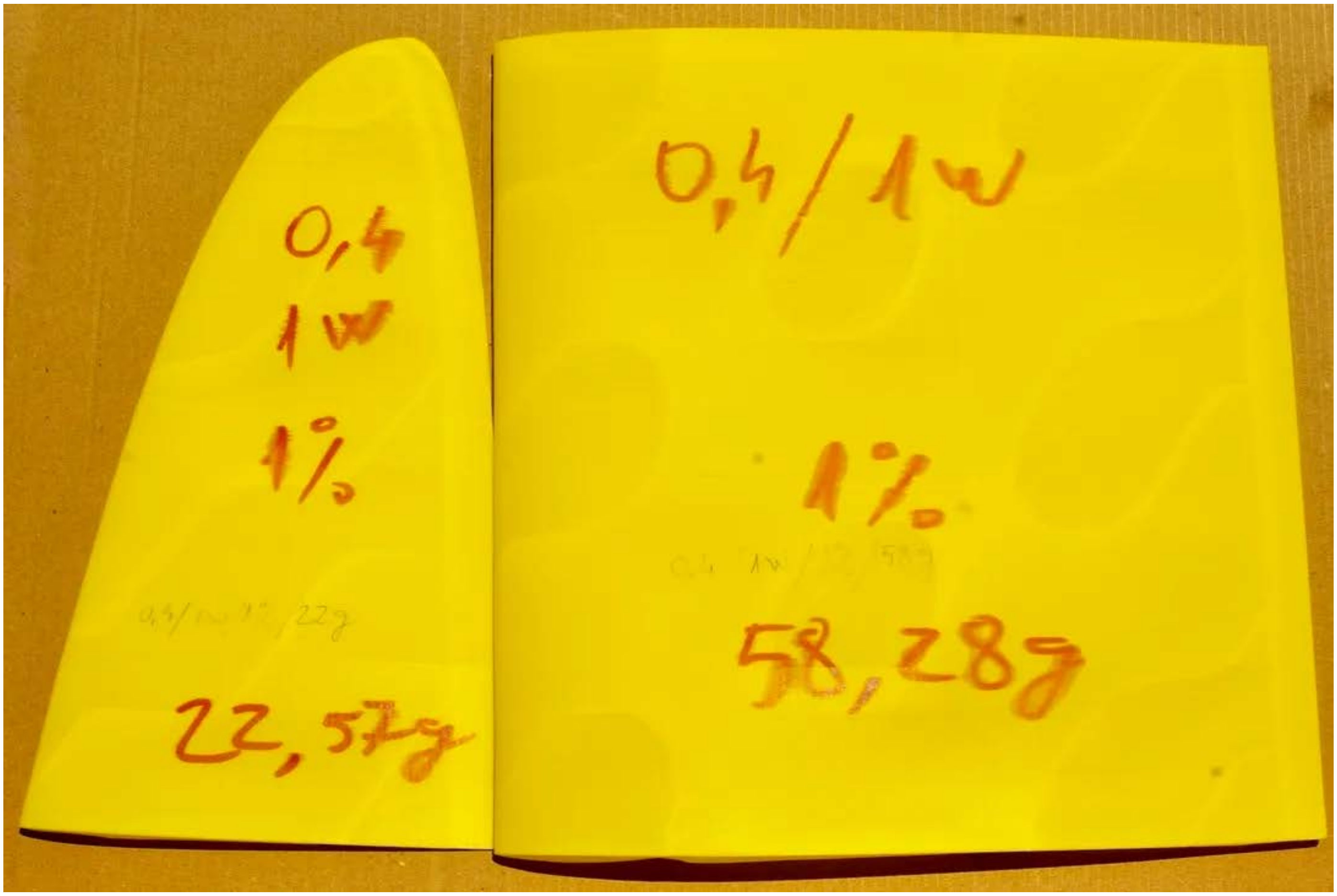
Wing 3D-Printing Test Methodology

We will test two 'quarters' of a wing: the first quarter at the root and the last quarter at the tip. These are the easiest and hardest quarters to print, respectively. Also, this is just a 'plain' wing — no other additional elements like cutouts for control surfaces, servo pockets, joiners or spars. Of course when you 3D-print an actual wing you intend to fly, you will need to consider those and prepare them either in `xflrwing` and/or *OpenSCAD* (see Resources, below). No big deal, you will do a `difference()` between the wing segment and a cylinder or cone or a square-section tube used for spar — remember to do it a little bit larger and not exactly the nominal size of the spar.

We will compare slicer estimated weight versus printed weight, and then we will estimate the printed weight for the full wing by doubling the slicer estimate for a print of all quarters in a half wing. Note: it is not the 'virtual' wing of $75dm^2$ and $6000cm^3$ we used for weight estimation. It's a 'real' wing with 3.84m span, 24cm chord, $76.12dm^2$ projected area and $6487.80cm^3$ volume. We will observe and measure three variables: weight, printing time and quality. There is an old saying something like "pick two of them because you will never get all three at the same time" — let's see if it's true.

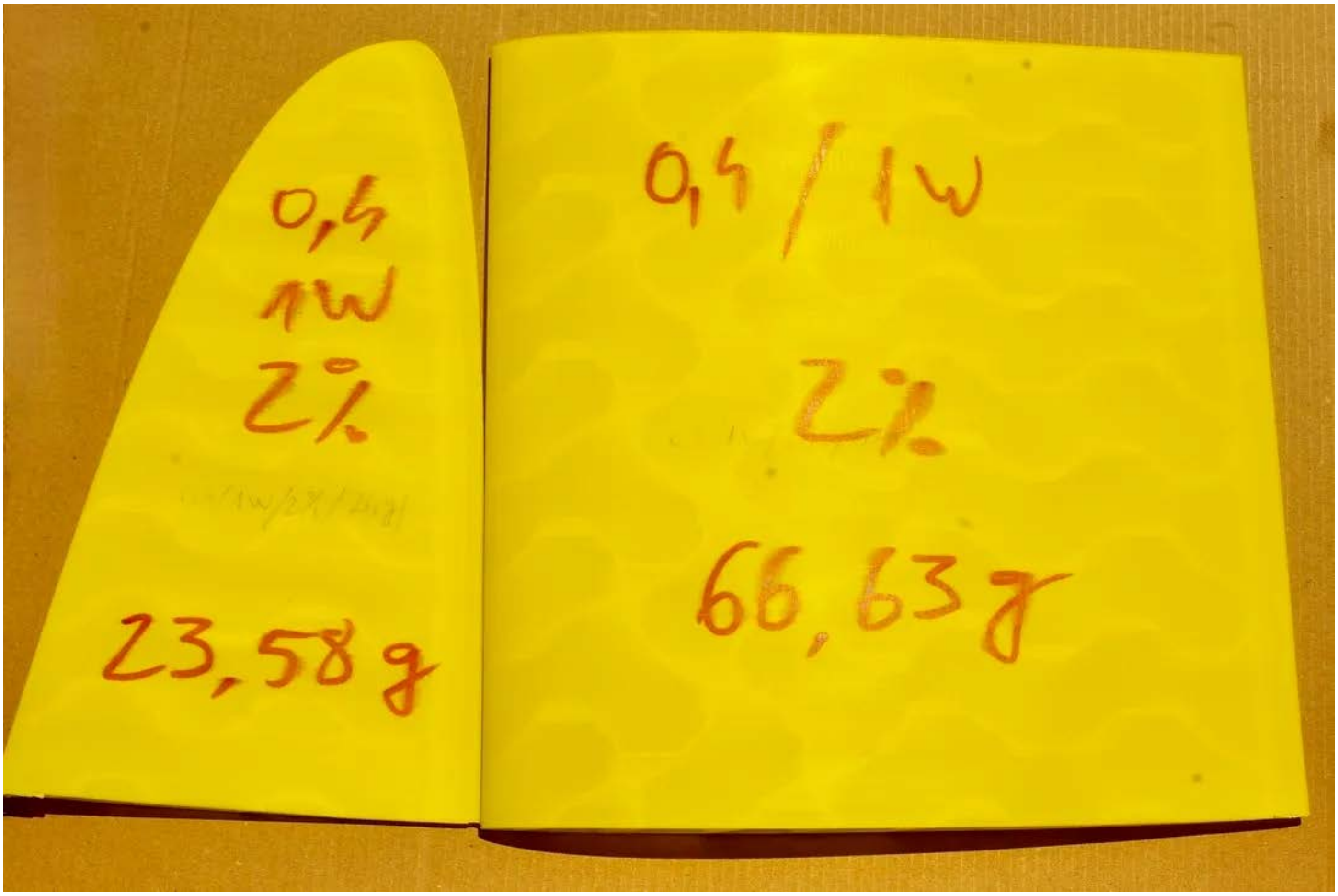
OK, let's start the first round of wing parts printing. Remember, this is a standard 0.4mm nozzle on a standard printer without enclosure.

PLA+ / 0.4mm Nozzle / One Wall / 1% Infill



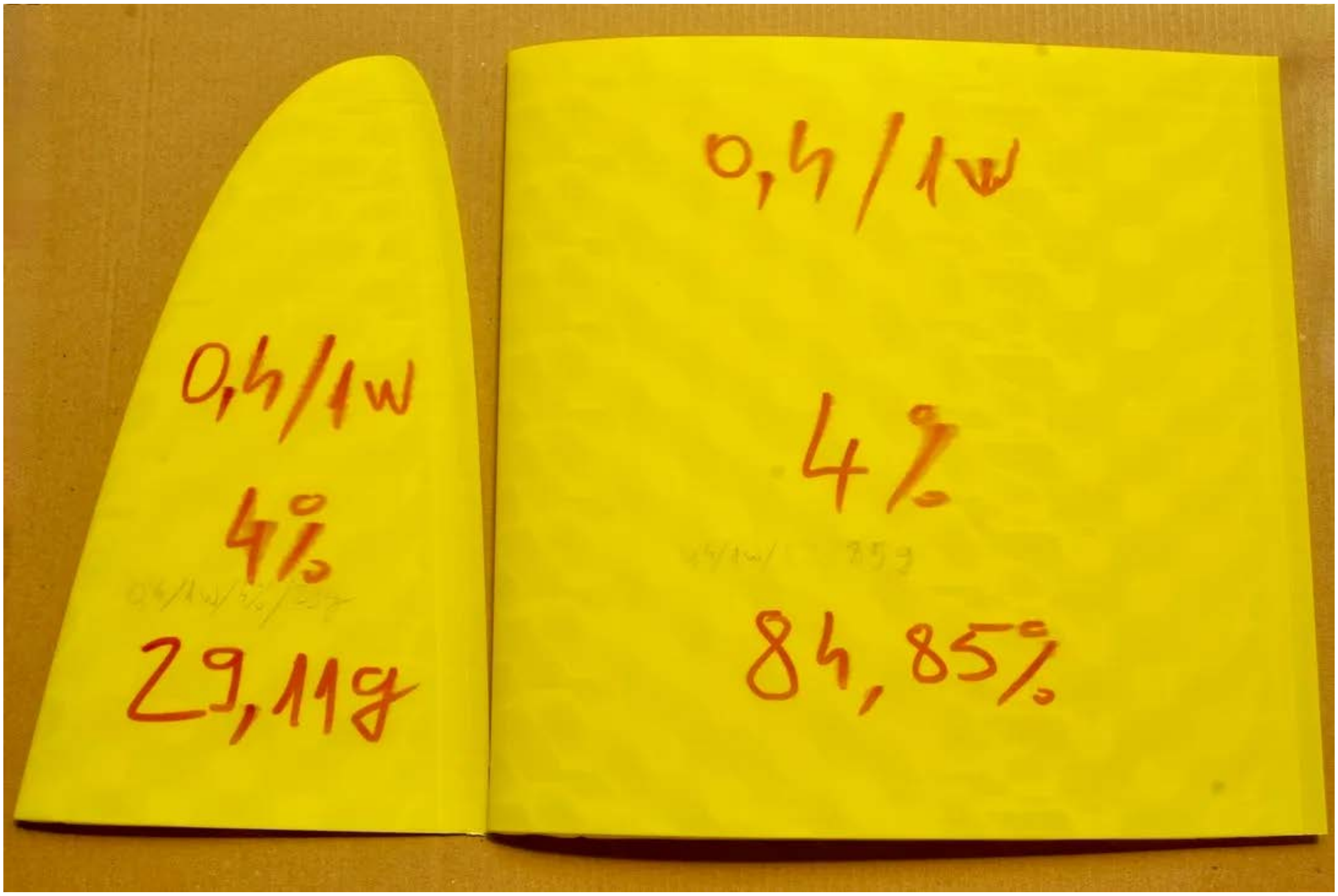
It’s a failure. Weight: root quarter 58g, tip quarter 22g, total 80g–81g as compared to 86g estimated by the slicer. Likely there is a small difference in plastic density or my filament if actually a mix of PLA and ABS. Full wing estimation: 615g and about 18h print time. Quality: good airfoil profile on printing bed, not so good — actually, really bad — in the rest. Good adhesion between layers. We notice some 5cm diameter ‘islands’ and a visible sagging of the airfoil between these. Also there is a small but visible ‘layer shift’ toward the tip.

PLA+ / 0.4mm Nozzle / One Wall / 2% Gyroid Infill



It’s also a failure. Weight: root quarter 67g, tip quarter 24g, total 90g–91g as compared to 94g slicer estimation. Full wing estimation: 700g / 22h. Quality: the same but ‘islands’ are smaller and also the sagging is not so bad.

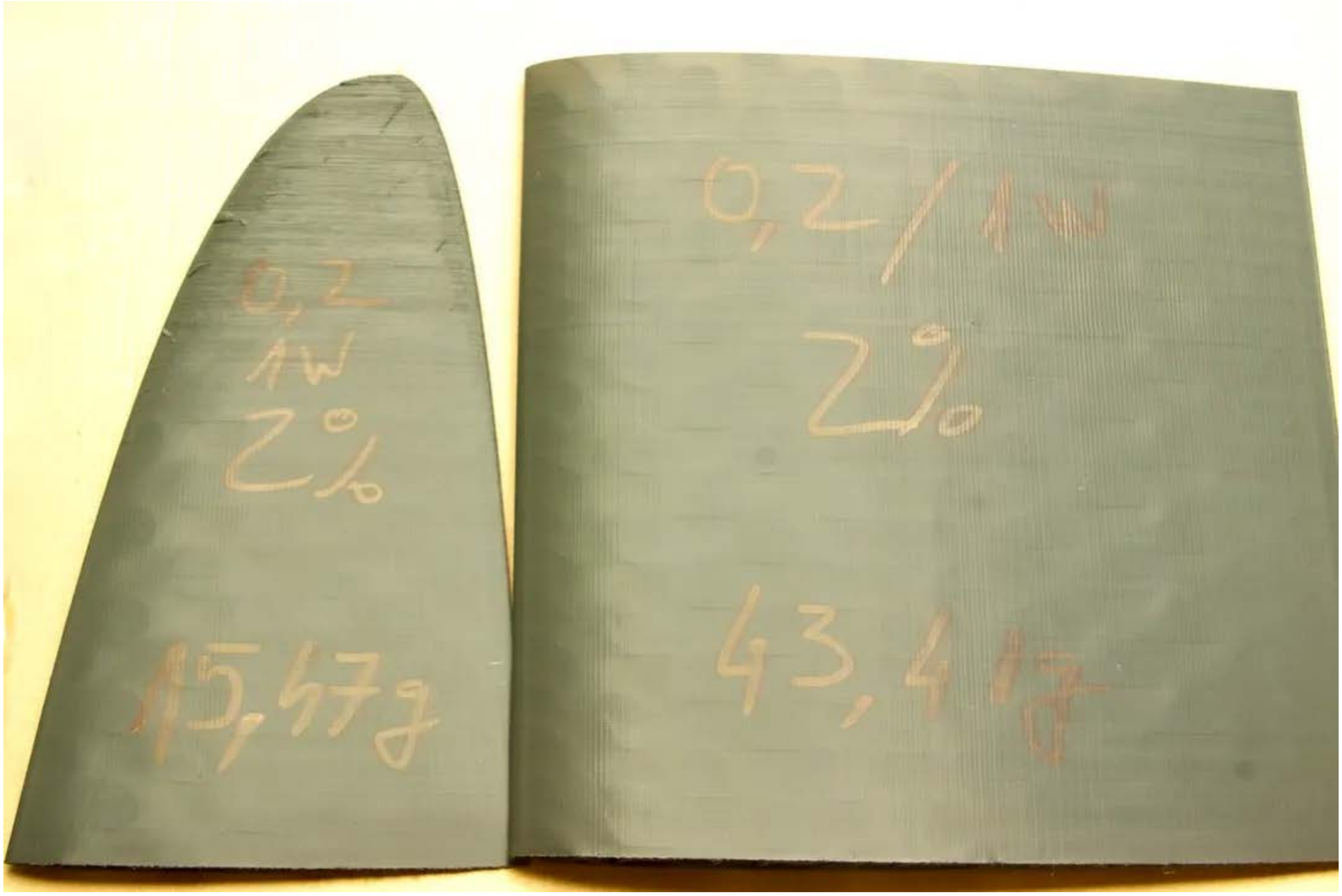
PLA+ / 0.4mm Nozzle / One Wall / 4% Gyroid Infill



It’s OK(ish) but importantly **not** a failure as there are no structural impediments. Weight: root quarter 85g, tip quarter 29g, total 114g as compared to an estimated 119g. Full wing estimation: 1000g / 26h. Quality: printed parts are tough, no sagging visible, still some layer inconsistencies on the tip.

After the first tests I received from Bambu Lab the package with the upgraded parts — new 0.2mm, 0.4mm, 0.6mm and 0.8mm nozzles along with camera and LED lamp as well as a fan for additional part cooling. We can do some additional tests. No point in testing 0.6mm and 0.8mm nozzles but we definitely want to test the 0.2mm nozzle. Another type of PLA, first round was on yellow PLA+, second round with grey PLA — that is, what was left in the roll after printing the enclosure for *P1P*.

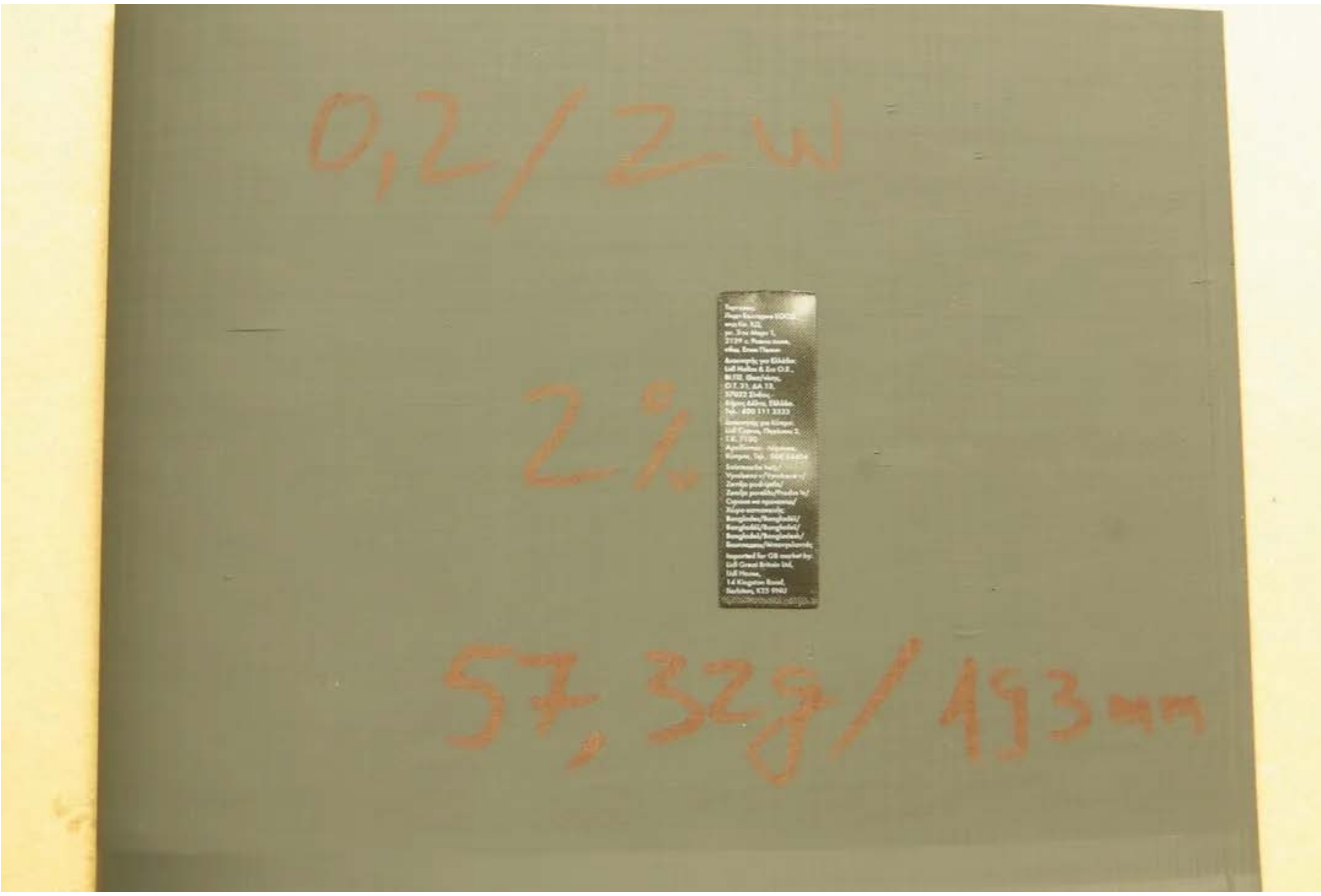
PLA+ / 0.2mm Nozzle / One Wall / 2% Gyroid Infill



'Mr. Golf Dimples' (see below)

Mixed results. Root is OK(ish), tip not so good. Weight: root quarter 44g, tip quarter 16g, total 60g as compared to 63g estimated weight with the slicer software. Full wing estimation: 640g / 3d and 14h. Wow! Quality: OK(ish). Some islands are still visible but similar in size with 4% infill for 0.4mm nozzle and a very small amount of sagging. Definitely can be covered / hidden by the composite surface. If it's not covered we should not care too much about it — best to think about how dimples in golf balls positively affect their flight, right? Now, how about the quality of the tip? The tip-of-the-tip is almost unusable: the layer shift is significant compared to the nozzle size and there is a visible adhesion problem between layers at the tip.

PLA+ / 0.2mm Nozzle / Two Walls / 2% Gyroid Infill



'Mr. Nice Guy' (see below)

This is just the root — I used the last part of the PLA roll and I estimated that there was not enough filament for both root and tip quarters. However, I was wrong — not even the root was finished, it printed only 19.6cm out of 23.75cm so we will extrapolate the weight and … drum roll … it's **OK**! Not just OK(ish) but rather it's fully flyable and airworthy. Weight: this partial print was 58g — so 69g–70g for a full print of the root quarer. No big surprises here, the weight of *0.2mm / Two Walls / 2% Infill* is similar to *0.4 mm / One wall / 2% Infill*. Full wing estimation: 980g and a total print time of 5d and 7h.

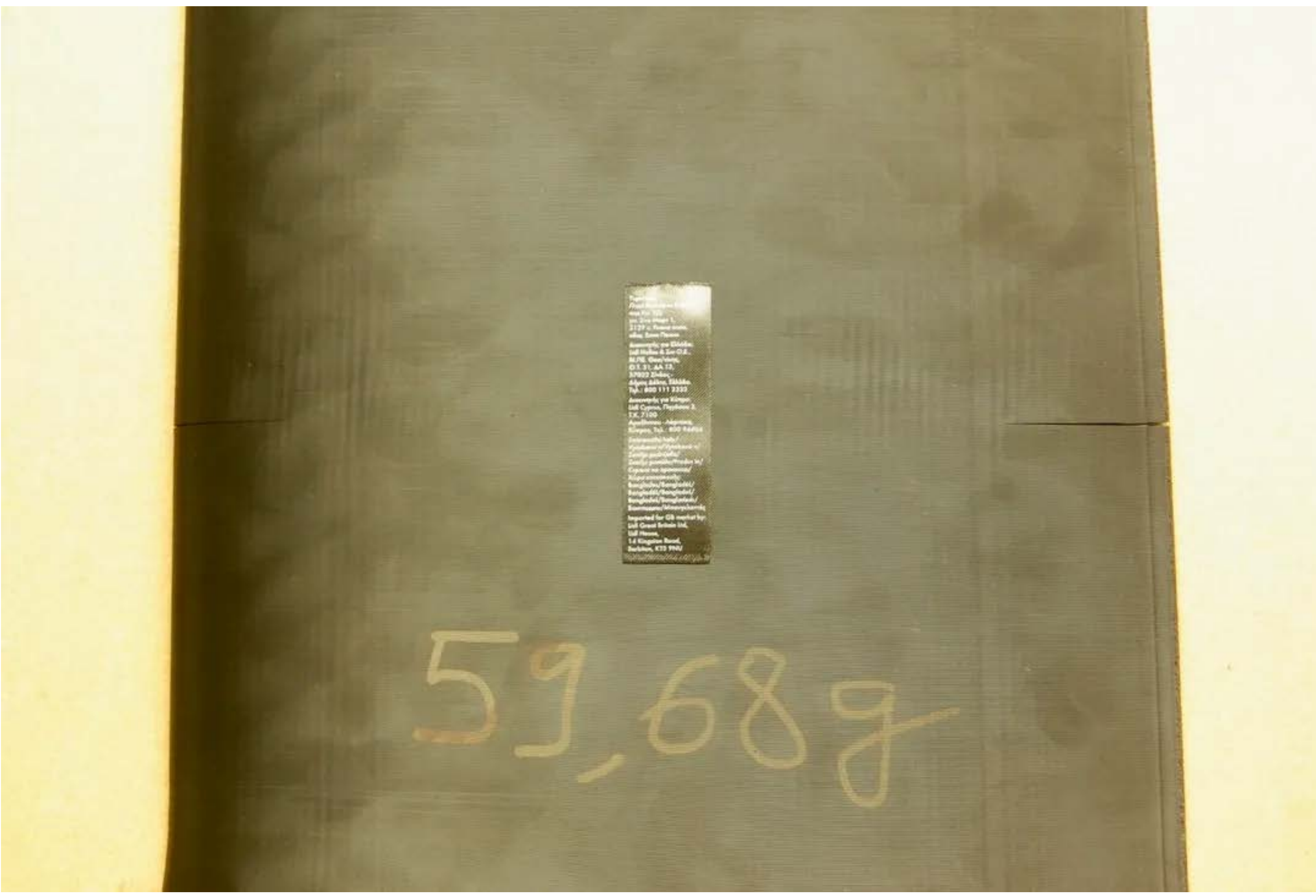
PLA+ / 0.1mm Nozzle / Two Walls / 2% Gyroid Infill

Just kidding, I'm not able to print with a 0.1mm nozzle on the *P1P,* at least for the moment. I have some 0.1mm nozzles and I've ordered some aftermarket hotends for the *P1P* and maybe I'll have the patience to do some printing with 0.1mm nozzles. But I finally finished the enclosure for the *P1P* using some PLA printed parts and acrylic panels from China. Let's try this new enclosure with some black ABS.

ABS / 0.2mm Nozzle / Two Walls / 2% Gyroid Infill

Actually I started this print but I had to stop because my 0.2mm nozzle clogged due to the old and dusty ABS roll of filament. I ordered some 0.2mm needles used in unclogging the nozzle but what I received are 0.24mm and 0.25mm needles. I probably can unclog the nozzle but in this case it will be a 0.25mm nozzle and the flow of plastic will be increased by 50% (`0.2 * 0.2 = 0.04` , `0.24 * 0.24 = 0.0576` , `0.25 * 0.25 = 0.0625`) and the tests will not be relevant any more — we will not be comparing apples with apples. So, I'll wait for the aftermarket hotend with 0.2mm nozzles. Back to 0.4 mm nozzle and black ABS.

ABS / 0.4mm Nozzle / One Wall / 3% Gyroid Infill



'Mr. Stinky' (see below)

Weight: this print was 58g and a full wing estimation of 800g and 24h print time.

FDM Face-Off

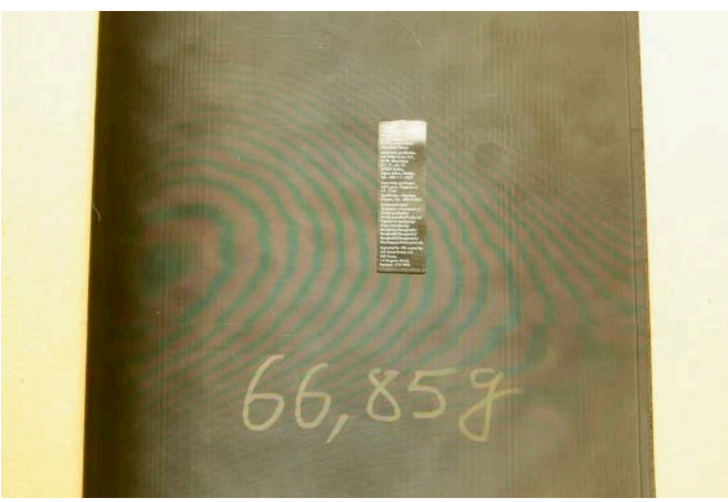
It's time to pause the FDM printing session and have a contest. So far we had two finalists: *Mr. Golf Ball Dimples* (PLA+ / 0.2 mm nozzle / 1 wall / 2% infill), *Mr. Nice Guy* (PLA+ / 0.2 mm / 2 walls / 2%), and right at the wire a new finalist: *Mr. Stinky* (ABS /

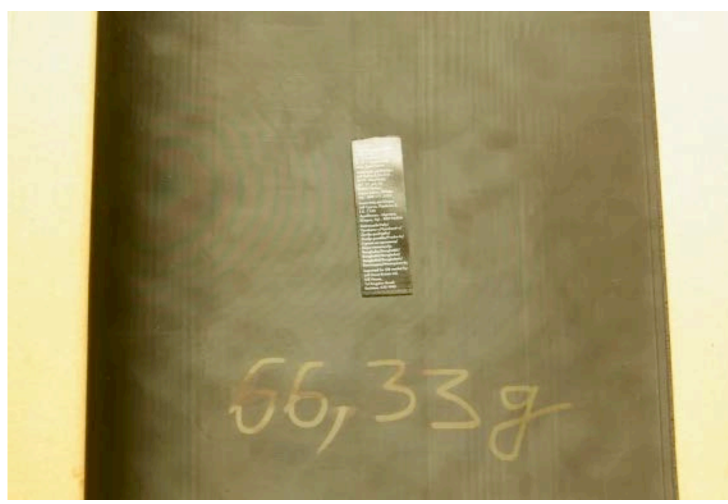
0.4mm / 1 wall / 3%) — ABS has a very bad odour when printing. Let's order these contestants with regard to four criteria. Three were mentioned previously — weight, strength and printing time — but let's now add how nice they look.

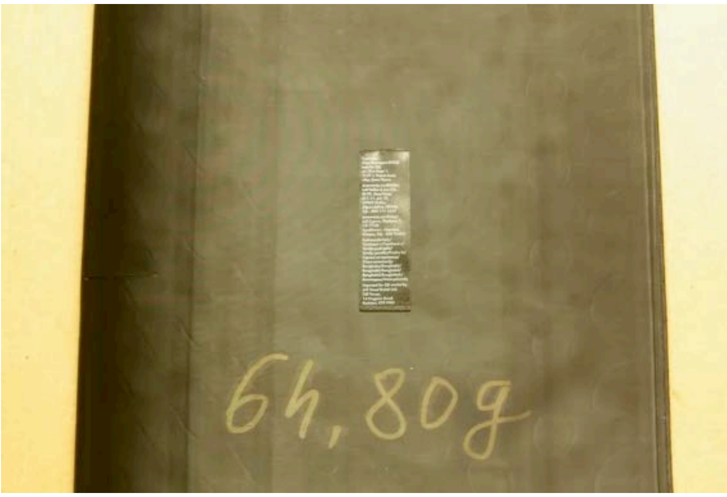
- Weight: no surprise here, *Dimples*. But *Nice* and *Stinky* are in a tie for second place.
- Strength: *Stinky* as it was rock solid, two very thin lines of 0.2mm PLA force-cooled can't beat a single 0.4mm line of 270C-fused ABS without part cooling.
- Printing time: *Stinky* wins by a large margin.
- Beauty: of course *Nice*, hands down. Both *Dimples* and *Stinky* have dimples — but *Stinky* subjectively looks better.

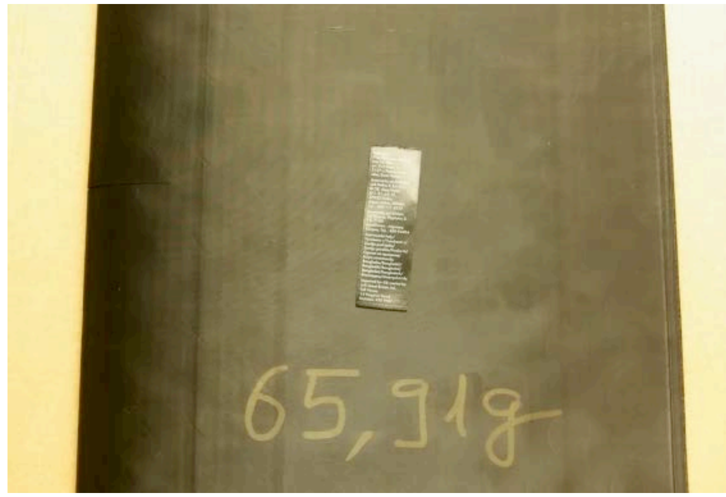
Interesting combination: *Stinky* wing estimation was 800g and a printing time of 24h. Let's estimate AUW (all up weight): another 100g for carbon spars, 80g–100g for tails, 250g–300g for fuselage. Another 300g–400g for 'dead weight'. Estimated total AUW: 1500g–1700g. If I will print this with a 0.3 nozzle I can get the wing weight down to 600g and total AUW 1300g–1500g. Pretty good — the wing was designed for AUW 1380g. Another thing: I printed this segment four times with four different speeds which I will call *Silent*, *Standard*, *Sport* and *Ludicrous*. What I wanted to test was consistency of weight, extrusion and layer adhesion at high speed.

ABS / 0.4mm nozzle / One Wall — Speed and Consistency Test









There is no big difference between these four prints: actually *Sport* and *Ludicrous* look **better**. With this high speed the wing printing time is reduced to 12h –14h. This means I can print the whole glider in one day using 1kg of ABS. The 0.3mm nozzle can print with a layer height of 0.2 mm and the printing time will be the same but with a reduced weight. The problem with this combination: it uses a standard 0.4mm nozzle but not every printer can handle this type of ABS printing. Not your average *Ender 3* anyway — ABS is notoriously bad at warping. And with extreme speeds there are definitely some adhesion problems, not visible at printing time but rather later — internal tension leads later to some cracks on the leading edge.

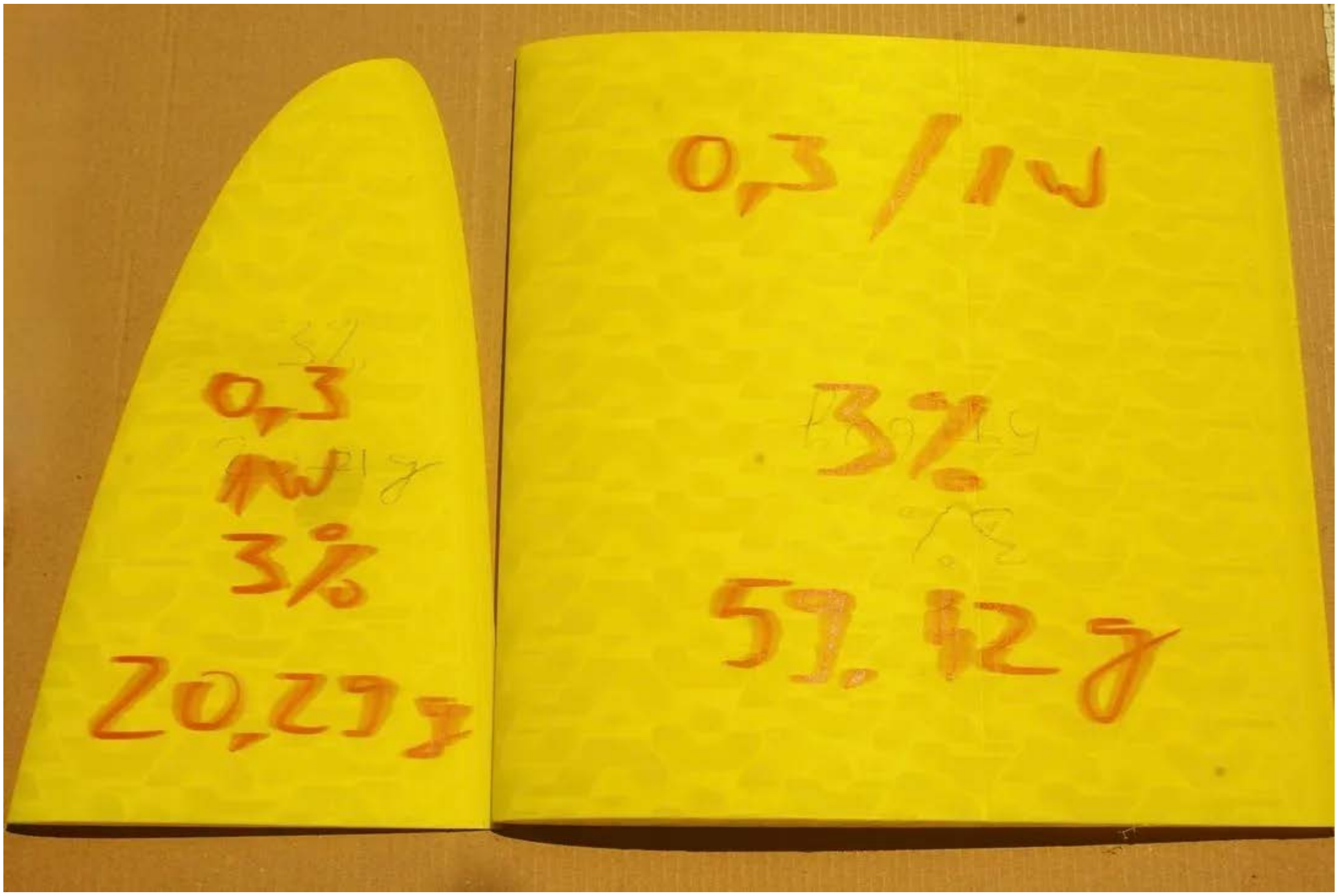
Good Things Come in Small Packages

Meanwhile I received a small package from China with a couple of aftermarket hotends and some nozzles: hardened steel 0.2mm, 0.4mm and 0.6mm along with CHT (core heating technology) 0.4mm and 0.6mm. CHT nozzles are for printing with increased speed. The filament is driven through three different paths inside the hotend in order to obtain a faster, more consistent melting of plastic and hardened steels for abrasive filaments like carbon fiber plastic. The CHT 0.6mm I'll use for structural parts and CHT 0.4mm for wing parts where I want to obtain the maximum speed. However, the real trick is an old 0.3mm brass nozzle mounted on this aftermarket hotend using standard 6mm nozzle thread.

Time for Round Three

This round is for tuning in printing with this 0.3mm nozzle. We can achieve the same print time with 0.3mm nozzle / 0.2mm layer height and 0.4mm nozzle / 0.2mm layer height — but our goal now is weight reduction. Back to PLA+ yellow.

PLA+ / 0.3mm Nozzle / One Wall / 3% Gyroid Infill

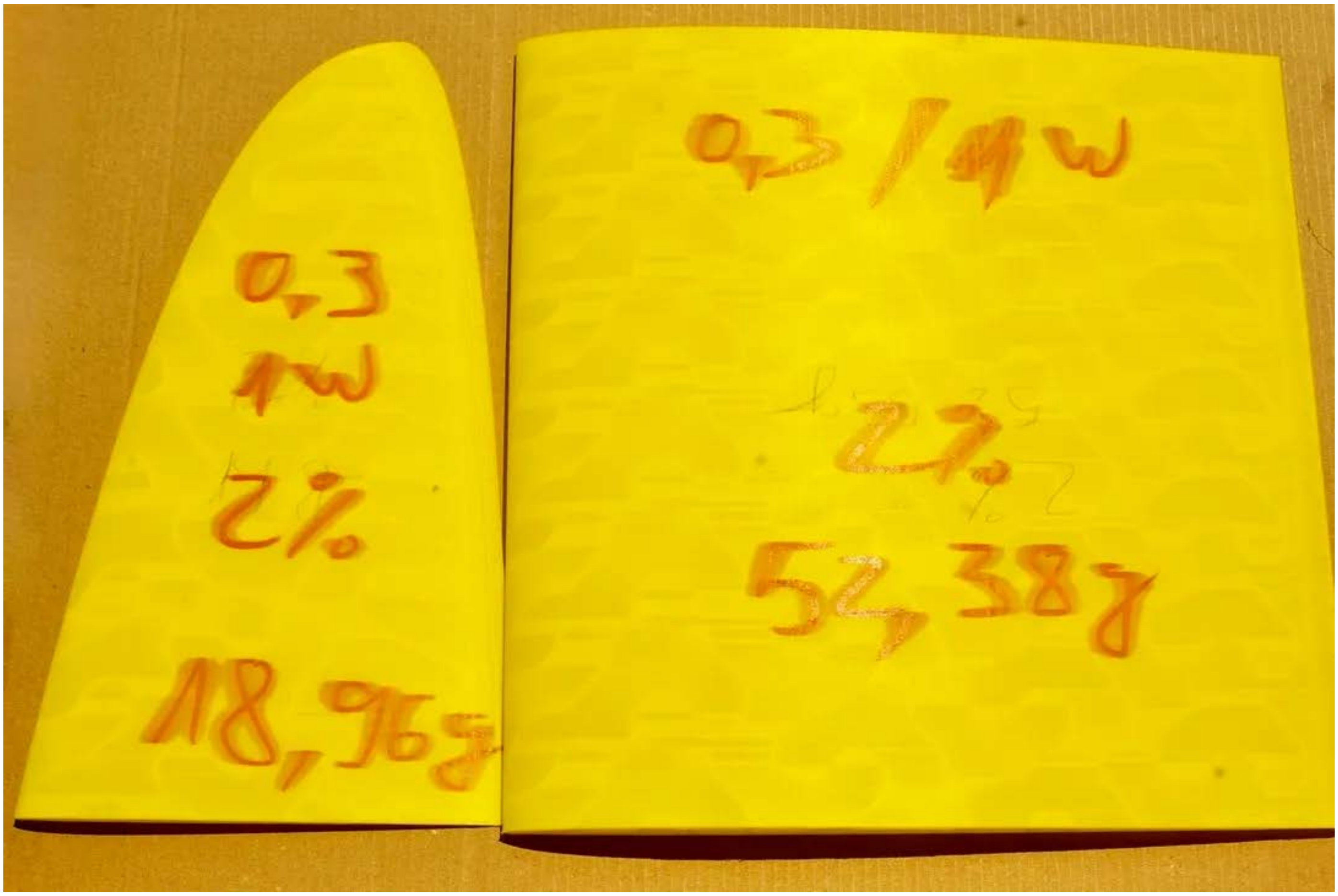


Weight: 59g root and 20g tip, total 79g as compared to slicer estimated 81g.

PLA+ / 0.3mm Nozzle / One Wall / 2.5% Gyroid Infill

Weight: 56g root and 20g tip, total 76g as compared to slicer estimated 81g.

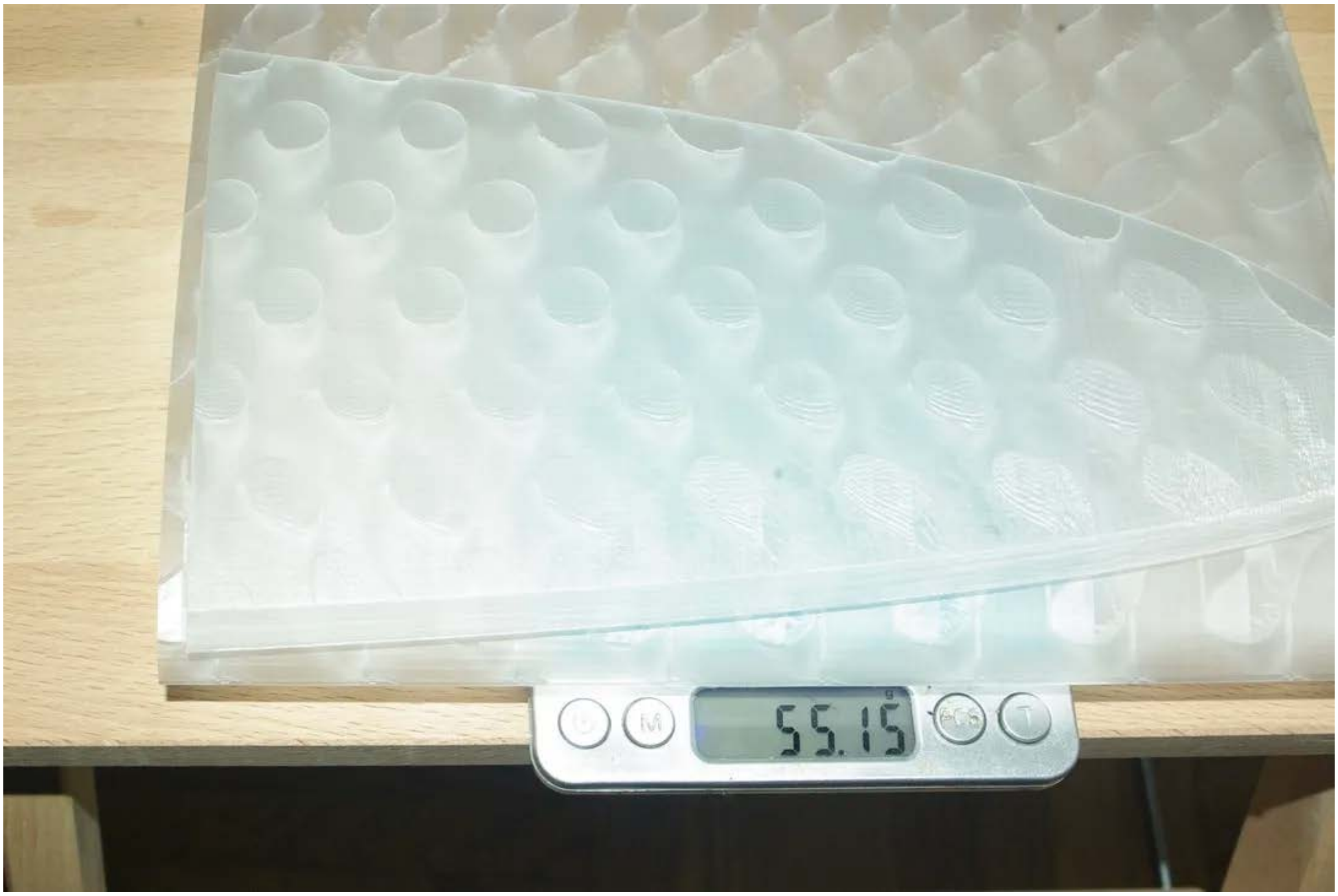
PLA+ / 0.3mm Nozzle / One Wall / 2% Gyroid Infill



Weight: 52g root and 19g tip , total 71g as compared to slicer estimated 76g.

Now let’s see how low we can go with the weight by printing with transparent ABS — the layer adhesion is better without any dye in the plastic using 0.2mm nozzle.

Transparent ABS / 0.2mm Nozzle / One Wall / 2% Gyroid Infill



Weight: 55 g, as compared to slicer estimation for the whole wing of 600g and print time of 91h — ouch! Even if printed using the fastest speed I can get with this printer it will be two days or similar. But the print looks great and the structure is fine. Probably that's the lowest value for weight at 600g and maybe I can push it to 550g. But — damn! — printing time is huge.

Some Interim Conclusions

Weight and structural strength are linked, which is normal after all: more material equals more strength. However, good looks and low printing times are not very good friends, I'm afraid.

- **Weight Estimations** — Quite good, for FDM 3D-printing we can trust the estimations of the slicer software. And in some cases what we got from the printing plate is even lighter — around 95% of the weight estimated by the slicer.
- **4m Wing 3D-Printed Under 1kg** — This was my original goal many years ago. The answer is yes, definitely, it can be achieved. But if you want some weight savings you need to print with ABS (1.05g/cm^3) instead of PLA/PETG (1.25g/cm^3). ABS, on

the other hand is a lot harder to print. You have to deal with contraction, warping, a heated print chamber and other considerations. Better forget ABS and print PETG instead with a 0.3mm nozzle.

- **Print Time** — On the very fast *P1P* printer times are acceptable for 0.4mm/0.3mm nozzles although significantly increased for 0.2mm nozzle. And it's not simply doubled. At one end of the spectrum — for 0.4mm / one wall / 2% infill — it's 22h and at the other end of the spectrum — 0.2mm / two walls / 2% infill — it's a whopping 127h! The same amount of plastic but with 5.77 times increase in printing time! Note that a four times increase is actually what's expected — double the layer numbers plus double the walls plus double the infill. However, it looks that there are some additional factors such as how the slicer software is handling the extrusion. Also, the printing times above are for *Standard* speed. With the *P1P* I mentioned there are four speed settings of which *Standard* is the second slowest. The faster *Sport* and *Ludicrous* settings will certainly speed things up, but at what cost in terms of quality? Finally, these print times were estimations for standard layer height half of the nozzle diameters but in theory you can print with a layer height up to three-quarters and in this case the total print time will be reduced by two-thirds.

- **Quality** As you will see from the pictures above, it is possible to achieve acceptable quality using FDM 3D-printing with the right settings and some simple precautions.

Next time, I'll be taking what has been learned with all of this testing and turn it into specific recommendations for optimising FDM 3D-printing for RC sailplanes. If you have any questions feel free to add them in the *Responses* section below. You get there by clicking the little 💬 below.

Thanks for reading. Until next time, best of luck!

Resources — 3D-Printers

- *Anet A8 V2* — "High cost performance ratio desktop FDM 3D-printer …"

- *TwoTrees Sapphire Pro* — "CoreXY SP–3 high resolution professional cube 3D-printer …"

- *TwoTrees Sapphire Plus* — “CoreXY SP–5 fast … large scale 3D-printer …”
- *Tevo Tarantual Pro* — “3D-printer FDM (235mm x 235mm x 250mm) …”
- *Bambu Lab P1P* — “Fast 3D printing right out of the box …”
- *Creality K1* — “Speedy 3D-printer …”
- *Kingroon KLP1* — “a fast-print-speed CoreXY 3D-printer with Klipper firmware and a protective enclosure …”
- *VORON2.4* — “We build space shuttles with gardening tools so anyone can have a space shuttle of their own …”
- *BLV mgn Cubes* — “an open-source 3D-printer project …”
- *Anycubic Photon* — “colorful touch screen equipped with Photon system and bring new functions …”
- *Creality LD–002H* — “High precision resin 3D-printer with large printing volume …”
- *Anycubic Photo Mono X* — “A large build area for your 3D-printed creations: 192mm x 120mm x 245mm …”

Resources — Other

- *G-code* on Wikipedia. — “the most widely-used computer numerical control (CNC) programming language. It is used mainly in computer-aided manufacturing to control automated machine tools, as well as from a 3D-printing slicer app…”
- *OpenSCAD* — “software for creating solid 3D CAD models. It is free software…”
- *RCGroups* thread for Project ALTius. — “altius, citius, fortius — sounds familiar? That’s the Olympic motto where ‘altius’ means ‘higher’. But the spelling (ALTius) is related also to my initials — Atudorei Lucian Tiberiu…”
- *xflrwing* — “STL generator for an XFLR project wing…”

*All images by the author. Read the **next article** in this issue, return to the **previous article** in this issue or go to the **table of contents**. A PDF version of this article, or the entire issue, is available **upon request**.*

June 2023 | Aeronautical Engineering | Aviation | Rapid Prototyping | 3D Printing

Soaring the Sky Podcast

E131: Engineered to Soar — Adriana's Aviation Adventure

Chuck Fulton · Follow
Published in The New RC Soaring Digest
4 min read · 4 days ago

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Our thirteenth instalment of this ongoing series where we select and present episodes from Chuck Fulton's highly regarded soaring podcast. See Resources*, below, for links where you can find* Soaring the Sky*, or simply click the green play button below to start listening. — Ed.*

Born in Guadalajara, Mexico, Adriana Barragan grew her passion for life, beauty, science and freedom. During her childhood and teens, she was exposed to disciplined arts and sports that would let her develop her spirit and realize the power of the mind. Raised near the International Airport of Guadalajara, airplanes made her wonder. She had a revelation while learning basic aerodynamics on the internet. She was filled with pure passion and excitement. This was the most amazing applied physics she had ever read and represented the greatness of invention. Her learning and joy for flight only grew from that day.

At age 15, Adriana confirmed her vocation for aviation while feeling reflected in the book *Running from Safety: an Adventure of the Spirit* by Richard Bach (see link in *Resources*). Soon she realized that flight testing combined everything she loved, defining her pursuit to become an experimental test pilot. After making her vocation public, her family could only show concern.

Regardless, she took the steps to become proficient in English and applied to MIT, ERAU, and Wichita State University. After receiving letters of admission, she camped on her roof during a clear night where she made her affirmation. This journey promised her everything — adventure, growth, romance, achievement, freedom, joy — and so her family understood this 'bug'. Six months before coming to the US, her family supported her to get a private pilot's license in Guadalajara. Later, she graduated with a Bachelor of Science in Aerospace Engineering from Wichita State University in December of 2014. She worked as a Research Engineer at the Computational Mechanics Laboratory of the National Institute for Aviation Research for three-and-a-half years, three years as an Experimental Flight Test Engineer at Gulfstream Aerospace, and two years as a Manoeuvre Loads Engineer at Gulfstream Aerospace.

Adriana has been flying since 2010, besides her Private Pilot Certificate, she paid for her Instrument rating, Commercial Pilot Certificate, Flight Instructor Certificate, Glider rating and a bunch of aviation specialty courses including tailwheel, aerobatics, soaring events and seaplanes. After almost 10 years working as an engineer, Adriana 'retired' from the corporate world to start ORKA, where she helps people obtain Private and Commercial Pilot Certificates, tailwheel endorsements and supports many students through her remote, online course.

Her vision is to lead those with a burning aviation desire to the finest flight instructors/coaches/teachers and aviation specialty courses. Because in her aviation journey, aiming for elite training and education, she found most training institutions were leaving gaps of knowledge and experience. ORKA will be the trusted platform to find effective, high quality training and vocation to teach. ORKA connects people, specially those new to aviation, to the richness of the aviation community. A network of humble, caring, available and talented individuals with deep knowledge and sharp skills. ORKA brings together educators, flyers, engineers, competition pilots, recreational pilots and others who have something to teach and want to teach.

Like the flight test of an airplane, Adriana found developing skill and knowledge in a pilot benefits from the disciplined approach we use in Flight Test to expand the envelope. But this time, she was to dedicate her career to develop ability to fly an aircraft to its full capabilities.

Join Chuck and this fascinating guest for an in-depth discussion on this episode of *Soaring the Sky*.

Resources

- *ORKA* on **Facebook** and **Instagram**.
- *Running from Safety: an Adventure of the Spirit* — "an adventure of heart and mind fifty years ago … this encounter with his nine-year-old self Richard Bach tries to explain the things that really matter..."

- ***Soaring the Sky*** — "an aviation podcast all about the adventures of flying sailplanes. Join host Chuck Fulton as he talks with other aviators around the globe". You can also find Chuck's podcast on **Instagram**, **Facebook** and **Twitter**.

Subscribe to the Soaring the Sky *podcast on these preferred distribution services*:

- ***Podbean***

- ***Apple Podcasts***

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June 2023 | Aviation | Gliders | Podcast | Women In Aviation

"Robin DR400" (credit: Condor)

Condor Corner

Kato and the Ghosts

Scott Manley · Follow
Published in The New RC Soaring Digest
6 min read · 4 days ago

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The fifth of this series to appear in the New RC Soaring Digest. *The original version of this article first appeared in the June 2022 issue of* Soaring *magazine. — Ed.*

Prologue

Scott Manley

After two years and 80 training flights in the club environment, without earning his private pilot/glider certificate, Mark Griffith was beginning to wonder "what it was he didn't know". Having seen my lesson sequencing chart in *Soaring* magazine and been impressed with its organization and completeness, Mark contacted me with the hope I might help solve his mystery. Over the next three months, we met regularly online, with Mark completing my entire 32 session curriculum, including two lessons he later related to me as "having saved his life." After completing our online work, Mark traveled to Wisconsin where I was instructing at a commercial glider operation. Within the span of a week, after making a dozen actuals flights and conducting more than 30 hours of knowledge review, I had the pleasure of endorsing Mr. Griffith for his practical test. Twelve days later, having returned home and easily passing his practical test, Mark had achieved his boyhood dream of being a pilot.

Kato and the Ghosts

Mark Griffith

According to the record, prior to earning my private pilot/glider rating on 2 Oct 2015, I had logged approximately 40 hours of 'dual time' in *Condor* with Scott Manley as my very generous 'distance coach'. During these sessions, the realization that unexpected things can happen was brought to bear by the introduction of what was referred to as *Kato and the Ghosts*.

Kato was a character introduced in a 1936 radio program. He was a martial arts expert and assistant to the crime fighting main character, the Green Hornet. Kato's task was to keep the Green Hornet's awareness level sharp by jumping out unannounced from unsuspecting locations as if to attack. Ghosts are a feature of the *Condor* simulation software whereby one or more gliders can be made to appear unexpectedly to challenge the glider pilot during otherwise benign practice sessions. Ghosts can appear anywhere at any time, like Kato. The heightened sense of awareness and muscle memory that was developed from this expectation in *Condor*, resulted in positive outcomes to two unusual real-world flights.

Kato

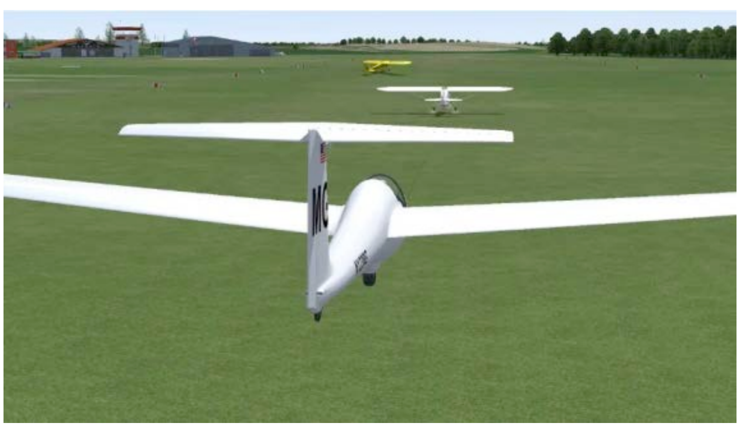
Logbook entry 28 June 2015:

```
Emergency release from aerotow, 10’ AGL. Runway incursion.
```

At our uncontrolled airport, we use radios to announce our intent to take off, glider in tow, a few minutes before and immediately prior to launch. As the takeoff ground run progressed, my glider had just lifted off when I observed another aircraft — Kato? — appearing to “hold short” at the fuel ramp, adjacent to and roughly two-thirds of the way down the runway. However, instead of continuing to hold for the tow operation, and without warning — no radio call — Kato taxied onto the runway in front of us.

Based on my training experience in simulation and hours of simulation-based practice dealing with what can go wrong at various points on an aerotow launch, I was already anticipating Kato. Even as my tow pilot announced our standard call: “abort, abort, abort” — which means release immediately and take care of yourself — I was off the rope, full spoilers, down and stopped behind the tow plane. Having powered down and applied hard braking the tow pilot, while coming within only a few yards of the offending aircraft, was also able to avoid a collision.

Completely unaware, the incursion aircraft taxied ahead to an intersecting runway and departed. We learned later that Kato was a training flight, with an instructor and student, distracted with the operation of an unfamiliar intercom.



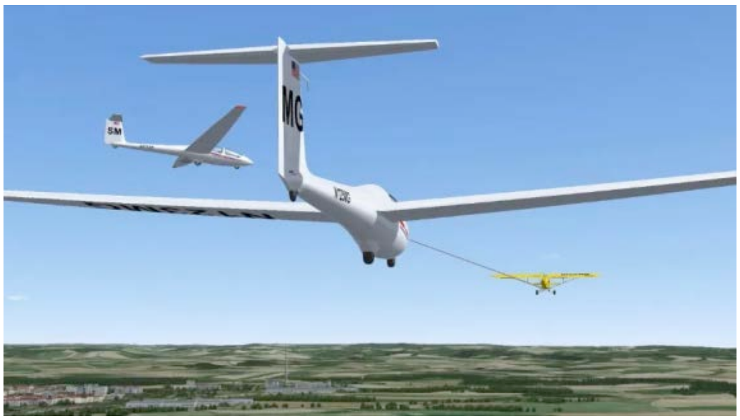
The Ghost

Logbook entry 1 Nov 2015:

```
Early release from tow, 800’AGL, abbreviated pattern/landing. Near midair collision.
```

After launching from our active runway, the tow plane initiated a smooth, climbing, turn to the left. As I was anticipating another left turn, I looked left to see another glider—the Ghost — at my 8 o'clock, slightly higher but very close. My immediate thought was that the other glider was either going to contact the tow rope or collide with me. Release, pitch down, full spoilers, big slip to lose altitude, smooth landing back onto the runway. On debrief, the other glider pilot never saw us on tow.

Thank you, Scott, *Condor*, Kato and the Ghosts.



Epilogue

Scott Manley

The two events related above could have had much more serious endings. Mark rightly credits his simulation-based flight training with adequately exposing him to situations rarely if ever experienced in aircraft-based training, affording him the opportunity to practice and perfect the procedural planning, situational awareness, prompt, proper decision making, and flight maneuvering skills required at various stages of an aerotow launch that terminates unexpectedly. For a review of my three-part series on premature tow terminations see the *Soaring Magazine* archive for my *Teaching Soaring* articles: September, October and November of 2020.

I recently developed a *Condor* flight plan to help rating candidates learn to scan for other airborne traffic. The scenario has the pilot flying in the vicinity of the airport and eventually entering the landing pattern. To make things interesting, as many as six other gliders — Ghosts — are simultaneously doing the same thing. In a future *Condor Corner*, I'll cover in detail how I developed this scenario and the *Condor* features and functions that make it such a valuable learning experience.

Congested Traffic Pattern is another lesson in my curriculum that helps prepare rating candidates for the unexpected. Using *Condor's* multiplayer function, I have candidates fly normal traffic patterns and landings while I play the role of Kato, repeatedly getting in their way by entering the traffic pattern in front of them and landing short, cutting inside them on base leg, appearing on a straight-in approach as they about to turn base-to-final on the same runway and then limiting their landing options by landing/stopping mid-field in front of them, approaching on a right base as they approach on left base, landing opposite direction on the same runway, simultaneously landing on an intersecting runway and similar.

Upon completion of this lesson, there is very little rating candidates have not realistically experienced and confidently dealt with, leaving them much better prepared to properly handle whatever real-world Kato throws at them. Just ask Mark Griffith.

Thanks for reading! Please leave any questions you may have for either me or Mark in the *Responses* section below — you get there by clicking the little 💬 below.

Resources

- ***Condor Corner*** in the New RC Soaring Digest. — The complete set of articles as they have appeared in this publication.

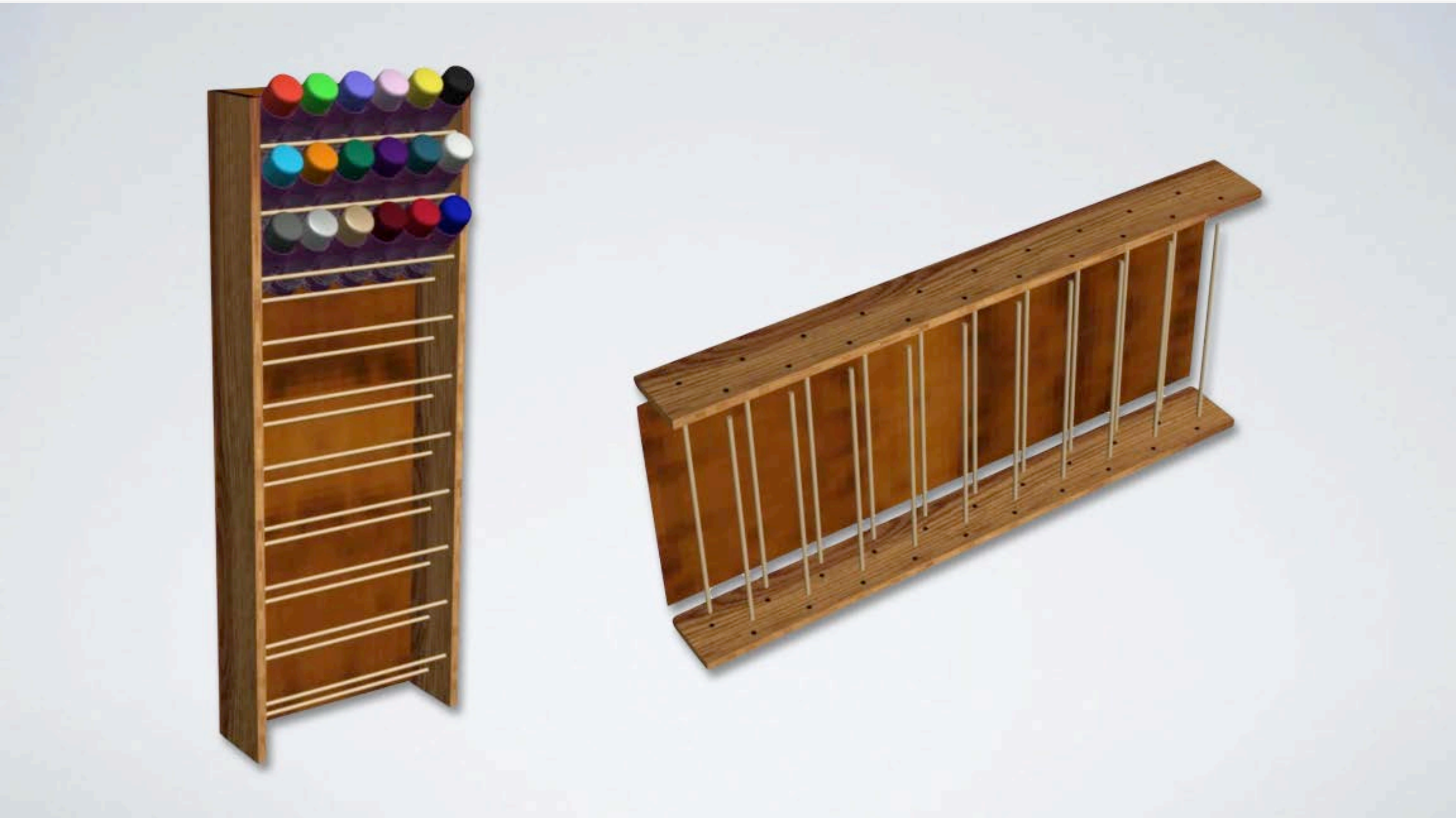
- ***Simulation-based Glider Flight Education***, the author's website. — "to provide you with the information and resources you need to self-manage the flight training and aeronautical knowledge development required to qualify for a Private Pilot Certificate with a Glider Category…"

- ***Condor*** — "simulates the complete gliding experience on your computer. With it you can learn to fly gliders and progress up to a high level of competition skill. The core of the simulator is the state of the art physics model and advanced weather model aimed at soaring flight."

- ***Soaring Magazine***, the official publication of the Soaring Society of America. — "each issue brings you the latest developments on safety issues, delightful accounts of individual soaring accomplishments, a sharing of ideas and experiences, tips from the great soaring pilots of our times, and…"

*Read the **next article** in this issue, return to the **previous article** in this issue or go to the **table of contents**. A PDF version of this article, or the entire issue, is available **upon request**.*

June 2023 | Flight Simulation | Aviation | Gliders | Safety Training



Very Simple Spray Paint Rack

Mere minutes to make but 30+ years to get around to it.

Tom Broeski · Follow

Published in The New RC Soaring Digest

3 min read · 4 days ago

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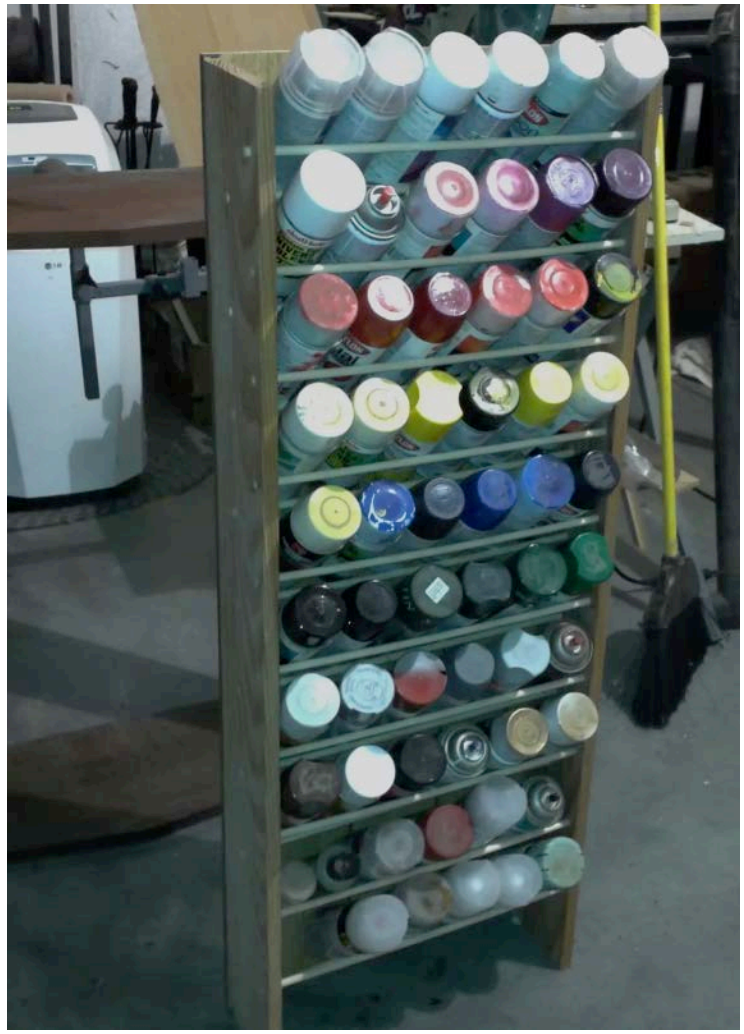
I've been needing a spray paint rack for years — I have a hundred spray cans on various shelves here and there. So, I finally built one.

I had some 3/8" dowels, an eight foot piece of 1x6 and a piece of scrap paneling. It took about 35 minutes to make but 30+ years to get around to it.

I cut the 1x6 in half and clamped the two pieces together. I measured down a couple of inches and drew a line across the board at 45 degrees.

Then I measured down 4 1/2" and drew a second line. I did this a total of ten times for the boards I had.

I then came in 2 1/2" from the back and 3/4" from the front of the board and marked the drill spot.



I then drilled a total of 20 3/8" holes, stuck in the dowels, put both sides together, found a scrap piece of paneling and screwed it to the back. You could put a couple of wheels on the back corners so you can roll it when tilted back.

If you put it on your *Round Tuit* list now, you should be cuttin' lumber 'round 2053.

Thanks for reading and if there is a particular tip you would like to see, please consider leaving a comment in the *Responses* section. You'll find it if you click the little 💬 below.

Resources

- ***Tom's Tips*** — The complete compendium as presented on the pages of the New RC Soaring Digest.

All images by the author. Read the ***next article*** *in this issue, return to the* ***previous article*** *in this issue or go to the* ***table of contents****. A PDF version of this article, or the entire issue, is available* ***upon request****.*

June 2023 | Makers | Hobbies And Interests | How To | Woodworking

Left: Stamp which is the subject of this article. | **Centre**: The pages from 'World Sailplanes, Volume II' covering the Košava. (credit: OSTIV) | **Right**: One of the two Košava's produced. (credit: Belgade Aviation Museum Photo Archive under under CC BY 3.0)

Stamps That Tell a Story

Honouring the Košava, a classic design by Miloš Ilić and Adrian Kisovec.

The New RC Soaring Digest Staff
Published in The New RC Soaring Digest
4 min read · 5 days ago

Listen Share More

This article first appeared in the April, 2003 issue of Gliding *magazine. Temporal references have been retained as originally written. — Ed.*

The day before the opening ceremony of the 13th World Soaring Championships in Vršac, the Yugoslav Post Office, Philatelic Services, issued a souvenir sheet with nine stamps of the same design. The postage stamp on the left shows the *Košava* (North Wind) two-seater high-performance sailplane.

Several stamps with a glider design were issued by this country in the past, so it is not surprising to see the *Košava* shown for this international competition. But one could question why a 'vintage glider' was chosen to help publicise the 1972 Internationals. No official documentation could be located, but here are some reasons which seem plausible.

The Yugoslav Flying Sports Organisation commissioned Miloš Ilić and Adrian Kisovec to design a sailplane similar in performance to the German *Kranich II*. The goal was a two- seater with good flying characteristics at high speeds and minimum sink at low speeds.

The resulting *Košava* sailplane was built by the Ikarus factory of conventional wood and fabric, and the prototype first flew in March 1953. According to the *World Sailplanes, Volume II* (see *Resources*, below) only two ships were produced. Thumbnails of the two pages covering the *Košava* are featured in the montage, above.

At the 1954 Internationals — at Camphill, England — this design, flown by Božidar Komac and Zvonimir Rain, took first place in the Two-Seater Class. In 1956, the *Košava* took second place at Saint-Yan, France.

The *Košava* was indeed a successful competitor in national *and* international competition and a tribute to excellent Yugoslavian sailplane design.

Plans for holding the 1965 Internationals in Yugoslavia were well along when disaster, a major earthquake, struck at Skopje in July, 1963. Having lost more than 1000 lives and with a city leveled, most upcoming international events were cancelled. England offered to take over and the 10th Internationals were staged at South Cerney.

Most likely the design of the postage stamp to be issued for the 1965 Internationals was already in the preliminary design stages. When Yugoslavia won the bid to hold the Internationals in 1972, the original stamp design was updated and made available for general distribution.

References

- ***The World's Sailplanes, Volume 2*** by OSTIV and available from AbeBooks.† — "256 pages; each craft described illustrated with photograph and scale drawings, as well as tables of data …"

- ***Sailplanes 1945–1965*** by Martin Simons and available from AbeBooks.† — "Soaring, after 1945, acquired a hard commercial edge that had not been apparent before. Something was lost. Something else, the modern sailplane, was gained …"

†*Also, make sure to check your local used book store for these titles — there's a reasonable chance they'll have them and it's always best to shop local if you can!*

Resources

- ***Stamps That Tell a Story: The Series*** — Catch up on your missing instalments of this excellent, informative series of articles presented previously in the New RCSD and of which this article is the most recent part.

Simine Short is an aviation researcher and historian. She has written more than 150 articles on the history of motorless flight and is published in several countries around the world as well as the United States. She is also the editor of the Bungee Cord*, the quarterly publication of the Vintage Sailplane Association. Simine is currently working on a biography of aviation and soaring pioneer Octave Chanute.*

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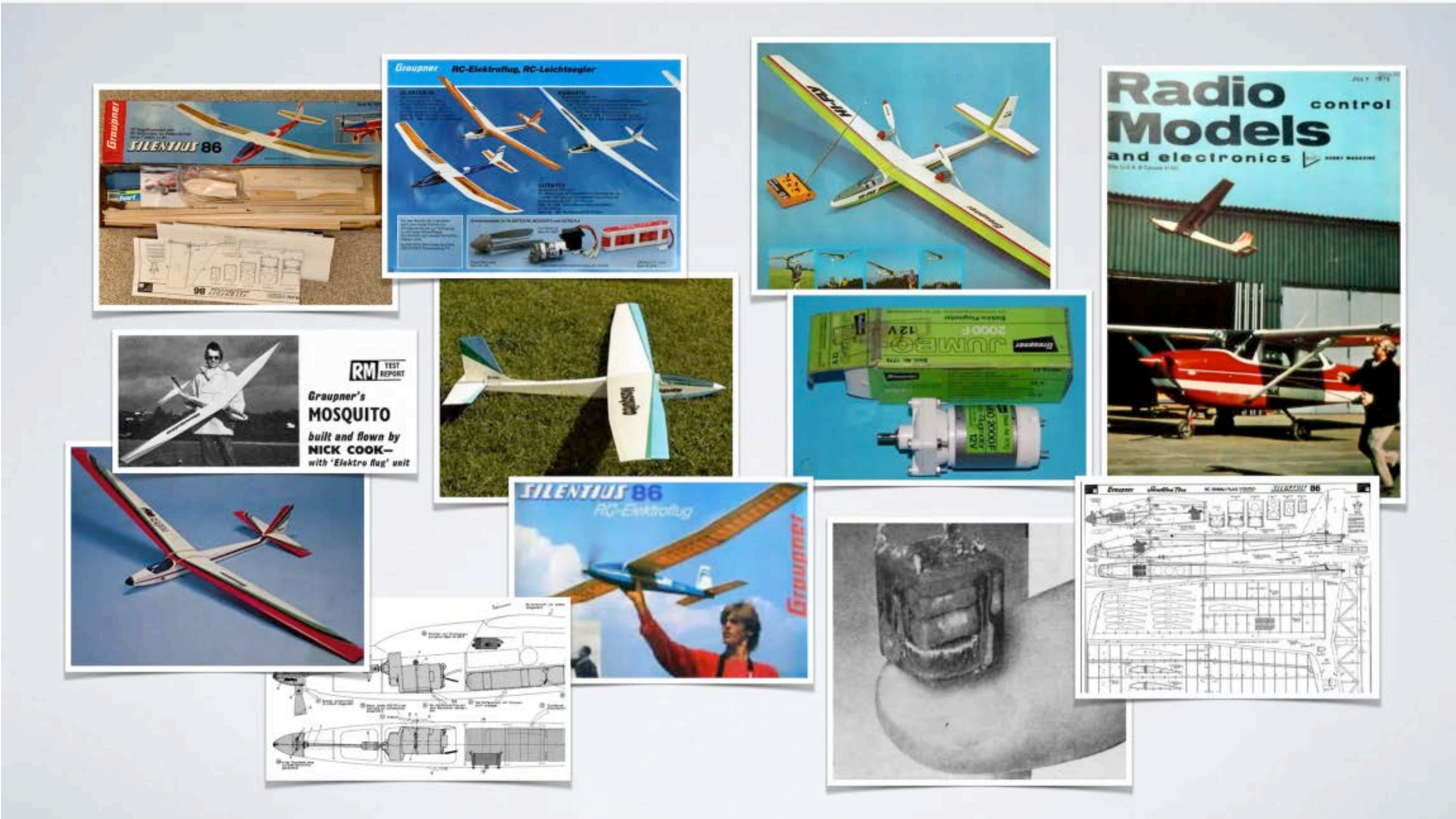
June 2023 | Gliders | Philately | History | Yugoslavia



The History of Electric Flight

Part II: The steady evolution of electric RC gliders at Graupner.

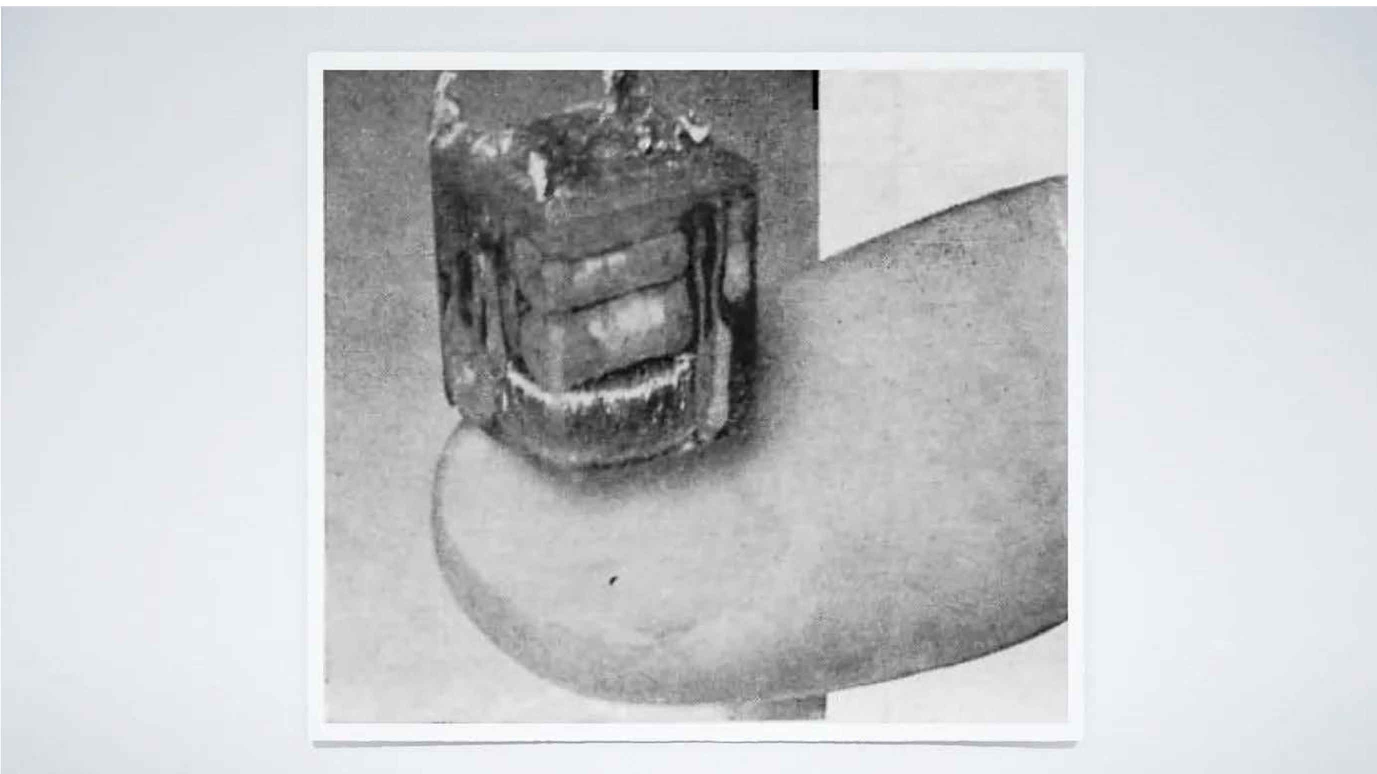
Mike Goulette · Follow

Published in The New RC Soaring Digest

7 min read · May 29

*Although not a prerequisite, you may want to read **Part I** before proceeding with this article. — Ed.*

In Part I of this series I covered the early history of electric flight in Germany, led by Fred Militky, Chief Designer at the German Graupner model aircraft company. As a footnote to that early development of free-flight models, in the March 1964 *Aeromodeller* magazine, it was reported that Militky had been able to put single channel radio in a stock *Silentius* using the remarkable Bentert 3.5g receiver and a magnetic actuator. The Bentert receiver was a super — regenerative design on 27mHz and was completely sealed in epoxy resin. Together with the magnetic actuator it gave proportional control of the *Silentius*' rudder although only one model could be flown at the time without interfering with each other. A long cry from today's frequency hopping and, essentially, interference free radio systems where we take 3.5g receivers for granted!

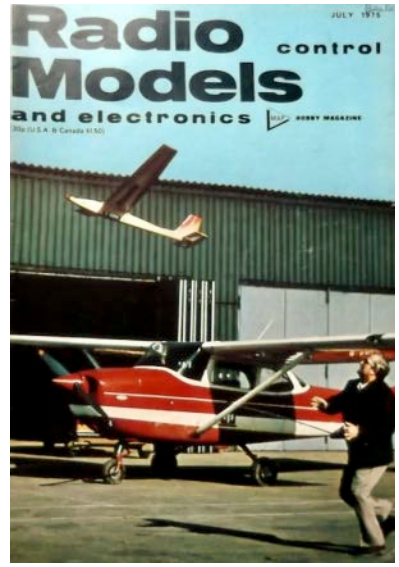


The Bentert receiver used in the Silentius was literally thumbnail size!

This time I will follow Graupner's developments a bit further, starting with the Militky designed *Hi-Fly* model that I showed last time held by the designer in front of his pioneering full-size electric motor glider. The *Hi-Fly* was introduced in 1973 and could be built in three versions: a pure glider, with an IC (internal combustion) power pod over the wing and also with twin electric pusher motors mounted on the wings. The geared motors were designated *Jumbo 2000F* and were made by the German Marx company. The nominally 12V brushed motors were geared 5:1 for driving folding pusher propellers. The motor mounts were corrugated, presumably for cooling and, if you want to recreate the appearance of them on a modern build there are files for a 3D-printed replica on Thingiverse — see *Resources* for the link. The 3D-printed version will house a modern brushless motor. There is contact information on the Thingiverse page to obtain a CAD version of the *Hi-Fly* plan if you want to laser cut a kit. There is also a scan of the original plan on Outerzone which is also linked in *Resources*.

Left: Graupner Hi-Fly with twin pusher power. | **Centre**: The Hi-Fly motors were made by the German Marx company for Graupner. | **Right**: The Hi-Fly was Graupner's first RC electric glider. (credit: Graupner)

The Marx motors were high quality and efficient but not capable of very high power hence the need for two of them to power the *Hi-Fly*. Militky's next design overcame this problem by making use of a inexpensive Japanese brushed motor with decent brushes that could handle a lot more power. Graupner designed their own gear box and a neat extension shaft to a nose mounted folding prop for the *Mosquito* model that was introduced in 1975. One of the problems at that time was that there were no electronic speed controllers so motors were switched on and off by a servo driven microswitch. The sudden torque of start up to full power could damage the gear box so a neat shock absorber was built in the drive train using O-rings to absorb the loads. The *Mosquito* was the first of many designs to use a similar drive set up and would not look old-fashioned on today's flying fields. I have linked the plan in *Resources*, below.



Left: The Graupner Mosquito used a nose-mounted geared Mabuchi motor. (credit: 'Oliver S' / Outerzone) | **Right**: The July 1975 cover of the British RCM&E magazine showed Fred Militky launching his prototype Mosquito. (credit: RCM&E)

The motor used in the *Mosquito* was the Mabuchi *RS 540*, later better known by the Graupner designation of *Speed 600*. This 6:1 geared version drove a 14.5in diameter folding prop and was designated *Jumbo 540 FG6*. It used a seven cell NiCad pack for power. Until the advent of inexpensive brushless motors from China, the *Speed 600* and its smaller brother, the *Speed 400* were the workhorses of economical electric flight around the world and I will return to them in a later article.

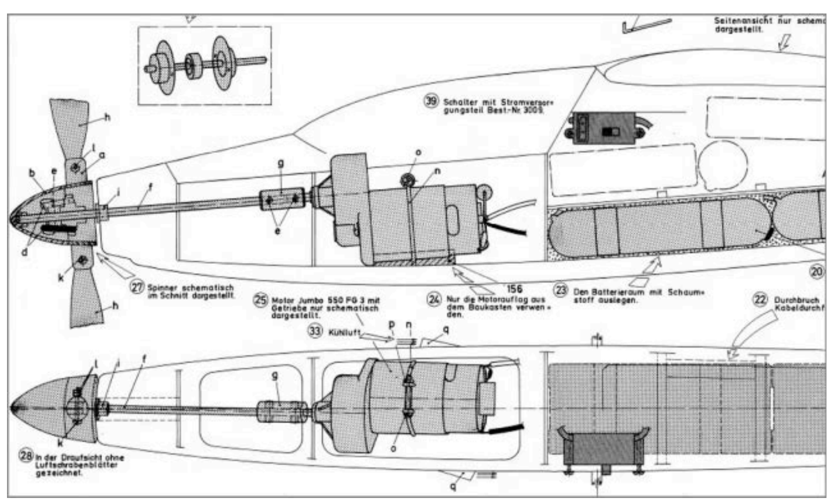
The *Mosquito* was reviewed by Nick Cook in the British *Radio Modeller* magazine. Nick was very impressed by the quality of the kit and said:

> *"all the pre-shaped components fitted exactly and all the rough cut parts were just oversize. That's what properly engineered kitting is all about."*

Graupner kits were quite a contrast to the cottage industry UK kits of the time. He was also impressed by the performance of the model which took about three minutes to climb to about 150 metres. Three climbs from a single charge gave consistent flight times of around 25 minutes without thermal assistance. Practical — and economical — RC electric gliding had arrived!

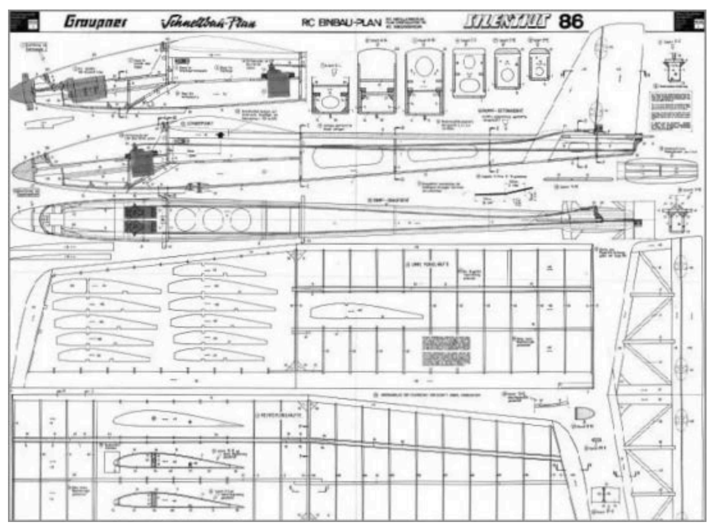
Nick Cook reviewed the Mosquito in Radio Modeller. (credit: Radio Modeller)

In 1979 Graupner reissued the *Hi-Fly* with a single geared motor, this time mounted in the nose, and renamed the model *Ultra-Fly*. The shock absorber was now incorporated in the nose spinner which made for a neater and easier installation. The new, lower KV, motor ran on ten cells and was designated *Jumbo 550 FG3*. The two packs of five cells each slid sideways in to the base of the fuselage and an electronic relay switch was used for motor control. The installation diagram from the kit shows how this all fitted together and how down and right thrust was built in to the model. I suspect that the climb performance with the new motor and cell combination was significantly better than the *Mosquito* but I have not been able to track down a review online. I have linked the *Ultra-Fly* plans below.



Left: The Ultra-Fly was a reissued Hi-Fly with a geared motor in the nose. | **Right**: The geared motor was installed in the Ultra-Fly nose with down and right thrust. (credit: Graupner)

For the 25th anniversary of Fred Militky's original free-flight *Silentius* kit release Graupner brought out the two metre wingspan *Silentius 86* electric RC glider. This used a newer version of the geared Mabuchi motor running on seven cells, simpler construction than its predecessors and a modern lower cambered wing section. Altogether, a very practical model. At the first electric World Championships in Belgium in 1986 the Graupner display team had a fleet of these models in identical colour schemes and displayed them to great effect. Graupner distributed a poster at the event to show off the *Silentius 86* which also had a thumbnail picture of Militky launching the original free-flight *Silentius* which I featured in Part I of this series. I was flying at the event and brought a copy of the poster home which now refuses to lie flat to be photographed. I could only track down a low resolution image of the poster but it does show the link between the two models and the colour scheme of the display models.



Left: The Graupner team displayed the new Silentius 86 at the first electric world championships in 1986 | **Right**: Silentius 86, released on the 25th anniversary of the original Silentius. (credit: Graupner)

By 1989 Graupner had rationalised their electric glider range and all three models were offered with the same drive train of a geared Speed 600 motor and seven 1.4Ah NiCad batteries.

Left: Silentius 86 was a quality Graupner kit. (credit: author) | **Right**: The 1989 Graupner catalogue showed that the Mosquito, Ultra-Fly and Silentius 86 now had a common drive-train based on the geared Speed 600 and seven 1.4Ah NiCads. (credit: Graupner)

Unlike the other models above, the plans for the *Silentius 86* do not appear to be on Outerzone at this time. If anyone has a plan tucked away please let me know so that it can be scanned and made available to the community.

Next time the story moves across the Atlantic to the USA and the pioneering work of a pair of brothers — the Bouchers. Please leave your comments in the *Responses* section below, which you can access by clicking the little 💬. I would love to hear what you think! Thank you so much for reading and see you next time.

Resources

- ***Graupner Hi-Fly*** scanned plan and photos from Outerzone. — "from Graupner kit #4239. Note the *Hi-Fly* was available in two versions: as a glider and as a twin-engined electric model…"
- ***Graupner Jumbo 2000F Motor for Hi-Fly*** from Thingiverse. — "This is the motor for the Graupner *Hi-Fly* electric RC soarer of the 70s. This is a wooden soarer with 2.30m span, which flew extremely well and I wanted to build the model again, after about 40 years…"

- ***Graupner Mosquito*** scanned plan and photos from Outerzone. — "Electric glider model. Wingspan 250cm … A very good model manufactured by Graupner. I have three…"

- ***Graupner Ultra-Fly*** scanned plan and photos from Outerzone. — "Radio control 2.3m electric sailplane model. Graupner kit #4257.…"

*Read the **next article** in this issue, return to the **previous article** in this issue or go to the **table of contents**. A PDF version of this article, or the entire issue, is available **upon request**.*

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The Ed at the end of what he says was one of the best days of his life. (credit: Michelle Klement)

The Trailing Edge

Happy trails.

The New RC Soaring Digest Staff

Published in The New RC Soaring Digest

2 min read · 4 days ago

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By now you will likely have read the news which *The Ed* broke in his *In the Air* column (see *Resources*) this month. If not then you won't know this is, in fact, the last issue of the New RCSD. To be candid, we really don't know what to say, so we'll let Dale Evans do it for us:

> Some trails are happy ones,
> Others are blue.
>
> It's the way you ride the trail that counts,
> Here's a happy one for you.
>
> Happy trails to you,
> Until we meet again.
> Happy trails to you,
> Keep smiling until then.
>
> Who cares about the clouds when we're together?
> Just sing a song, and bring the sunny weather.
>
> Happy trails to you,
> Until we meet again.

It's been a slice, folks, and we're really sad to go. We'll see you on the slope someday. Until then …

Get out there and fly!

Resources

- ***In The Air: All (good?) things must come to an end*** by Terence C. Gannon in the June, 2023 issue of the New RCSD. — "It is with a mixture of regret and relief that after 30 issues of the New RC Soaring Digest, I announce this will be my last …"

- ***Happy Trails*** on Spotify. With apologies to Dale and Roy, we prefer the drunk-sounding, post-apocalyptic version of the cowboy classic recorded by the *Quicksilver Messenger Service* in 1969.

*Read the **previous** article or go to the **table of contents**. A PDF version of this article, or the entire issue, is available **upon request**.*

June 2023 Gliders Aviation Goodbye Happy Trails