On the 'Wing... #140

Vitesse

Dave Camp and Glyn Fonteneau have been correspondents for quite a while, and we always look forward to hearing about their current project(s). Their last, a CO8-like 'ship with 2 meter span (RCSD October 1999), became the impetus for a larger version which is described in detail in this month's column. Take a close look at the included photos! You'll see that leading edge fences have already been installed, and Dave's model sports a C-wing configuration. Here's what Glyn and Dave have to say about their project.

Vitesse is a 3.4m flying wing of our own design, incorporating lessons we have learned with our previous CO8-2m which was a cut down version of CO8 by Hans-Jürgen Unverferth. (See *RCSD* October 1999.) The performance of the CO8-2m has exceeded our expectations, but of course restricting the span compromised performance. Our aim with the Vitesse was to have a flying wing with a performance as far as possible on a par with the F3J type of model being flown within our club, typically Starlites, Graphites and Storchs. At least those would be the designs we would judge our success against.

Glyn did most of the basic design work, using the Panknin twist calculation program, plus of course evaluation of typical design parameters used with other successful wings and our own experience.

Design Targets

Design targets we set were roughly as follows:

All up weight 4.5 lbs.
Flying speed 20 m.p.h.

On the basis of the above and looking at other examples we set the following parameters:

Span	3.4m (134")
Chord	9.25"
Sweep	25 degrees
Section	RS004a — the same as used on our CO8-2m
Twist	- 4.5 degrees total, divided across three sections

Control surfaces 3 per side, i.e. whole trailing edge is effectively trimmable

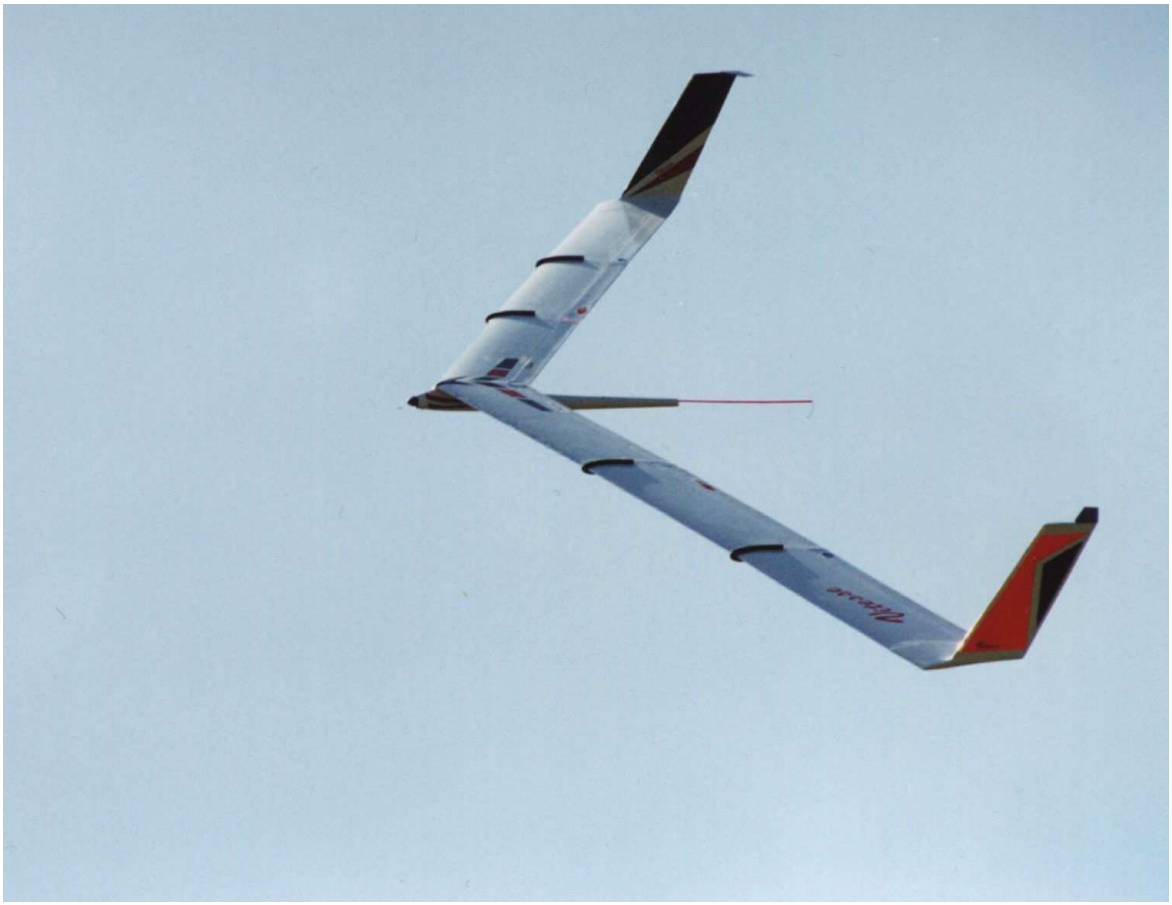
Inboard sections are flaps and used as airbrakes

Mid sections are ailerons only

Outboard sections are elevons

3 piece wing with plug in winglets

Winglets	RS004a section



Dave Camp's Vitesse in flight. Several items of note: Wing fences, C-wing configuration, and the NyRod which supports the antenna.

Closeup of the winglet and wing fences, Dave and his Vitesse. Both Vitessemodels are well behaved and fly magnificently.

Construction overview

Blue foam with carbon and glass skins, and a single carbon shear web used with carbon blade and rod joiners.

So that was the basics decided, a plan of action was then required to get the materials and to start work. On the face of it, it should have been a fairly quick project we thought, after all there isn't much to a flying wing is there? Suffice it to say the project has taken far longer to reach the flight test stage, starting work at the beginning of December 1999 and finally we both reached completion around the third week in April 2000. Anyway, onto some of the key points and/or problems:

Details of construction and design

Wings are cut in 3 sections per side. This follows the middle third theory used by Hans-Jürgen Unverferth. This allows the wing twist to be stepped across the span, rather than linear.

Outer two sections are joined together prior to vacuuming. The cores are sliced to allow the shear web to be glued in. The shear web is de-swept. That is, the root of the center section it is placed at approximately 25% root chord and at the extreme tip at about 15%. This is designed to reduce flutter. While the cores are split, a cable slot is hot-wired. Carbon fibre shear spars are fitted using epoxy resin, the cores are returned to the beds to ensure alignment is maintained. While fitting, the shear web joiner boxes are also bonded in. This makes life a little difficult because all three sections have to be butted together for alignment.

When the epoxy has hardened, the joiner boxes are sawn through to separate the center section from the outer panels. The joiner boxes are mounted to the front face of the shear web and the cable duct to the rear.

Ply ribs are mounted at the ends of each panel. In future we would make these much thicker to aid vacuuming and adding strength. The wing skins are vacuumed in place using Mylar in the normal way. Skins are 5.6 oz/yd^2 carbon (from Aerospace Composites) at 45 degree bias, with 100g glass cloth (from Nic Wright) on top aligned spanwise.

The center sections are joined together using new beds cut to incorporate the required anhedral. Vacuuming the center section is quite difficult because the bottom Mylars, when taped together, cause the top Mylars to overlap. This causes laying up to be very interesting. We had the same problem with the CO8-2m and therefore were ready and practised for this.

Having trimmed up the finished bagged wings, holes were opened up to accept the electrical connectors. Servo pockets are also opened, having ensured we know were the spar is located. On Glyn's wings the servos protrude outside the surface a bit because he used JR 3341 servos. Dave use JR341's which just sit flush.

Glyn Fonteneau's Vitesse on the ground and in the air. Glyn, like Dave, added double sets of wing fences and saw an immediate performance and handling improvements. Glyn did not add the sub-winglets to make a C-wing configuration.

The wiring is not easy because of the thinness of the wing. Therefore it is difficult to get much slack in the wiring so that you can pull the wire out far enough to solder and fit heat shrink and then pull it back and solder the joints for the servo. We used four wires for the servo's, this means you must make the +ve and -ve common and the signal wires MUST be kept separate.

The winglet is fitted to a short wing tip which is made from a specially cut section of wing. We didn't put enough time into the design of the tip—winglet joint; therefore there are some differences in our designs here. The winglets are blue foam with one layer 100g glass vacuumed as per wings. A carbon uni-web strip was used as a spar on both sides, plus a strip one side of the trailing edge.

Setting up the surfaces took some hours, making sure travel direction is correct. Programming took many hours to ensure we had what we felt looked right and in the desired mode.

The center of gravity was calculated using the Panknin twist program which is obtainable from the B^2 web site through <http://www.b2streamlines.com/Panknin.html>.

Fuselages were our own design and we both had our own idea as to the shape that they should be. We agreed on one part, that the wing should be pylon mounted. The fuselage was carved from blue foam with glass and Kevlar vacuumed on. The blue foam was melted out later with solvent. An access hatch with a carbon cover was made in the fuselage bottom. This is only required for charging, a switch was made accessible from the outside. The wing seat was 1/32 ply, an access hole being cut for the servo leads and then the fuselage bonded to the center section using a mix of epoxy and glass microfibers.

The aerial extends out the rear of the fuselage, a length of red Sullivan snake outer providing protection and support. Tow hooks are mounted one third of the span each side, so that towing is done using a bridle.

The finished models came out heavier than planned (don't they all) at around 5.25 lbs. Nose weight was required to achieve the required CG position, which is the opposite of our 2m designs. We made a mistake with the fuselage designs; the nose is too short. So if we had kept to the proportions of the 2m designs we could have used less lead. Most likely this is because of the considerable increase in span, with a lot of structure behind the CG. However we are finding it difficult to see where weight savings could have been made.

Torsionally the wings are very rigid, but they do still bend span wise. We do not believe the lay-up can be reduced to save weight. The total weight of each complete winglet and stub was only 4 oz., but of course that amounts to 8 ounces total behind the CG. Perhaps these should be hollow molded in future, and this could still be done in retrospect.

JR PCM10 receivers were mounted under the wings and 1.2ah ni-cad packs used. Glyn uses a Graupner/JR MC24 transmitter, Dave a JR PCM10S. Programming is an area being experimented with, as will be seen following initial flight trials.

Flight testing

Initial flights:

To start with we set the CG 0.5" in front of the position indicated by the Panknin spreadsheet. Glyn had carried out some rechecking of his sweep and it certainly looked like the sweep was near 26.5 degrees, the result of some awkward moments joining the center section and vacuuming. This makes a big difference to the CG; he therefore balanced his accordingly. Dave's had 25 degrees sweep; this indicated a CG at 17" behind the LE at the root, so 16.5" was used as a starting point. Incidentally, it is worth mentioning that balancing something of this size and configuration is not that easy. We ended up using a thin chord looped around the body, but a 3.4m wing suspended indoors is a bit of a handful!

The very first flights were hand launches into a moderate breeze. Yes this can be very risky, but we thought any serious problems would show themselves and it would be better than committing to a winch launch or slope flight. Anyway, launching each revealed no problems, so it was decided to go straight to winch launching as, after all, this is what they were designed for.

The first winch launches took place on a day with a moderate breeze, a bit gusty at times, so not ideal, but after all this time patience was wearing thin. A bridle to cope with the wing mounted hooks was made up, using stainless steel trace wire, with lengths of plastic snake to add protection.

Dave took the first launch, Glyn throwing the model flat, this resulted in a low launch, the model overtaking the line, Dave not pitching the model up. Still, the handling seemed OK, with a good glide. The next launch was fine The model was pitched up soon after release and was very steady, releasing easily off the top. Handling was good, very sensitive in pitch, but roll control steady, not quick but positive. A check of the flaps showed that they produced a very strong pitch up effect. Full down elevator would not control the model with full flap used. So landings were without flap. This results in a LOT of ground being covered. These wings just keep going, despite the 10+ m.p.h. breeze.

Subsequent launches were made with a slight nose up attitude as this gave better launches. Dave contacted lift on the fourth flight, circling away downwind, and tight circles could be maintained without problem. At the higher altitude the wind speed was obviously greater, however penetration was not so good coming back and some positive down elevator was required to get it moving. This indicates a need for a fast cruise setting on a 3-position switch, just a tiny amount of down would be required, 1mm or so.

Glyn unfortunately had a very rough time of things. The first launches overran the line, but a good launch was made and handling seemed OK, but there was a difference apparent. Worst was yet to come when a decent launch was made and then Glyn realized he had control difficulties, the model being unstable. On approach to land a wing dropped suddenly, probably due to a gust, and hit the ground.

With a model of this size one must expect damage, and we found in this case the carbon skin had cracked on the center section near the root, plus other slight damage was done at the panel joiners. The rear carbon tube joiners were shattered. In hindsight we concentrated too much on the early launch problems — the model either coming off early by over running the line or pinging off early when climbing. We should have spotted the signs of a too rearward CG.

Not to be deterred, Glyn has managed a repair. Considerable work was involved to maintain strength and an even spread of load, carbon webs being inserted and large thin carbon plates vacuum bonded onto the skins, fairing in when all was cured. The rear joiner in both models has been changed to steel as Dave had also found a fracture following a heavy landing.

Subsequent flights:

The next session with both models was in turbulent breezy conditions (15mph measured on the ground). Dave launched OK for a few flights. Control was fine in the turbulence and lift was contacted. The use of flaps has still not been sorted for landing. Despite further down elevator mix the pitch up is too strong. However, the performance is encouraging. In the breeze a lot of tension was applied during the launch with no problem, although the outer panels were bending quite a bit!

Glyn had a few troubled launches. Things were better than before, but the hook position needed examining. As a comparison, Dave flew his CO8-2m and found it difficult to handle in the turbulence and a pair of conventional aileron equipped soarers flown at similar times did not manage the conditions any better.

The last session held was very brief, but was trouble free, launching in only a light breeze. Glyn had moved his hooks forward to match Dave's — one inch in front of CG. This appears a safe position, as slight nose up launching has started without problem. Launch height wasn't bad, even with no launch flap used so far. In light conditions the thermal flap setting seems OK, allowing tight circling if required and generally slowing the model slightly.

Our latest session to date (May 14, 2000) was held in virtually calm conditions and a restricted field that only allowed around 150 meters of line to the turnaround. Launching was trouble free, but release height was probably only around 100 meters or so. However, the Vitesse is exhibiting a very good glide angle and will work weak lift very well, particularly with thermal flap set. Dave had nearly 9 minutes using weak lift and Glyn had 18 minutes in slightly better air.

Glyn had a chance to explore the new "speed" setting — this made progress around the sky at a controlled fast cruise a delight. Once established in a thermal turn the workload is light, as they lock in nicely. A short video was made of Dave's flight. Reviewing this later revealed no sign of adverse yaw or pitching in turns. As before, the shortcoming is in the landing. With such a flat glide it is hard to imagine ever landing short! Some more options are going to be explored to give the controlled high rate of descent required for spot landings and small field work.

So, summarizing the flying so far, Glyn could certainly have done without the early breakage, but we are both now very pleased with the performance. It is too early to see if we have met the aim of matching the conventional F3J models, but it looks encouraging. Landing is the area needing most

work, but this should come from some more radical program developments we have in mind. The center of gravity location is absolutely critical, as expected, and the flaps initially appear to be far more effective than seen on the 2m wings.

As further testing takes place we will provide updates on our progress. Hopefully we will be able to get some MPEG video footage for internet downloading.

Glyn and Dave and their various Vitesse models. The two meter versions are on the ground in the foreground. The versions they're holding have spans of 134 inches.