Experiences and Observations with the First Glider

The purpose of this article is to pass on some of the collective experiences and observations acquired while flying the First glider in competition for a couple of seasons now.

The Aircraft

The First is a 2 metre, 2 channel polyhedral glider. It is manufactured by Blejzyk in Poland. The wing construction is a foam core with black poplar sheeting. The wing joiner is a steel blade that is fixed in epoxy in one wing and slides into a mating rectangular brass tube that is also fixed in by epoxy in the opposite wing. The fuselage is made from fibreglass with a slip on nose cone. The cruciform tail is made from solid balsa.

The aircraft uses the 7037 wing section and penetrates noticeably better than the traditional built up 2m 2ch aircraft like the Gentle Lady, Spirit or Sagitta. The wing thickness on the First remains about the same as these other built up aircraft at approximately 22mm. The typical First will weigh a little more than the built up aircraft. I believe that the dead air sink rate on a First is slightly greater than a Spirit or Sagitta. However this disadvantage is more than offset by the ability to launch higher, penetrate better and cover more sky in search of that elusive lift, particularly at the windier coastal fields around Sydney.

The points listed below are oriented towards competition flying where the pilot wants the plane to repeatedly and reliably launch hard with no nasty vices and still have pleasant flight characteristics and be strong enough for the occasional hard landing. Knowing that your plane is sorted out and will provide a good launch lets you focus on what the air is doing and hunting down the lift.

Wing Dihedral

Build the wing with the recommended dihedral and polyhedral specified in the build instructions. Some models have been assembled with less than recommended dihedral, or no dihedral, and this results in sluggish turns and the aircraft noticeably oscillates in yaw when turning or when flying through turbulent air.

Wing Saddle Area

The wing saddle area of the fuselage has been prone to cracking and splitting, particularly with rough landings. Remove the minimum amount of material in the fuselage wing saddle so that the maximum strength is retained. The cut-out in the wing saddle really only needs to be large enough to allow access to the tow hook nut, insert the receiver and permit the access for a small clamp when you glue in the plate with the wing hold down nuts. Keep the corners of the saddle cut-out rounded so as to minimise stress concentration in the corners.

Later models of the First have been significantly reinforced in the saddle area with some additional kevlar cloth along the fuselage sides and carbon tow under the edge of the saddle.

Fuselage Reinforcing

After seeing a couple of pilots get some fuselage cracking in the area behind the trailing edge of the wing following cartwheel landings, I resolved to strengthen my own aircraft during construction. I did this by laying in four lengths of carbon tow, each 150mm long in this area. Just lightly wet them with epoxy and drop them in and press them against the fuselage before you epoxy in the inner nose cone. The four were positioned with a 90 degree spacing to provide resistance to bending from all angles in that region. So far so good, the fuselage remains intact despite two full seasons of Millennium Cup competition and two seasons of club competition - and there have been some ugly landings in that period.

Servos

The forward fuselage is quite roomy and full size servos can be mounted in a tandem layout. Clearance towards the very front under the nose cone gets very tight and you need to ensure that the servo arm and its clevis don't foul the nose cone. Smaller mini servos avoid the clearance issue and micro servos can even be mounted side by side at the very front, but this layout brings up the clearance issue again.

Wing Coatings

Many pilots have coated their aircraft wings with a natural clear varnish or polyurethane finish, which is as per the build instructions. This looks attractive too - if you like wood grain. Others have used automotive touch up spray paint, two pack epoxy paints (a heavy solution) and Monokote/Profilm covering (great colour range and even patterns are possible). The paints result in a heavier wing and there can be some remnant wood grain texture in the surface depending on the number of coats applied and the amount of sanding in between coats. The Monokote/Profilm approach provides a very smooth surface but bubbles under the film can be a perennial issue requiring ongoing attention. I don't know if the film has difficulty adhering to the wood sheeting or if the foam is continuously gassing. Bubbles under the film can also appear when travelling to higher altitude fields such as Queanbeyan (~2000') or Armidale (~3600'). This film bubbling happened to me, but after returning home and getting out the wing to re-iron it I found that the bubbles had all disappeared.

Wing Bolts

The 4mm nylon bolts provided with the kit are adequate to handle any launch loads. However these bolts are hollow in the centre and readily shear with rough landings. 4mm nylon bolts are also difficult to procure from local hobby shops and are usually available only in small quantities and high prices, if you can find them. If you are a beginner, the air is turbulent in the landing area or you don't have the aircraft flying the way you want it, then you may need several sets of these wing bolts in a single flying session. I purchased a bag of 50 over the net for US$3.50 from www.microfasteners.com but beware, the shipping charges can more than double the cost. There are other suppliers of small parts that you can find on the web.

The wing hold down nuts mounted in plastic collars that are supplied in the kit have been known to cause some issues over time, particularly if the aircraft is abused. The plastic collar cracks and the nut then spins freely or falls out completely. Once the aircraft is fully built getting back in under the wing saddle area to install a replacement (if you can obtain one) or fit something else is difficult. My solution to this has been to use metal 10-32 blind nuts and 10-32 nylon bolts. These are a slightly

greater diameter than 4mm bolts but the additional strength is not the requirement, as 4mm is strong enough, but the 10-32 nylon bolts are easier to obtain locally. Unfortunately I can also vouch for the fact that the 10-32 nylon bolts will still shear through with a big impact. The shearing of the nylon bolts goes some way to minimising the risk of wing damage and saves the wing saddle area from high transmitted impact forces.

Some pilots are using metal bolts to hold the wings down. This removes any issues with wing bolt shearing and having to find replacements, but the prospect of damage to either the wing or fuselage arising from awkward landings is increased.

Elevator and Rudder Hinges

The tail pieces come with pre-hinged stabiliser/elevator and fin/rudder items. This is a nice touch - but a real trap. Inevitably these hinges work their way loose and major control issues can arise in flight usually immediately after the zoom or after high speed flight. I would not trust these hinges at all and strongly recommend taping over the hinge joint with hinge tape as a standard build practice. After taping the hinge line there are no further problems in this area.

Wing Decalage/Incidence

When the aircraft is built with the wing flat on the wing saddle and the stabiliser flat on the tail mounting, the aircraft will want to fly very quickly and requires considerable up elevator trim to slow it down. Almost all pilots have modified the decalage by either packing up the leading edge of the wing or installing a balsa wedge under the stabiliser.

Using the wedge under the stabiliser method requires a wedge that is around 2mm thick at the rear. This wedge results in a trim setting where the elevator is in line with the stabiliser at normal flying speeds.

Using the wedge under the stabiliser approach results in a tail down fuselage attitude in normal flight which some find unattractive, so packing up the leading edge of the wing could be a more aesthetic alternative.

Overall Weight

Full size servos (44g each), a standard 4xAA NiCd 600mah battery pack and a Monokote/Profilm covered wing, results in an aircraft with a 1000g all up weight. Painting the wings adds around a further 40 grams and using two pack paint adds 200g for a 'pre-ballasted' aircraft. Smaller mini or micro servos, or a smaller battery, can save weight but this saving will be offset somewhat by a requirement for increased lead weight in the nose to maintain the CG position. I think that flight loads are not very high and the smaller servos provide good service barring any landing 'arrivals' or cartwheels. A number of aircraft have been built with their all up weight in the 950g range.

The newer kits that have the reinforced wing saddle area in the fuselage are a little heavier than earlier kits. The added strength is worth the weight penalty though.

Elevator Sensitivity
The aircraft is quite sensitive in pitch. The control rod clevis should be affixed to the hole furthest out on the elevator horn, or dual rates and/or travel throw adjustments used to limit the elevator throw. Ensure that full up elevator doesn't foul the rudder.

Centre of Gravity
The recommended CG position at 85mm from the leading edge is quite conservative. I find that a CG position a further 10mm rearward at 95mm from the leading edge still provides a controllable aircraft that it is more 'lively' and responsive. Even with this more aft CG position the aircraft pitch stability remains slightly positive when evaluated using the 'dive test'.

Tow Hook Position
While the plans do not specifically state the tow hook position, scaling the dimensions from the drawing leads me to a figure of 90mm from the leading edge. This tow hook position is just acceptable. A few mm further back at 92mm appears to be even better. With the tow hook further forward of this position the rotation is leisurely and the climb relatively flat. A tow hook positioned at 92mm provides a much better rotation upon release and the aircraft climbs steeply while still being very stable. Tow hook positions further back at 100mm have been tested but the aircraft is extremely unstable in the launch leading to a very high likelihood of pop offs. This extreme rearward setting makes the launch very exciting but not the vice free and repeatable launch I seek.

Also see the section below regarding additional up elevator preset when launching.

Tow Hook Angle
The standard tow hook provided with the kit is a very sturdy and attractive unit. However it appears that the angle of the hook is not tight (acute) enough and the aircraft is quite prone to popping off a tow line when launched aggressively. Perhaps the floor of the fuselage is distorting under load and the tow hook is rotating forward presenting the back of the tow hook and allowing the tow ring to slip off. Anyway the simplest way to correct this is to remove the tow hook from the aircraft, place it in a vice and give it a few gentle taps with a hammer to make the angle of the tow hook more acute i.e. less than 90 degrees. It doesn't need much. This modification keeps the aircraft on the tow line even on the hardest launches. No-one who has used this tow hook modification has had any difficulty releasing the aircraft from the line when the time comes to get off.

Rudder Throw
The construction manual recommends a rudder throw of 9mm left and 9mm right. This is so ridiculously small it just has to be a typographical error. Try to get around 50mm+ in each direction. At low airspeeds the aircraft is quite insensitive to rudder inputs and having decent rudder throws will help in the landing pattern. If you are heavy on the sticks or you find too much rudder sensitivity in normal flight, try some exponential to soften the response around the centre position while still retaining full throw for the low speed flight regime.

Launch Preset

Many pilots have programmed in a small amount of up elevator for the launch phase. This helps the launch rotation and keeps the aircraft pulling up and maintaining line tension all the way up on launch. Some experimentation is required to ascertain the appropriate setting to prevent over rotation and popping off or instability in the climb. What I have done is to have flaps permanently lowered in the radio (I know the aircraft really has no flaps) and then mix 10% to 20% flaps to up elevator through a switch as a launch mode. I am sure there many different ways to implement this. The actual value of the mix will depend primarily on your elevator throws and tow hook position.

If you have the unthinkable happen and you do pop off you can quickly remove this launch preset for an absolutely pop off free subsequent launch. Our competition rules only allow one pop off so the second launch must be good, even if it isn't optimal.

The use of the launch elevator preset will require implementation of the tow hook position, tow hook angle and elevator throw adjustments mentioned above. These things are all inter-related for an optimal launch.

As an aside, I have similarly implemented a 'speed' mode with my radio. This is the reverse of the launch mode as it mixes a small amount of flap (remember the flaps are always deployed in the radio) to down elevator. This causes the aircraft to fly at a faster natural speed for greater penetration. You don't have to hold the elevator stick forward nor do you need to remember how many clicks of down trim you put in. If you choose to use the programmed 'speed' function, experimentation will be required to arrive at the appropriate mix value for your aircraft.

Fin Failures

The fin on the First is constructed from solid balsa. It actually appears to be two pieces laminated together as there is a glue joint down the centre. There are two ways to mount the fin. The first method is to use 3mm bolts supplied with the kit to go up from the bottom of the boom through the stabiliser into the into pre-fitted nuts in the base of the fin. This permits disassembly and makes transporting the aircraft a little easier. The second method is to just glue the stabiliser and the fin to the boom.

In 2006 there have been a number of observed failures of the fin on launch. All the observed incidents have occurred during the dip and zoom phase on launch. After having lost the rudder usually the elevator function is impaired or non functional too. The next few tens of seconds can be quite exciting but a heavily damaged model is the usual result with one model being lost entirely as it disappeared into a swampy area a great distance away.

There have been instances involving the removable fin and stabiliser implementation where the knurled nuts have simply pulled out of the base of the fin. For the glued together construction there have been cases where the fin has broken off completely at a point about 3-5mm above the triangle fillet pieces, near the base of the fin. It could be that the fin might be fluttering and the additional flutter loads are causing the breakages.

I would suggest two things be done here to mitigate these fin breakages.

Put a small lightweight fibreglass bandage about 30mm wide around the base of the fin. Covering the fin base triangular fillet pieces with this bandage will help to keep the fin as one unit and stiffen the base area. This stiffening reduces the risk of fin/tail flutter and the creation of excessive loads that might cause a failure.

If using the bolt together tail assembly, I would suggest a very close examination of the integrity of the gluing of the knurled brass nut in the base of the fin. Inspection of these nuts will require the removal of the thin plywood fin base. If the gluing appears to not be of a good quality then additional epoxy or CA might be required to strengthen this nut installation. In the removable fin installation the integrity of the fin and stabiliser relies entirely on this nut to fin glue joint bond.

As a further precaution I suggest that some attention be given to the rigidity of the rudder pushrod installation to help mitigate against flutter.

Alternate Wing Profiles

A couple of pilots have used the First fuselage mated to a MH32 profile foam core I piece wing with spars and covered in either fibreglass or balsa. These aircraft also fly very well and the MH32 profile may offer a further gain in penetration performance in windier weather. The zoom capability of these wings also seems to be improved. It is a very interesting experiment.

Conclusion

The First has proved to be a very popular glider for our 2m 2channel competition. The purchase price of the kit is a premium on built up kits but it still represents good value. The First is quite tough and to my knowledge none have folded wings on launch, no matter how vigorous the reflex hand tow or the electric winch launch has been. Its flight performance is a step up from the built up models and the ability to launch with impunity and readily achieve high launches also proves to be an advantage in competition. Its success as a design can be measured to some degree by the fact that of the top 20 pilots in the 2005 Millennium Cup for 2m 2ch gliders, 15 of these pilots were flying the First.

Fred Lodden

Some Firsts photographed at a Millennium Cup competition