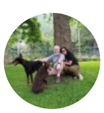
Alpina getting the old heave ho. (image: Gerard Risbourg)

Designing for an Alpine Soarer

The hills are alive...with sailplanes designed for for the rigours of mountain soaring.



James Hammond Follow
Jun 9 · 16 min read

This is the last in my series of four articles on design, but fear not, there is more coming. In an article in the near future, I'll be highlighting the Aeroic Sine Wave Spar (ASWS) — a feature now used to great effect in all my models. For this article I'm going to go through the design processes used in this case for my Alpenbrise (Alpine breeze) alpine soaring model. I don't really know how others do their designs, but what I can do is to let you in on how I do it; so, I do hope that this article will help to give you an insight into the thought progressions behind the model's development. Hopefully it won't be too boring. — JH

Alpine: Related to High Mountains

Photo 1: Can you imagine? The lift is all around you… (image: Hahnnenmoos Burger Hotel)

Well Then, What's an Alpine Soarer?

I'll answer my own question: they are designed to fly in the mountains and valleys; typically, an airframe that's larger than we have been dealing with so far. An alpine soarer is a model that's designed to have the ability to fly higher and further than any of my previous design studies, by utilizing the different kinds of lift that mountain sites provide.

Alpine Flying?

Before doing anything else, we have to try to understand the potential flying conditions that we are dealing with, as this will have a very direct effect on how we set out our model design. We have to realize that there can be real differences in alpine soaring when compared to slope flying. A mountain flying site can be a really diverse flying environment to let's say a hillside, or maybe an ocean-facing slope. One thing that remains the same is that our models are flying on updrafts of air. The sources of the updrafts can however, be quite unlike those associated with 'normal' slope flying.

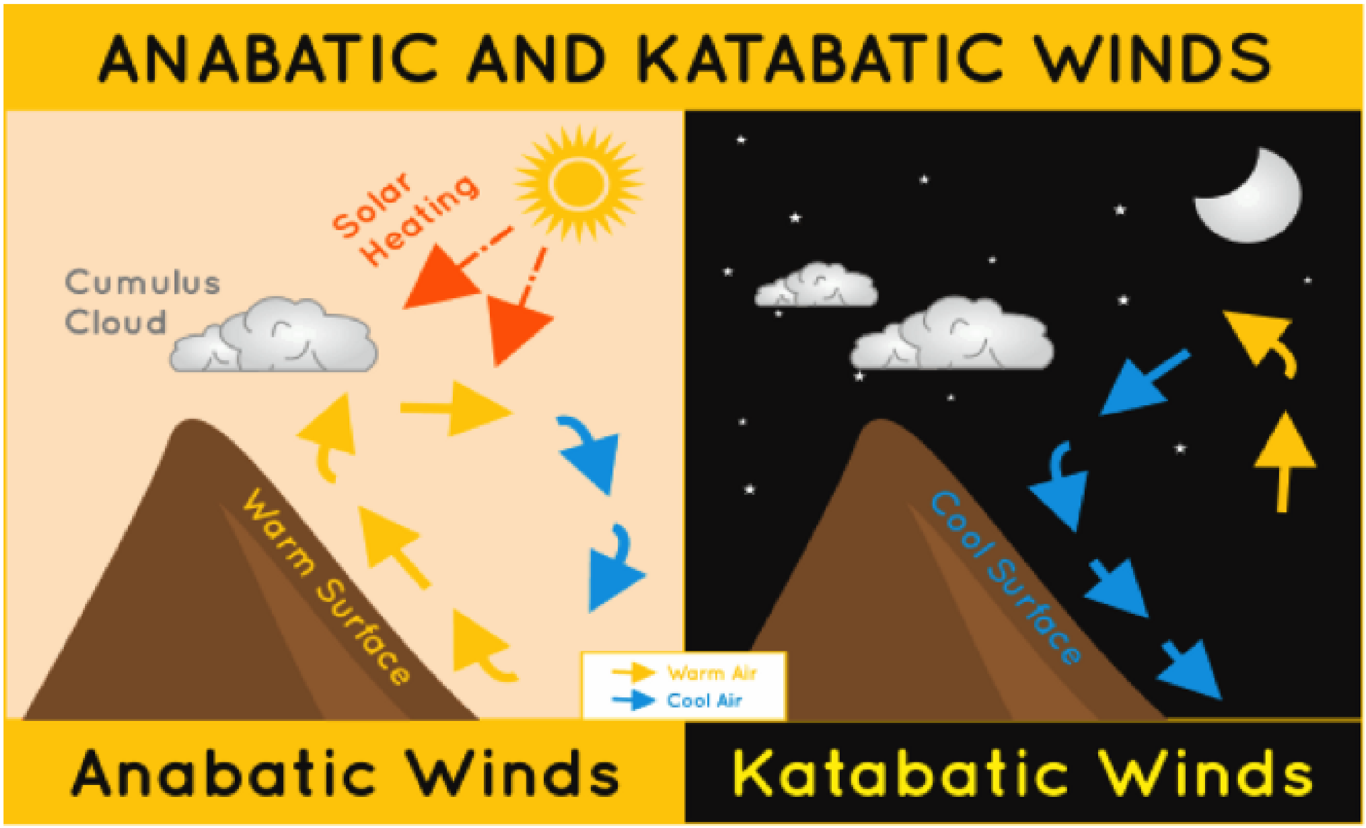
Lift

On a hillside or an ocean slope, most of the lift is coming from wind directed upwards by running into an angular obstacle, with the occasional thermal thrown in if we are lucky. However, on a mountainside, though we still find thermals — sometimes huge ones, typically the air is naturally flowing upwards as a result of thermal difference — hot air rises. Since the valleys are typically flat, may have roads, may be cultivated, and may have towns or villages; the temperatures at the lower elevations will normally be higher than those at higher elevations. Added to that, the surface of the mountainside over which we want to fly is probably being heated by the sun too.

Photo 3: The Famous Hahnnenmoos pass — would you like to fly against that backdrop? (image: Modellfluggruppe Wohlen)

Night and Day

Many alpine (mountainous) flying sites, especially those in Europe where alpine flying originated, have air constantly flowing up the mountainsides as heat rises. A good example in the USA is the Mammoth Mountain area where depending on the temperature differences, the daytime rising air flow can be sluggish or really quite fierce, but unless there are some really adverse wind conditions, the lift is almost always there. This is explained by simple thermal activity in the form of anabatic airflow (daytime) versus katabatic airflow (night time)



Drawing 4: (image: Pinterest)

Get the Feel

I have often stood on mountainsides in central Taiwan marvelling at how small clouds or skeins of mist seem to be rushing up the mountainsides all around me, or maybe on a distantly visible mountainside, but always quite fast — yet I can feel little or no actual wind. This is alpine lift. Sometimes you can't see it, most of the time you can't even feel it — but it's there. Now we know what we are dealing with, what do we need to make a model that will fully utilize this 'ghostly' lift?

Size Matters

The first thing to realize is that alpine lift can be very variable — even on the same day, in seemingly the same conditions, and it can be hard to gauge. So, to get the most out of it we need a model that's probably larger than the average slope model. A good example of a model that was specifically designed to fly in alpine lift conditions is the now classic Multiplex *Alpina* — as its name suggests. The *Alpina* flew incredibly well, it would hang in low lift, shriek through the air in good lift and was really very aerobatic — in short everything we would want, so it's a really good model to study if we want to make our own alpine soarer.

Grunt in the Front

Last but not least of the flying performance design considerations is the provision to easily fit an electric motor drive. This not only makes the model more adaptable, it also makes it suitable for the smaller GPS Triangle racing classes — though a propeller on the front does not please all of the purists! It's an easy provision actually as it only needs the front couple of inches of fuselage being perfectly round to be able to accommodate a spinner.

If we study a bit, we find that in fact, the actual differences between a small GPS class soarer and an alpine model are almost zero. Both fly higher and further than we would typically venture on a slope, and both are relying for the most part on non-slope type lift, so although I'm calling this an alpine soarer it could easily be classed as an alpine/GPS model. In addition, having a motor in the front and a larger battery to drive it; to many people represents 'payload' which is far, far, better than adding lead slugs in the front.

> Takeaway: Alpine flying is not the same as slope flying, though some aspects can be similar.

> Takeaway: Models fly higher and further, so they are better designed larger.

> Takeaway: Design your model with provision for an electric motor up front — you never know.

Multiplex Alpina: Possibly the First Alpine Soarer?

Photo 5: Alpina — the beautiful lines of a classic in every way. (image: Gerard Risbourg)

Wings

Four meters span (158") which would be large for a non-scale slope model, but it has a nice scale look. The aspect ratio is over 20:1 which again is pretty high, and more in keeping with scale or full-sized sailplanes.

Aerofoil

The aerofoil is a Ritz 3–30–12 which is a 12% semi symmetrical non-undercambered section with a slightly blunt leading-edge — which to our modern-day eyes may look a little strange or maybe dated on a glider. Nor is this a section I would have chosen, but the key point is, it works.

Fuselage

More like a slimmed down ASW or other scale model type rather than the broomsticks we use on our fast slope models. Lots of room for a motor if needed, retracting undercarriages, servos and radio gear, tow releases and the like. The general feeling is of an attractive scale type arrangement.

Horizontal and Vertical Stabilizers

Large and nicely proportioned vertical stab with a huge rudder. Horizontal stab oddly is of the all-moving (AMT) type. Again, this is not something which I would have done — but as usual it works well enough.

Performance

In short, a model that really did exactly what it was designed to do. With its long high aspect ratio wings its rarely caught out by light lift, with the thicker 12% section it will do spectacular big air manoeuvres with great energy retention, and on those low, fast, fly-bys, it sings a lovely song.

Overall Impression

This, to me at least, is very important. The original *Alpina*, as designed is a true classic and although there have been many attempts to improve on it with various 2001, 3001, 4001, versions, and now I see we have a 5001 version, I'll stick my neck out as usual and say that to me all of the 'improvements' have failed to retain the most important aspect that I am looking for which is the wonderful looks of the original — especially in flight. If the machine works…

Photo 6: Perfect proportions and outstanding flying characteristics…if it looks good… (image: Gerard Risbourg)

> Takeaway: For good start off information on what is good, take a look at the successful past and present designs.

> Takeaway: Learn from the models available, look at the specs, make use of the valuable lessons that can be found in them.

Now Let's Look at Our Own Alpine Soarer Design

Now that we have more understanding of what we need, and what has already been done, let's look at our own design.

Concept to Model

As many of you will now understand,what I tend to do before designing any model is to try to figure out what I want to achieve, and then to make a list of design points that I hope will achieve those goals. When that list, let's call it a 'design envelope' is completed — and assuming that all the things that I want are actually compatible with each other, I start sketching. The key point here to get all the technical stuff onboard first, and *then* tweak the boxes to make it look beautiful. You can have the most beautiful model in the world but if it won't fly well in the conditions it's supposed to, then its pretty useless. By the same token, a bunch of boxes just strung together is like a box of spare parts and unlikely to give much satisfaction.

Flying Environment Requirements

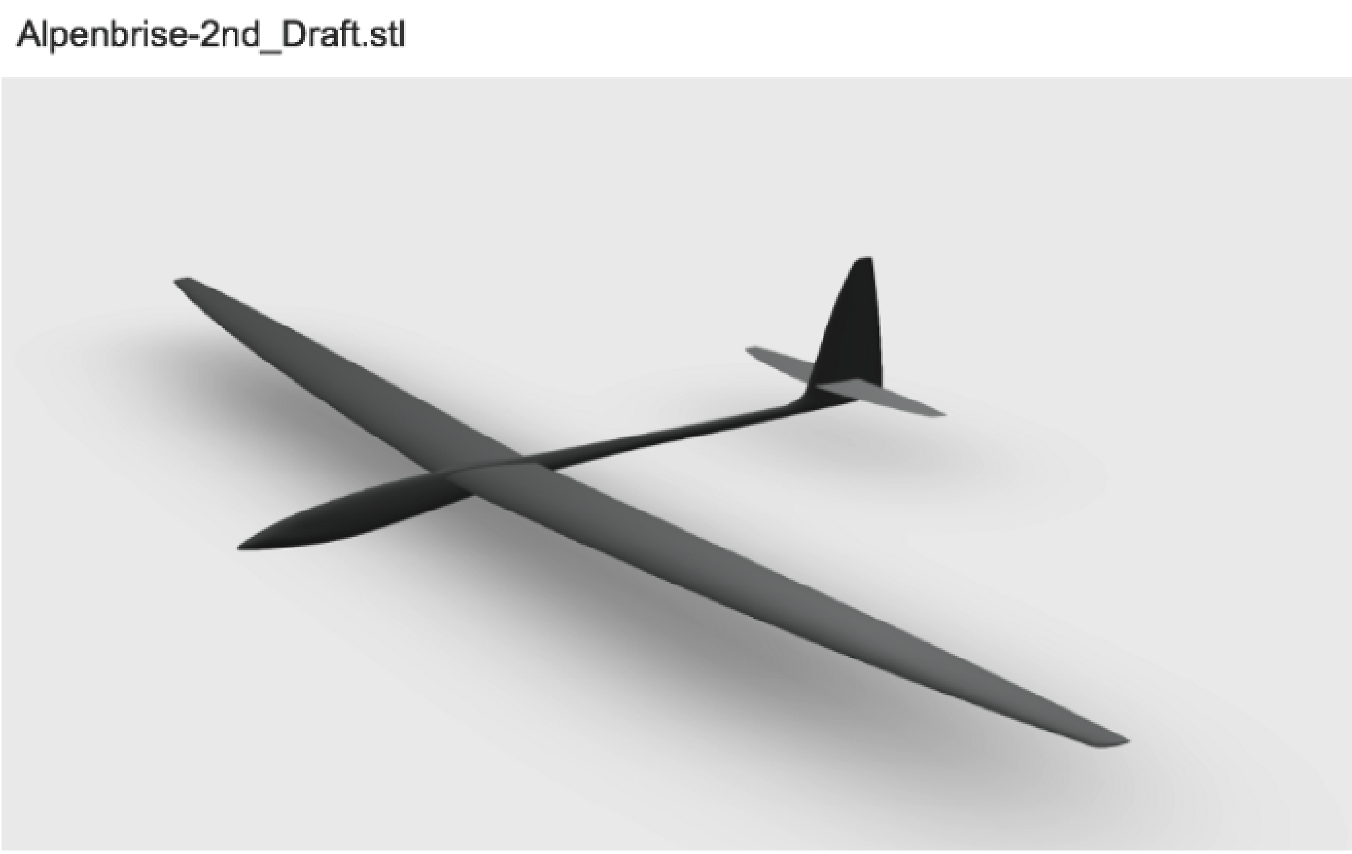
For alpine flying, let's imagine a flying place that has suddenly been 'de-restricted' and by that, I mean that most, if not all of the slope restrictions have gone. No more need to fly in the compression band, no need to fly so close to the edge, no need to avoid rotors or no lift zones, and as long as the model can be seen then it's mostly possible to fly further and wider than would be possible to fly on a simple slope. All that against a backdrop of snow topped mountains? I'm in!

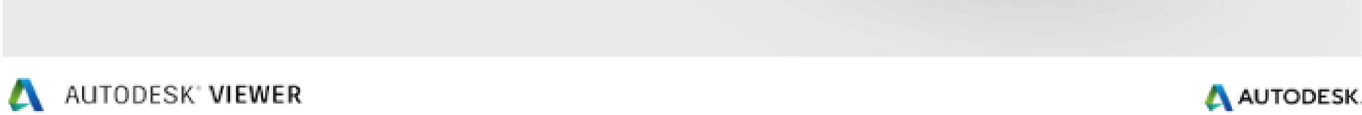
Make Your Mark

One point here, when designing a model for yourself, it's not always a good idea to try to do better than any existing design — unless of course you are a hardened competition flyer who will demand the sharpest of cutting-edge performance. Sometimes it's better to take the lessons learned from what's available and then use the parts that you like in your design, but please don't forget that you have a golden opportunity to put your own unique stamp on the resulting model.

> Takeaway: Take time to jot down the requirements personal and practical for your model before putting pen to paper.

> Takeaway: Only AFTER deciding your technical design envelope is it time to bend and curve to make your model beautiful.





Drawing 7: Alpenbrise initial CAD rendering. (image: Dr. James Hammond)

The Decision Tree Is Planted

What Is Different From What We Have Done Before?

We'll be flying further, probably higher, maybe even faster at times than we would with a racing slope model. Bigger models are better we know, but bigger is also potentially faster and definitely more efficient, plus much easier to see at distance too.

Scale Effect

The bigger the model gets, the thinner, or relatively less viscous the air becomes, relative to it. That's why if a full-sized aircraft prototype is to be wind tunnel tested, then to give meaningful results the test model needs to be at least 33% of the full size. This is the area that we begin to enter with these larger alpine models, and so the aerofoil considerations change when compared to a fast slope plane.

> Takeaway: Try to study what you need and make decisions on each important part of the model design before drawing it up.

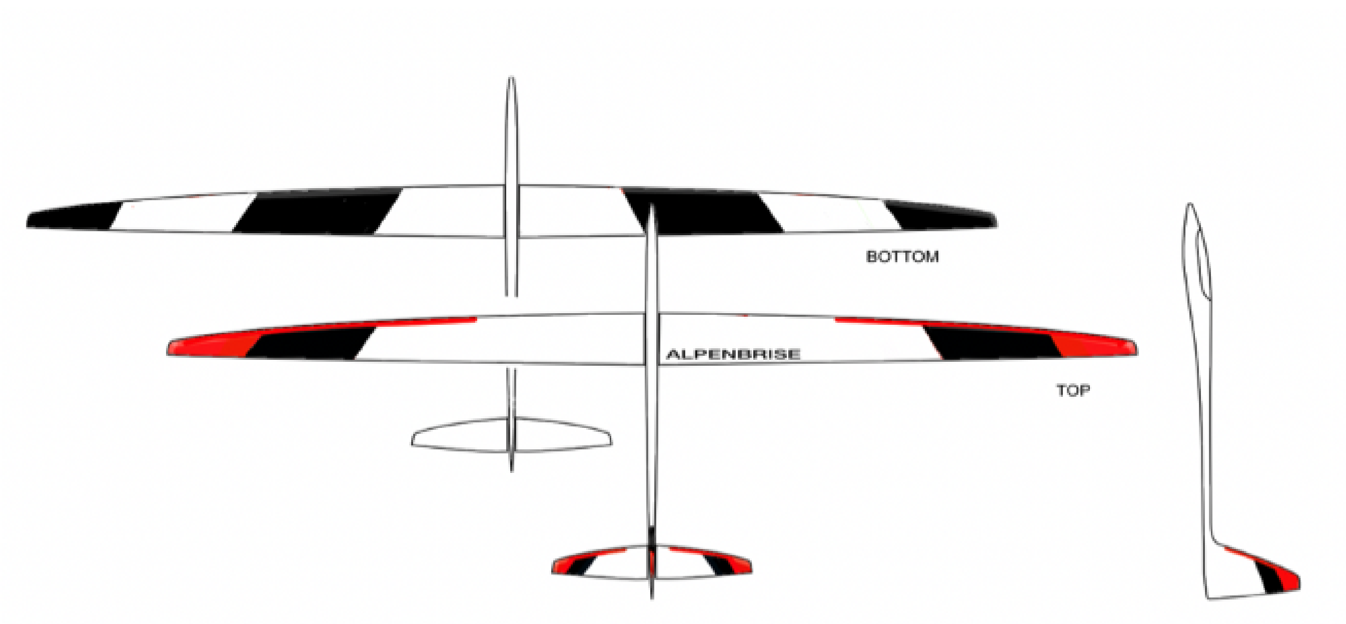
Wing Span

As usual the first decision on which everything else follows is how big are we going to make our new model. As this will be a specialist model, designed for its job, we need for it to be big enough to perform really well, yet not so large as to cause severe transport difficulties, so let's limit ourselves to four metres (150" to 160") right now.

Although bigger is better — *always* — any larger than this and for many, except possibly the super-scale enthusiasts, the problems with transport and storage, plus spouse/partner pacification could become a serious problem. Added to that the aerobatic performance, especially in roll and stall turns, tends to suffer if the aspect ratio is too great in favour of span. Last but not least on wingspan, let's face it, if we wanted a six- or seven-meter monster, then there are now so many ¼, or even ½ scale models out there — if you have the craving and the disposable budget.

Wing Planform Design

As any of you who have read any of my other articles in this series will understand, for any high-performance model that I design, I am a firm proponent of putting the wing area, which is to say lift, where it's needed and only where it's needed. There really is no point in having oar-like wings with loads of area out near the tips. It's just not needed there and can cause a wide variety of unwelcome problems.



Drawing 8 (image: Dr. James Hammond)

Aspect Ratio

Since fast turns are no longer critical on our alpine soarer, we can shift our attention a little to think about a wing that will be somewhere in the middle of the requirements for out and out speed, but also provide agile turning ability. I have designed my *Alpenbrise* to be in that ballpark at a little over 22:1 — so it's not up there in the scale zone of 25:1 or even higher, nor yet down in the three-meter performance area of 19:1. In this way with good chord — think 'lift' — distribution we will be in a good position for both speed and turning and at four meters the wing area will give a low wing loading that will be adequate for very light air operation if needed.

Chord Distribution

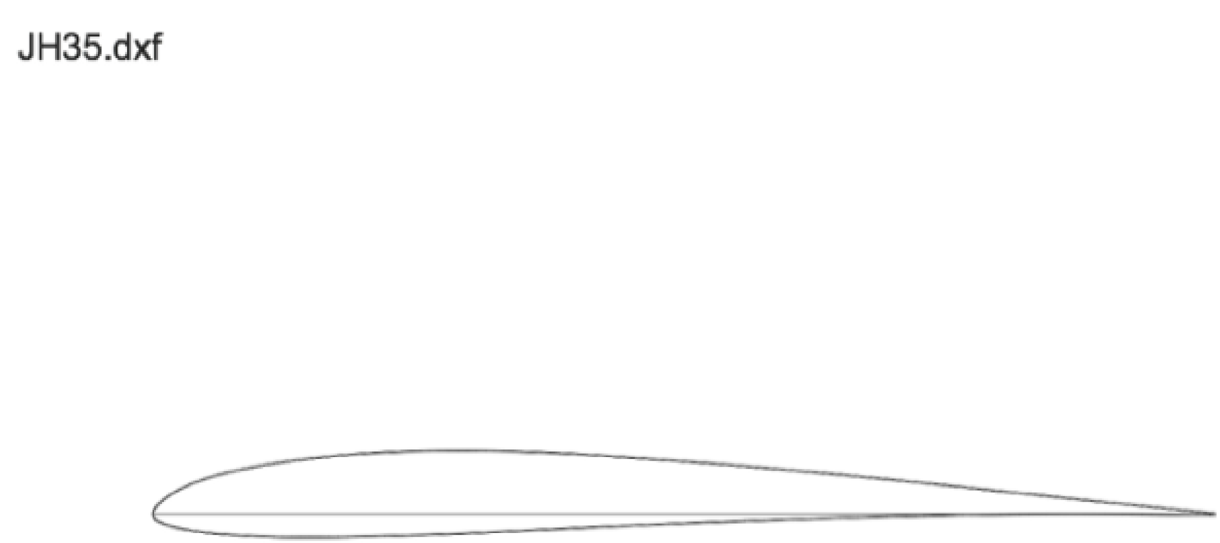
Many people have been concerned at first when they see the shape of my wings with small tips, but actually alarm has turned to happiness after they fly them.

Setting the lift in the right positions, in the amounts we need and no more makes a very fast yet well behaved wing, which will not only accelerate like a racing snake, but at the other end of the flight will also slow down well with no problems. I always plan the chord distribution on my wings to end up with a tip chord that is half the mean chord. There is no real formula for this but it works very well. As usual I design an elliptical curve with the leading edge sweep back roughly twice that of the trailing edge. As we have learned before, this slightly separates the MAC and the CG positions to give a nice stable yet responsive wing.

Aerofoil

This is a very important part of any design but as I have mentioned in previous articles, it is not the be-all and and-all, not yet does it have the greatest influence on the overall performance as that honour belongs to the wing planform design.

This is a larger model than we have been talking about before, and it will operate in a different environment, so logically it might need a somewhat different set of performance goals — similar to say a racing model but not exactly the same.



AUTODESK® VIEWER AUTODESK.

Drawing 9: JH35 High lift/high response aerofoil. (image: Dr. James Hammond)

Thickness and Camber

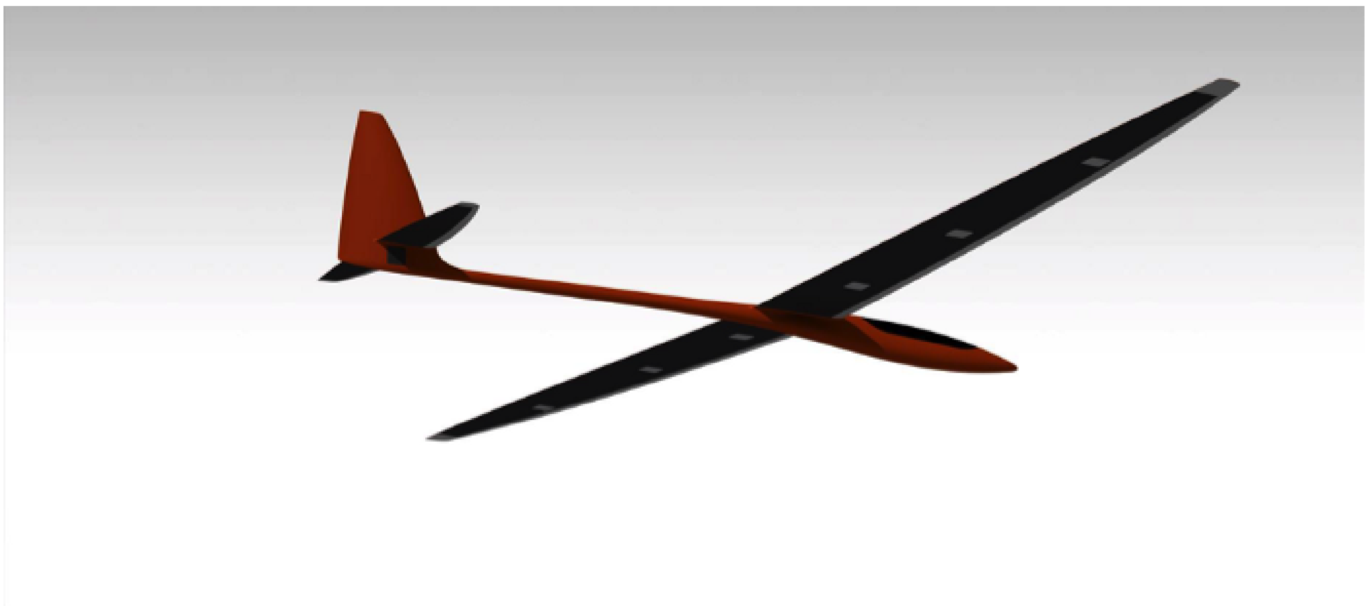
Where we wanted to get a nice balance of lift versus drag on our fast slope racer, the chord length on the alpine model has increased and this gives us more scope. As the alpine airframe gets bigger, and the drag influences on the model become less of a consideration, we can now begin to consider aerofoils with more thickness and more camber. This also helps with the construction as a thicker aerofoil gives a thicker spar and internal construction can be made stronger but without much weight penalty.

Which Section?

For the new *Alpenbrise* model I'm using a new section: JH35–9 which was a result of some recent research that was not actually aimed at models, but seemed to have all the parameters I'm looking for to use for an alpine soarer.

Photo 10: Beautiful lines even 40 years ago. (image: Gerard Risbourg)

In fact, there are suitable sections such as the HQW series by Dr. Quabeck, the RG 15 by Mr. Girsberger, and many others and the selection becomes easier as we enter the larger airframe performance envelope. Low drag, good lift, no drag bucket, around 9% thickness or even thicker with the right aerofoil. As a hint, I think if I were starting out, what I might be tempted to look at would be the GPS model sections as the performance requirements are very similar to that of an alpine soarer. The original *Alpina* used a Ritz 3 section.



Drawing 11: My 'Alpenbrise' Alpine/GPS soarer — hopefully a tribute to the great Alpina. (image: Dr. James Hammond)

> Takeaway: With a larger alpine soarer, we are beginning to get into the realm of full-sized sailplanes.

> Takeaway: Typically, thicker sections can be used on larger models than those we need for their smaller brethren.

The Back End

Horizontal Stabiliser

Here we need to consider the stabilizer aerofoil to be used, the tailplane area and whether to go for an all moving tail (AMT) or a conventional elevator setup.

Stabilizer aerofoil choice is not too hard and there are many sections to choose from: A symmetrical aerofoil of between 7 to 10% is required. As usual I use my JHSYM-9 at a controversial 9% thickness — probably more thickness than most people would go for, but as mentioned in my other articles, 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.

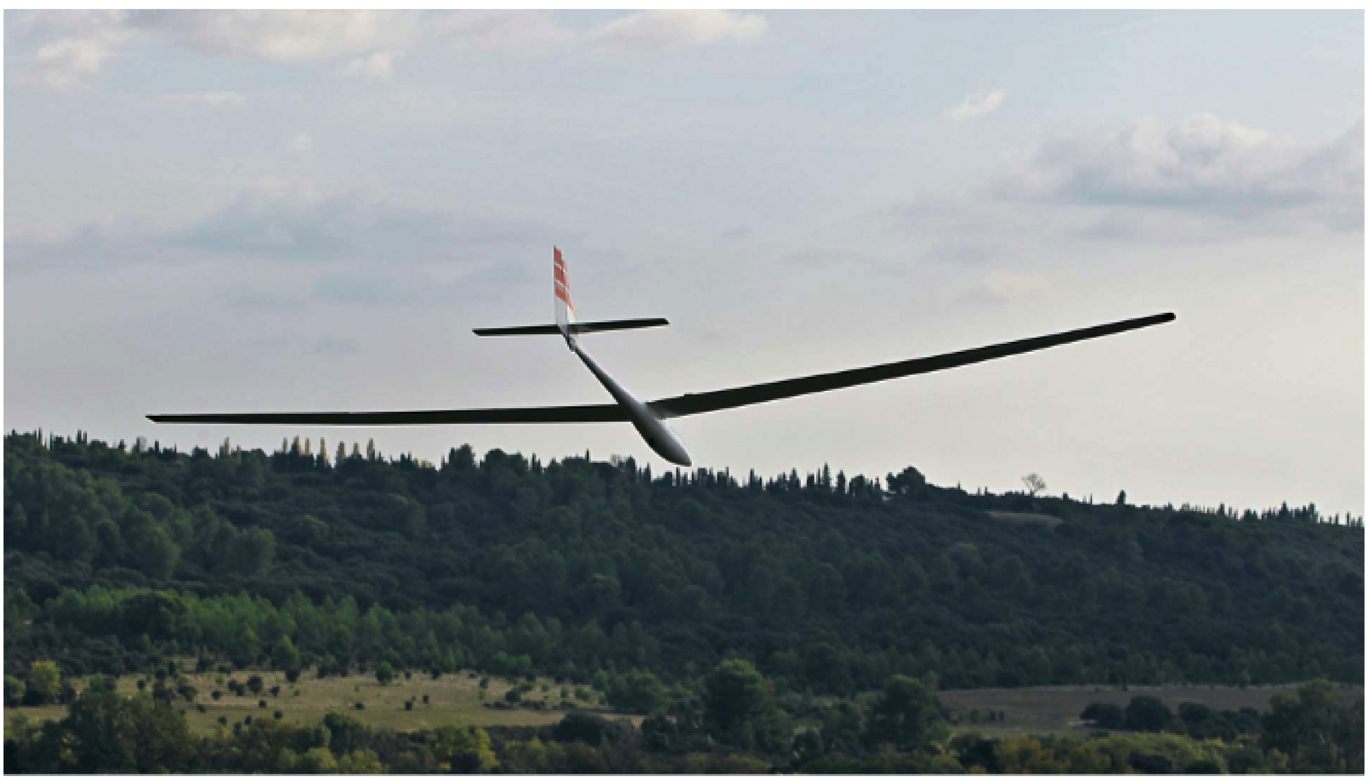


Photo 12: Off we go… (image. Gerard Risbourg)

Stabilizer Area

If you go for 10% to 15% 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.

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 all-moving tailplane (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?

As usual, 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.

Cross-Tail, V-Tail or T-Tail?

It's entirely up to you. There may be some control advantages to the cross- and t-tails while there might be a very narrow drag advantage to the v-tail configuration. Personally, I like the cross-tail as it's a bit more robust than the t-tail and works better than the v-tail. But practically, on this size of model, there is no significant advantage to differentiate one from the other so it really comes down to the designer's preference. Have to say though…t-tails look really cool!

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

> Takeaway: A tail volume of between 10 to 15% of the wing area will work well.

> Takeaway: Elevator setups work better than AMT type.

> Takeaway: Elevator or AMT, make the stabilizer shape similar to the wing shape — the same rules apply.

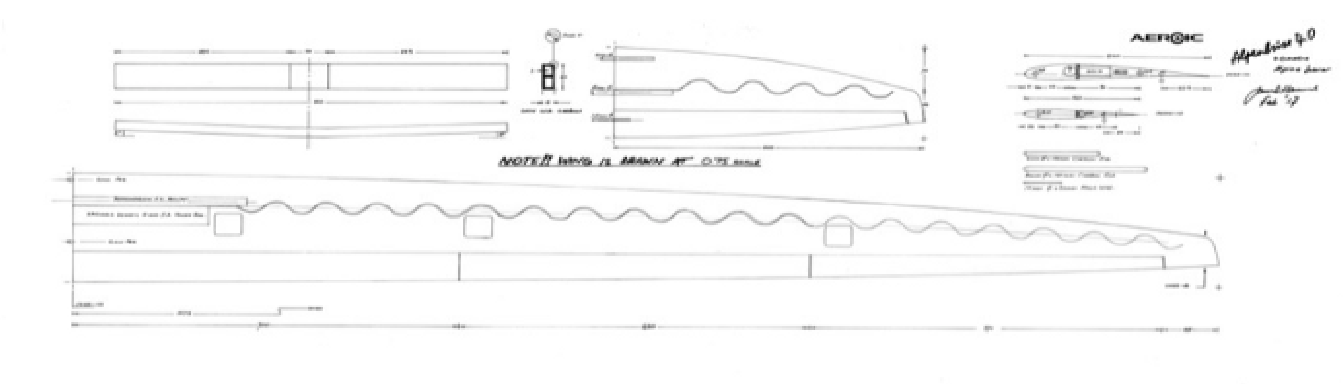
> Takeaway: There is no practical difference between cross-tail, t-tail and v-tail.

Building the Flying Surfaces

Wings/Tails

The most important part for success, construction of the wings and tailplane(s) should follow conventional practice with a cored glass laminated structure, carbon reinforcements where needed, and a decently designed, possibly box type spar with good UD carbon spar caps. Carbon used for the wings should be of the highest modulus available.

And Now for Something Completely Different



Drawing 13: Get a wiggle on…the ASWS in the Alpenbrise wing. (image: Dr. James Hammond)

The Aeroic Sine Wave Spar (ASWS)

Here is where I depart from the norm yet again with a unique and I think vastly improved spar design. From about three years ago, all of my designs have featured a Sine Wave Spar. No, it's not my original idea, and in fact versions can be found in different forms on several military airframes. Then why 'Aeroic Sine Wave Spar'? I hear you query. Well, one, I am the first one to use this idea for commercially available model sailplanes, and two, my design is similar in principle, but completely different in practice when compared to full-sized applications.

Photos 14, 15 and 16: The ASWS under construction and installed in the completed airframe. (images: Dr. James Hammond)

The Future

The Sine Wave Spar and in particular the Aeroic Sine Wave Spar (ASWS) will be featured in its own separate article in an upcoming issue of RCSD. Watch this space!

Food for Thought: Other Commercial Alpine Soarers

Photo 17: Mistral 4.3M. (image: Paritech GMBH)

Above is the Mistral 4.3M from manufacturer Paritech, in Germany — another purpose designed alpine soarer, that as you can see from the nose has had an electric motor installed, thus increasing its versatility. This model also comes in a 4.6M version.

Photo 18: Condor (image: Paritech GMBH)

Above, at the other end of the purpose-designed scale, this is the impressive *Condor*, also from Paritech in Germany — at nearly 7 metres, 275 Inches — or almost 23 feet, it's a biggie! Wow!

Photo 19: Ikura 4M (image: Aer-O-Tec)

Another, purpose designed alpine flyer, this time from Aer-O-Tec in Germany. The *Ikura 4M* a beautifully set out model which uses a lot of advanced design techniques on the wings. This aircraft has a real 'presence' when in flight.

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