sticky air

An apparently small change to the wing design has taken the already attractive Savannah into a totally different performance bracket, as David Bremner discovered

In our Nov-Dec 2003 issue we tested the MXP740 Savannah, so it might seem a little odd to be testing it again, as it could hardly be said to have reached the age at which it acquires a vintage patina. Indeed sales are still brisk, with 31 on the register at the time of writing. But the latest version is significantly different, thanks to those two little letters – VG, standing for vortex generators – which have unleashed the potential in an already excellent design.

In fact the change is astonishingly simple; remove the characteristic leading edge slot in the wing and replace it with a row of vortex generators. That's it. And yet such a simple change has put 30% onto the cruise speed without compromising the amazing short-field performance – all with the same engine.

But before we look into the details of the changes, let's check the rest of the aircraft. I know we've done it before, but it was nearly five years ago, and you've probably lost your copy of the magazine by now.

The Savannah is imported by Steve Whittaker and Pete Wilson, aka Sandtoft Ultralight Partnership, and produced in Italy where it's manufactured by CNC machines (yes, all right, by robots...) at the ICP factory. The company's main business is brake parts and the like, but includes microlights, since they are the owner's passion.

Think Italian design and the word style immediately springs to mind. So how come an Italian has been inspired by the angular Zenair CH701, from the drawing board of Chris Heinz, and produced this?

Like the CH701 it's an all-aluminium high-wing side-by-side tractor monoplane with an uncompromisingly boxy outline, but it's smaller and lighter. In the previous article we compared it to a Land Rover, and it's hard to think of a better comparison – practical, functional, and about as un-Italian as it's possible to imagine.

It is only approved in the UK with the Jabiru engine, in order to keep the weight within UK microlight limits, but the design specification allows for a 560kg all-up weight and +6/-3g limits, which means that at 450kg it's got a simply enormous 8g margin of safety!

It's held together by a sackful of pop rivets, and one of the truly astonishing features of the kit is that every hole comes predrilled. How they are able to machine drill 3mm holes in thin metal and get up to four layers to line up exactly with each other is something I still can't get my head around, but I've inspected two or three builds, and everybody found it works. Amazing.

With that level of prefabrication and a good build manual (albeit in slightly idiosyncratic English), building your own is very straightforward and shouldn't take too long. When you can't understand the manual, Steve and Pete are more than happy to help out and the only bit that's not included in the price is the painting.

The result is an aircraft which can live outside, though it's always better to keep them under cover if you can.

Under the skin there are few surprises. The nosewheel is telescopic, with bungee suspension mounted on the firewall, and the main gear is on sturdy aluminium cantilever legs. Apparently when the WWII Lysander aircraft crashed, its forged undercarriage legs were never damaged, and one could imagine a similar scenario here.

The top engine cowls are held on with four quick-release fasteners per side, and the lower ones by three each side, if you need full access to the engine. There's an access panel to the dipstick too, for the daily inspection. ▷

▷ Behind the firewall, the cabin is of adequate proportions (wider than a Cessna 152, for example) but not palatial. I do like to be able to see out, and the Savannah, while it's perfectly adequate in this respect, is not the best on the market. The tall and relatively upright windscreen gives a good view forwards, but the aluminium roof, despite having a small window, significantly restricts one's view upwards. The top-hinged doors have windows which allow a good view sideways, but if you're above average height your eye level is fairly close to the underside of the wing, and the view downwards is not as good as some other types. There's no rearwards view.

The rear fuselage has an enormous inspection panel in the underside, big enough to get your shoulders in, so access is great. Inside is a massive bellcrank which actuates the flaperons in a slightly quirky way. Since the prototype was tested, a couple of ribs have been added to the rear fuselage to stiffen it up a little, and at the back the full-span anti-balance tab is electrically operated, removing the need for the old bungee system.

The wings, as mentioned earlier, are the major change, but even here, you could miss it if you didn't know what to look for. It's still a thick all-metal slab wing with twin struts and full-span flaperons, the inner and outer halves of which are still offset to give the wing some washout. Wing tanks, each of 35 litre capacity, are fitted in the root of each, both permanently connected to a 7 litre header tank in the rear fuselage, hence the total capacity of 77 litres. One internal change is the addition of a couple of extra ribs and some spanwise stiffeners to reduce the size of skin panel and the unsightly buckling that can occur.

But the distinctive leading edge slot, which was the most difficult part to build, has gone, replaced by a longer nose to the wing and a row of tiny vortex generators along the top of the leading edge.

The purpose of both systems is to 'energise' the airflow on top of the wing. The air going over a wing at a high angle of attack has to bend a lot, so the air going past the trailing edge from the underside is very tempted to come back up the top surface. Ultimately, as we all know, the airflow over the top gives up and doesn't 'stick' to the aerofoil any more, and the wing stalls.

The leading edge slot was developed as early as 1917, allowing air from the high-pressure underside through to the top surface at the point where the flow was starting to slow down, thus speeding the flow up again. One variant – an automatic slat developed by Handley Page – closed the slot up at low angles of attack by mounting the front part on hinges operated by the change in angle of attack. These were used on the Tiger Moth and even the ME109, where a sudden deployment in combat could be a bit exciting – particularly if only one slat deployed!

Previous page: The Savannah remains controllable at astonishing angles of attack; vortex generators clearly visible

Facing page, clockwise from top: Note lack of undersurface slots compared with (bottom right) our 2003 test aircraft – how many owners will want new wings, we wonder?; and electric trim is very powerful

Vortex generators date from after WWII and are used very frequently, either as part of the original design or as a fix for in-service problems. They consist of tiny aerofoils sticking out from the main surface at a slight angle to the airflow, generally in opposed pairs. The effect is difficult to visualise, but by giving the air in the boundary layer a twist as it goes past, they ensure that the boundary layer is turbulent. Like the slot, this helps the air to 'stick' to the main surface long after it would otherwise have separated and generated a stall.

Although they are often used in light aircraft to generate extra lift, they are also seen on airliners and military hardware to 'stick' the flow to other parts of the airframe – rudders, engine intakes, and so on.

The ones used here are available commercially and are simply little plastic widgets that are firmly stuck all along the top of the wing leading edge. They are located by small plastic pins on the underside which clip into pre-punched holes in the wing skin.

Inside the cabin there's a central stick, which makes access nice 'n easy, with a Y-shaped top so that it comes easily to hand from either seat. The floor-hinged rudders are aluminium and robust, with hydraulic toe brakes on the left-hand set. The flap handle (left-hand seat only) is shorter and sturdier than the original version, and is floor-mounted (which to a small extent reduces the benefit of the central stick for access). The three positions (off, half and on) are selected by a handbrake-type button lock on the top, engaging in detents as usual. I found the position slightly awkward to get at, but I've got very long legs, which probably didn't help.

The throttle is a panel-mounted push-pull type, with one for each seat. With a centrally-mounted stick, of course, the right-hand seat occupant has to use his left hand, with the throttle in his right. The other primary control, the trim, is now a rocker switch on the panel next to the left-hand seat throttle, with the usual LED position indicator. I found it a bit close to the throttle and would have preferred a central position (for a single toggle switch) or a stick-top solution of some sort. But that's up to the individual builder and isn't a criticism of the basic kit.

And since this is a kit-build, instruments and the other switches are less likely to be standard, but the demonstrator had a fairly standard array of analogue instruments fitted on the panel, and extra switches (electric carb heat, inside light(!) and circuit breakers) in the roof.

The only fuel-level indication is a sight gauge in the left-hand wing root, which owing to the possibility of intermittently different levels in the two tanks and wildly varying indications depending on the aircraft's attitude, didn't seem to me to be adequate for journey planning. There is an alarm when the header tank starts to empty (ie when there is only 7 litres remaining), but I'd certainly feel more comfortable with a fuel computer fitted.

The seat position is fixed, but provides a relatively upright posture and plenty of space under the dashboard for your knees. The test aircraft came with some very nice (non-standard) leather seat squabs. It proved able to accommodate a very wide range of sizes without problems and felt comfortable enough for a long trip. One owner who flew in during the test brought his dog with him...

There's a small baggage compartment behind the seats which has a reasonable 20kg weight allowance and is secured by a zipped leatherette panel, but you'd need to be pretty creative with camping kit if you wanted to carry it legally in there.

Once installed – and the gas-sprung top-hinged doors ▷


SavannahVG
G-CEGK


SavannahVG
NO PUSH


G-CBBI

▷ and the central stick do make this very easy – the door latches shut securely and there's an extra one at the front to stop draughts in flight. The four-point harnesses are easy to fix and adjust, and starting the Jabiru was as easy as... starting a Jabiru. Fuel on (there's a small valve on the floor), mags on, choke out if necessary, throttle shut and twist the starter. It instantly came to life, settling down to that wonderful direct-drive purr that is so pleasing at a visceral level. The noise levels were good, despite being inside a tin drum, and there was none of the drumming you sometimes come across in this type of construction.

Manoeuvring is dead easy. The short wheelbase, generous movement of the nosewheel and individual disc brakes mean that if you hit anything on the ground, you would struggle to blame it on the aircraft. If I were building one, I would be tempted to fit parking brake valves in the circuits, but that's a personal preference.

Pre-takeoff checks are one time I value all-round vision. It's good to be able to positively confirm movement of the tail surfaces, and to be able to check for circuit traffic. In the Savannah you have to open the door and lean out to check the tail feathers, and to turn the aircraft to check for circuit traffic. That's standard practice, of course, but we are supposed to point out the things we find less than perfect, and you can't have too much glazing in my view.

The brakes were more than adequate to hold the aircraft while the mags were checked, and we lined up on runway 25 with a strong gusty crosswind from the right. Even under these circumstances, control during the takeoff roll was more than adequate, and my chief problem was holding the nose up enough to keep the speed within the 50-60mph recommended for optimum rate of climb. The VSI indicated 800-900ft/min, which is pretty much in line with the official figures.

Once away from the circuit we settled into the cruise, when the chief benefit of the new wing became immediately apparent. The old one wasn't exactly a sluggard and would cruise comfortably at 75-80mph, but this one, with the same old Jabiru up front, was slipping along at 100mph and 2700rpm – an astonishing *30%* improvement*. Gaining 5mph can take masses of tinkering with an established design; here's an apparently minor modification which has simply transformed the aircraft, from Land Rover to Range Rover in a single bound.

It felt quiet and steady at that speed, with little wind noise and no detectable draughts. Pete even had to shut off the cabin heat after a while. I'm large and was wearing a bulky sheepskin coat, and while the cabin wasn't palatial, it wasn't too cramped. You could envisage longer trips being perfectly practical.

Even in the gusty conditions, the ride was very comfortable, and checks for stick-fixed pitch stability showed that stick forces increased the further out of trim you got. They also increased the faster you went, which helps you judge your speed without reference to the ASI. Stick-free stability – push the stick until you're, say, 10mph faster than trim, then let go – was also good. The nose rose slowly back until the speed was about 5mph below trim, then settled back to trim. That means the speed should remain fairly steady in turbulence, or if you need to take your hand off the stick to drink your coffee or refold a map.

To check stability in the other planes, you enter a sideslip and check that both rudder and aileron self-centre, and that the aircraft tries to fly straight again – which it does quite satisfactorily.

We'd arrived at the Trent, and before we drifted too far downwind, it was time to check the turning performance. Many – perhaps most – microlights suffer from some adverse yaw, but to be honest, I found I could haul the Savannah round the sky to my heart's content and never touch the rudder pedals. Even quite large applications of aileron barely moved the slip ball.

Adverse yaw, as I'm sure you know, is caused when the upgoing aileron gets into the low-energy air above the wing's trailing edge, whereas the downgoing one gets into the high-energy stuff below it. So the downgoing aileron does most of the work in generating lift to raise the outside wing, but also generates tons of drag which slows it down – just when the raised wing should be going faster round the outside of the corner.

So why is the Savannah so good in this respect? One reason could be the Junkers-type flaperons. These are separate aerofoils below and overlapping the wing's trailing edge, so both are working in high-energy air. But whatever the reason, it makes for very easy control, both going into and coming out of a turn.

The roll rate is snappy – 45° left to right using full aileron happens in the blink of an eye at cruise speed.

Established over the Trent, we amused ourselves by heading into wind and slowing down. At about 40mph indicated, the Jabiru was ticking over at less than 2000rpm, the scenery became more or less stationary, and we explored the low-speed end of things. Here again, the handling was fine, with minimal adverse yaw. The electric trim is very powerful – a function of the requirement to be able to trim the aircraft at all throttle and flap settings – but it was still reasonably stable down to 40mph indicated, and there was plenty of roll authority.

Cutting the engine back to idle, we kept the sped at 50mph, and the sink rate – albeit only indicated, and VSIs are not known for their accuracy – was 300ft/min. If that's true, the Savannah could make a very good thermalling machine... The official glide ratio has gone up from 7.5 to 10:1, leapfrogging the SkyRanger at 9:1. Ten to one at 50mph equates to 440ft/min, which seems more realistic – maybe we had the idle set a little fast. But however you look at it, this is a 30% improvement in efficiency*. It's like going from 45 to 60mpg on your car by fitting new tyres.

And while we were at the slow end of things, we tried to achieve a flapless stall but failed. Power off, and unaccelerated (ie a slow deceleration in level flight) we simply achieved a mush condition with the sink rate increasing to 800-900ft/min and all controls working normally, albeit with considerable buffet.

Still hovering over the Trent, we tried the flaps. One consequence of the increase in speed range is that you ▷

Clockwise from top right: This is how the aircraft arrives, just like a giant Meccano set, all machined to impressively tight tolerances; the 2008 cockpit is unchanged from the 2003 test aircraft shown here – comfy to fly, but visibility only adequate; and sturdy undercarriage looks as though it would take a lot of punishment


JABIRU POWERED
STATIC VENT


Savannah
G-BIFB

▷ have to be that much more careful not to exceed the flap speed (56kt or 64mph). The nose drops quite noticeably as you deploy the flaps, but that's no bad thing as it helps to keep the speed constant.

Nevertheless, I had to trim back to avoid an unacceptable increase in trim speed. With full flaps and idle power, there is a more distinct stall break preceded by unmistakeable buffet, but there's no tendency to drop a wing, and the recovery height was only a couple of hundred feet – probably less if you're in practice.

Those who remember the previous flight test will remember the amazing angle of dangle if you try a full-power, full-flap stall. Pete assured me things hadn't changed, and he was right. As you can see from the picture on the centre spread, we ended up lying in our seats with our feet above our heads until it dropped through. Although it tended to drop a wing on the way down, there was no indication that it wanted to flick into a spin, and the recovery was perfectly normal.

Pete had a private strip lined up nearby where we could try a landing or two. The high winds weren't conducive to meaningful measurements of landing roll – in fact I suspect that Pete could have landed it backwards if I'd let him – but apart from sitting for ages on final with the ground creeping past, there was nothing here to scare the horses. Pete usually uses full flap, so I did the same, and despite the gusty conditions I was able to put it down smoothly and in very little distance. The official figures show a slight deterioration in distances – take off up from 198m to 228m, landing up from 140m to 159m. But they are still significantly shorter than a SkyRanger – even with the 912S – and will still allow you to operate out of the shortest fields.

On the way back to Sandtoft I wanted to see what effect power had on trim speed. On most aircraft, changing power requires a change in trim if you want to keep the speed constant, and this can be irritating. The Savannah VG was one of very few types I've flown where there was no detectable change at normal cruise speeds. Set the trim up at 90mph in the cruise and it doesn't matter whether the throttle is set at full or idle, the trim speed is always 90mph. Where this comes in handy is on a go-around, when a sudden increase in power might cause the aircraft to pitch up (or down) unexpectedly, but the Savannah VG, as in all other areas, is perfectly well behaved.

The landing back at Sandtoft was going to be made interesting by the considerable crosswind, but we crabbed in at a massive angle and swung it straight at the last minute, and while it wasn't the neatest of arrivals, we left the aircraft usable, and that (according to legend) represents an excellent landing.

Taxiing back in this spectacular crosswind might have proved challenging for some types, but was no problem for the VG, and we parked up and hopped out. I still couldn't get over the transformation in performance, and I was enthusing about it all the way back to the clubhouse and over a cup of tea – indeed, on the way home, in the teeth of a headwind at 85kt airspeed and 35kt groundspeed, this seemed a perfect demonstration of the benefits of the VG wing.

Conclusions

The Savannah has already proved a popular aircraft in its Classic form, but three VG kits have already been sold, and I'd be surprised if SUP doesn't end up selling more of those than the Classic. In fact it wouldn't surprise me if Classic owners didn't choose to replace the old wings with new – at around £1000 it seems a snip for all that extra performance. Its handling and performance are delightful, and you can store it outside with less risk of deterioration than for ragwing types.

The alloy used is 6061 T6, with a corrosion-resistant coating added. Steve tells me that a trim tab from the prototype Classic, which lay on the frequently flooded hangar floor for four years, was opened up recently and the inside was like new! Like most of its competitors, the empty weight of around 260kg leaves little margin for extras, but the standard fit does include most of what you need. The fuel capacity is also similar to other types, so the range should much the same too.

The only things I can find to carp at are the flap handle, which is a little awkwardly placed between your knees, and the view (though SUP tells me that the factory offers fully-glazed doors and roofs). Other things – the position of the trim switch and the fuel contents gauge – could be improved by individual builders.

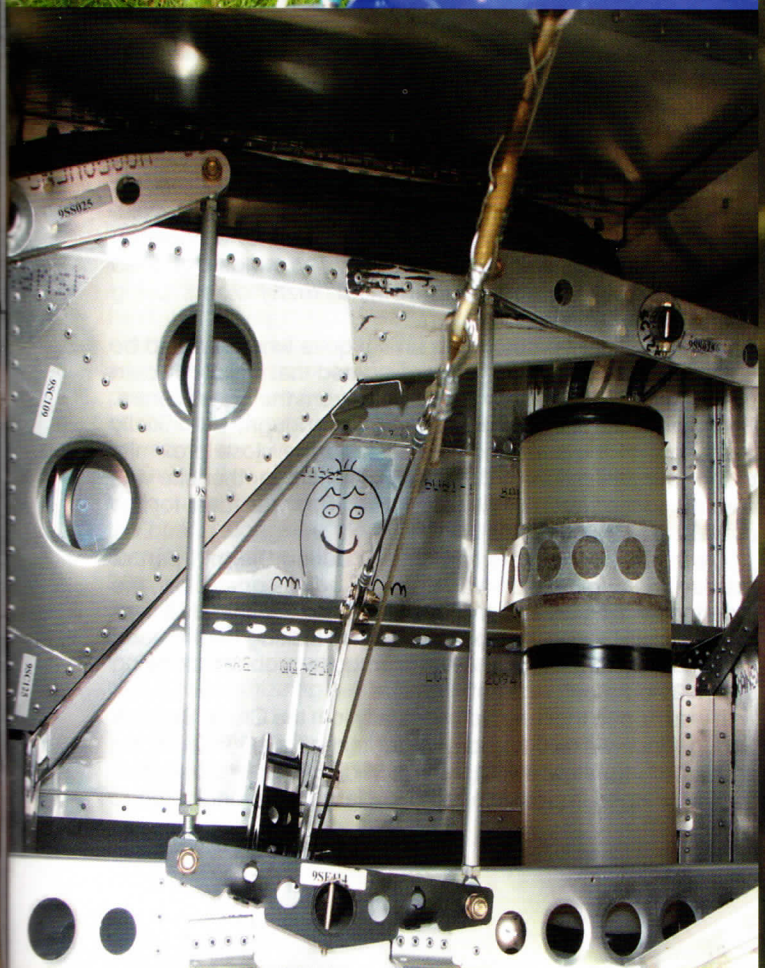
At around £23,000 its main competitors are the SkyRanger and Rans S6, both of which are a little cheaper depending on the options, but won't be quite as weather-resistant (though the XLAM covering for the SkyRanger brings it pretty close). Neither are they quite as fast, or as good at short fields. All three require similar levels of skill to build.

Or there's the Escapade and Kolb Twinstar Mk 3 Xtra, which are similarly priced and have a simple wingfold to allow you to keep them at home. The Escapade is of similar performance, but can be fitted with the Rotax 912 and has enough storage space in the back to sleep in. It has similar speed and range, but the takeoff and landing distances are about half as much again. Its other party trick is the ability to be swapped from nosewheel to tailwheel, but as the nosewheel is free-castoring you've got to taxi it using the brakes. Building it isn't quite as simple either.

Most engineering is a question of compromise – you improve two things at the expense of a third. Only very rarely does a designer manage to give the customer a free lunch, but that's what we have here. Aside from a small (and it is small) increase in ground roll, the effect of the VG wing is 100% beneficial. This latest version of the Savannah has all the practicality of its predecessor, but with a speed range that makes her a great companion for aerial adventures. **MF**

**On a very windy day, it was not possible to make independent checks of these improvements in speed or sink rate. But we have no reason to suppose they are inaccurate and, since the test aircraft is the one used for BMAA testing, the ASI calibration figures (for example) have been carefully checked.*

Facing page: (top) Plenty of room for long legs, enough room on the dash to keep even the most gadget-conscious builder happy, and we liked the leather seats; and (bottom) big bellcrank operates flaperons, 7-litre header tank incorporates low-level warning, and chad is a no-cost extra!



technical data

ICP Savannah VG

Manufacturer

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Importer

Sandtoft Ultralight Partnership, Low Lodge, Main Street, West Haddlesey, North Yorkshire YO8 8QA; tel 01757 229565; mob (Steve) 07876 507688, (Pete) 07980 359915; fax 01757 229225; <info@sandtoft-ultralights.co.uk>; <www.sandtoft-ultralights.co.uk>. Proprietors: Steve Whittaker and Pete Wilson.

Summary

Side-by-side two-seat high-wing monoplane with conventional three-axis control. Wings have unswept leading and trailing edges, constant chord; conventional tail. Pitch control by elevator on tail; yaw control by fin-mounted rudder; roll control by combination flaperons. Wing braced by struts; wing profile modified NACA 650-18; 100% double-surface. Undercarriage has three wheels in tricycle formation; single-piece Dural full-width sprung undercarriage on mainwheels and bungee telescoping suspension on nosewheel. Push-right go-right steering connected to aerodynamic controls. Brakes on mainwheels. All aluminium alloy (Dural 6061-T6) construction with plastic wing tips. Engine mounted below wing height, driving tractor propeller.

External dimensions and areas

Length overall 6.4m. Height overall 2.4m. Wing span 9.0m. Constant chord 1.32m. Dihedral 0°. Sweepback 0°. Main wing area 11.9m^2. Aspect ratio 9/1. Wheel track 1.50m. Wheelbase 1.50m. Main wheels dia overall 38cm. Nosewheel dia overall 38cm.

Power plant

Jabiru 2200 engine, air-cooled, direct drive. Max power 80hp at 3300rpm. GT 2-blade propeller, 1.66m diameter x 8.5° pitch. Power per unit area 6.30hp/m^2. Fuel capacity 77 litre.

Weights and loadings

Empty weight 260kg. Max take-off weight 450kg. Payload 195kg. Max wing loading 37.9kg/m^2. Max power loading 5.63kg/hp. Load factors +4, -2 recommended, +6, -3 ultimate.

Performance*

Max level speed 90mph. Never exceed speed 130mph. Economic cruising speed 98mph. Stall speed 33mph. Max climb rate at sea level 860ft/min. Min sink rate 300ft/min at 50mph. Best glide ratio with power off 10/1 at 55mph. Take-off distance to clear 15m obstacle 228m. Landing distance to clear 15m obstacle 159m. Service ceiling 12,000ft. Range at average cruising speed 450 miles. Noise level N/A.

**** Under the following test conditions***
Airfield altitude corrected for ISA ft. Other conditions N/A.

Price including VAT

£23,000 as tested, with specification as above, but excluding paint. Airframe-only kits £11,500 (to build airframe with fuel tanks and undercarriage), or £14,500 (to include everything except propeller and engine).

NA = Not available

Figures above are manufacturer's/importer's data
Figures in text are tester's experience