HOW GOES

THE e-Go?

Words by Brian Hope, photos by e-Go aeroplanes

It is nearly nine years since the LAA launched a microlight competition to spearhead the development of new designs to meet the recently announced SSDR (Single Seat De-Regulated) category. The CAA rules called for a maximum empty weight of 115kg, a maximum stall speed of 35kt and a maximum wing loading of 10kg per square metre which, to be honest, was something of a compromise to get what was the quite radical concept of allowing completely unregulated, non foot-launched powered flying machines to fly in the UK. The inevitably large wing area pretty well guaranteed that a typical microlight built to the formula would be a relatively slow, low energy machine. However, the competition had two categories, effectively simple 'traditional' construction, and state of the art. It was hoped that the latter would encourage some 'out of the box' thinking and maybe push the limitations of the design criteria to the extremes of creativity. And that is exactly what happened.

Giotto Castelli and Tony Bishop, two aeronautical engineers who had built an MCR01 Club together, presented an all composite canard design with a fully-enclosed glider type cockpit offering light aircraft performance. Called the E-Plane, the design took first place in its category and spurred Giotto to continue developing the design so they could build a prototype whilst Tony looked into market opportunities and possible collaborations.

After enlisting the help of a number of volunteers, including graduates in appropriate fields, by 2011 the design was at a point where it was considered a viable machine, the aircraft's name was changed to e-Go and e-Go aeroplanes Ltd was formed with £500K of Angel funding to build a prototype and develop it for production.

In 2012 the fledgling company was struck a devastating blow when a fire caused by fault with the curing oven, destroyed the offices, although thankfully no design data was lost. Undeterred, the team picked themselves up and on 21 July 2013, the prototype flew for the first time, with test pilot Keith Dennison at the controls, at Tibenham airfield, in Norfolk.

There is no doubt that building light costs

There's no doubt the e-Go is a spectacular aircraft from nose to, er, tail.

(Main) **Test pilot Keith Dennison brings the e-Go into land.**

money, and to meet the 115kg max empty weight the e-Go has had to be built almost exclusively in carbon fibre. It was therefore something of a mixed blessing when, in early 2014, the CAA announced that the SSDR rules were changing. A maximum all up weight of 300kg would now be allowed and, whilst the 35kt stall speed requirement was retained, the wing loading rule was abandoned and designers were able to use smaller wings to promote faster cruise speeds, with high lift devices – flaps or leading edge slats for example - incorporated to keep the stall speed within limits. That said, as of this moment in time, a very limited number of currently available SSDR machines have gone down this road. What it has meant for e-Go though, is that certain complex and costly design solutions necessary to make the 115kg empty weight have proved unnecessary.

I asked Giotto if, starting again under the current SSDR rules, he would have done anything radically different. Apart from some of the weight saving issues, he said no because the canard arrangement has so many advantages – fighter like visibility and safe stall characteristics, for instance. e-Go aeroplanes were actually contributors to the changes, sitting on the sub-committee to help define the new rules and believing it a good thing in the long term. They recognise that the earlier 115kg requirement had added a discipline to the design exercise because literally every gram had to be justified. It is always easier to relax and add a little weight to a good, light design than it is to trim weight.

So, with the design of the aircraft established to the point where production moulds could be finalised and built, first deliveries were promised for 2015. The inevitable delays that can affect any product launch, particularly one from a small, limited resource company, has meant that date has slipped but the first production aircraft is currently well underway and the first customer is now expected to receive his aircraft by the end of April 2016.

Customers are another issue of course, because ultimately it will be the number of people prepared to pay the current £50K plus VAT asking price that decides whether › the e-Go survives. Nobody really knows whether a high-end, technically advanced SSDR can carve its own niche market. The SSDR category has generally been considered to be useful for offering a low-cost, entry level machines and the e-Go is the first to turn that on it head and offer a sophisticated flying machine equipped with Mode S and 8.33 radio, and a Kanardia NESIS III EFIS linked to an e-Go data acquisition system and the Rotron Wankel rotary engine's ECU via CANbus. You could perhaps compare that to the likes of Breitling offering sophisticated £15K watches when you can get a Timex for £20. They have a successful business because they are selling their watches to a completely different market rather than to people who simply want to know what time it is.

FIRST PRODUCTION MACHINE

So, where is e-Go now, at the beginning of 2016 and looking to deliver its first production machine within a matter of weeks? Malcolm Bird, who flies a SportCruiser and a homebuilt Rotorway helicopter, has been with the company for five years and is the executive chairman, very kindly agreed to chat about the project and show me around the e-Go facility near Cambridge.

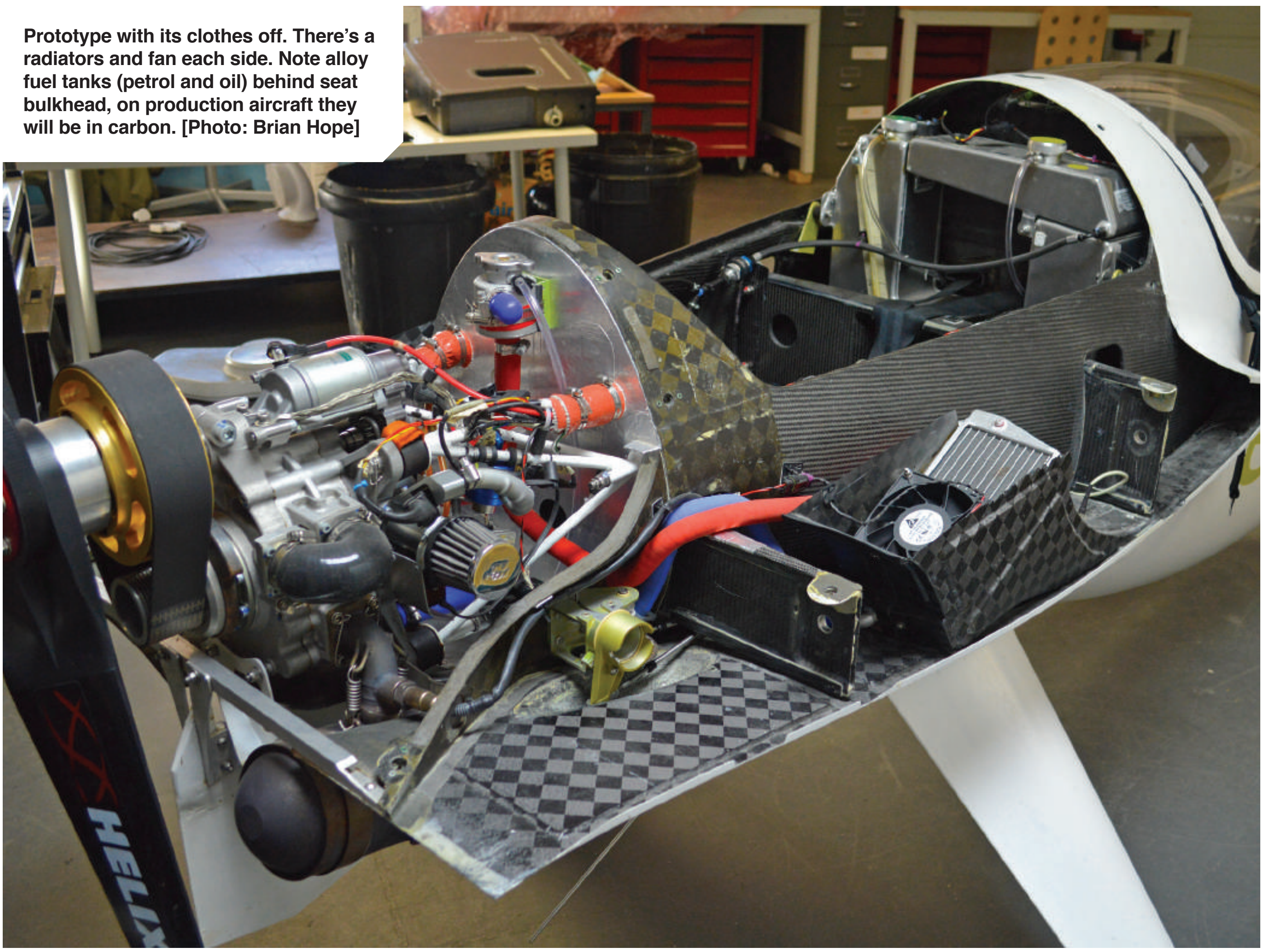
The first surprise was that the company had not been built on the back of development funding from the various government and regional schemes, although good and full use has been made of the UK R&D tax credit system. The entire cost of developing the aircraft has come from private individuals and companies who have wanted to support a new British enterprise. Readers may recall that a second fundraising call was made in 2014 when £900K was raised, partly by crowdfunding.

Before moving onto the aircraft itself, we discussed what direction the company might be going in now that the design had been settled and production was commencing. A cost reduction exercise is already underway and is seen as a vital requirement to try and prevent any further increase in retail price. Almost certainly some airframe parts of the aircraft could be made in glass rather that carbon, and components such as the aileron torque tubes, which are especially made in carbon by an outside contractor, could be substituted for stock aluminium alloy.

The engine too is a high cost item. Built by Rotron in the UK, this single rotor, 300cc powerplant produces 30hp at 7,500rpm. It is compact and lightweight (the core block weighs only 12kg) but its pedigree as a drone engine for the military means its complex metallurgy and other design aspects have been developed without cost being an overriding moderator. e-Go has already radically cut the price of the ECU by having its own unit manufactured by a US/Chinese company for a fraction of the original unit's price.

The aircraft was originally developed against a claimed 40hp for the engine but that power rating has dropped 25% in the real world. The company has recently installed a dynamometer in order to allow accurate characterisation of the engine and development to claw back some of that power (Rotron reputedly gets more than 40hp in certain drone applications). Changing the engine for an alternative would be difficult but not impossible, and perhaps an electric or hybrid powerplant or even a small turbine lies in the future, depending on whether customers want short periods of intense fun or a more relaxed, longer range and economical experience. Incidentally, the Rotron features a total loss oil system. Rather like a 'modern' two-stroke, oil is pumped to the vital organs before being burned in the combustion process. The fuel/oil mix is around 80:1, the two remote electric oil pumps, like the remote water pump, being controlled by the ECU. The aircraft features two small radiators with electric fans to keep them cool while the aircraft is on the ground. As soon as the aircraft has accelerated to 40kt and thus sufficient cooling air is passing through the radiators, the ECU turns the fans off. This automation is all part of the operational simplicity which is part of the aircraft's appeal. The production aircraft will have a single switch which controls everything electrical, meaning that the pilot will not have to concern himself with switching on pumps, charging systems, instruments etc.

Certification of the aircraft is certainly high up on the list of possibilities. It has been designed to comply with appropriate design codes, the required additional composite safety factors have been included in the structure for example, as approval for a number of foreign markets is being considered. Initially, however, the ASTM approval standard for SLSA is the



Prototype with its clothes off. There's a radiators and fan each side. Note alloy fuel tanks (petrol and oil) behind seat bulkhead, on production aircraft they will be in carbon. [Photo: Brian Hope]

frontrunner because there has been significant interest in the aircraft in North America.

There is almost a hint of irony in that a kit is also being talked about. The E-Plane was originally conceived as a kit but the company decided that it was prudent to prove the manufacturing processes to be safe and secure before deciding on what a homebuilder could reasonably do. The original criticality of hitting the 115Kg empty weight was also a major factor – with a bit of extra resin a 118kg e-Go would have been an expensive ornament! So, it was decided that ready-to-fly was the optimal option. After the factory built aircraft has proved the design and production processes, and with the subsequent change in the SSDR criteria, the company now plans to offer a kit, the major components being supplied as sub-assemblies and the avionics as an option. Add to that reduced company labour costs and you have a kit that could tempt more traditional homebuilder buyers. Moving on to a completely different tack, Giotto is also keen to look into developing a three-seat version of the aircraft.

It must be said though that none of the above options are even remotely firmed up, for now the target is set purely on getting completed aircraft out to the early customers and seeing how the market develops. A new CEO is being sought and in which direction the company goes once he is in place will ultimately depend on his and the board's vision.

Moving out into the factory, it is evident that it is currently a low volume production facility. Pre-preg carbon is laid-up by hand in polyester glass moulds with peel ply added at locations which will later need to be bonded to other components. The assembly is then vacuum bagged and cured in an oven at 100°C for about five hours. Depending on application, certain components are simply made from a couple of layers of carbon, others with up to 20 layers and some are a carbon/foam/carbon sandwich. Following the earlier fire, the curing oven is now sited remotely from the main building and has all manner of failsafe features that shut it down if a problem arises.

The moulds themselves are worthy of mention. Heavy tooling block – and it is so very heavy! – is used to make a pattern of a component from the CAD file by an outside contractor – they have large computer controlled milling machines to carve out the pattern. The pattern is then used to make the mould, and it is simply layer after layer of glass bonded with polyester resin to over 1cm thickness.

The completed parts are bonded together to make sub-assemblies which ultimately become the complete aircraft. The wings are interesting in that a skin is laid into the wing jig followed by a thin sheet of heat activated adhesive. The front and rear spars and a number of ribs then go in – all correctly jigged in place – followed by carved foam blocks, hollowed out to save weight, which completely fill the voids. Another glued sheet is laid on and then the other skin. The whole is compressed between the moulds and cured to produce a completed wing panel. A complete main wing panel weighs less than 20kg.

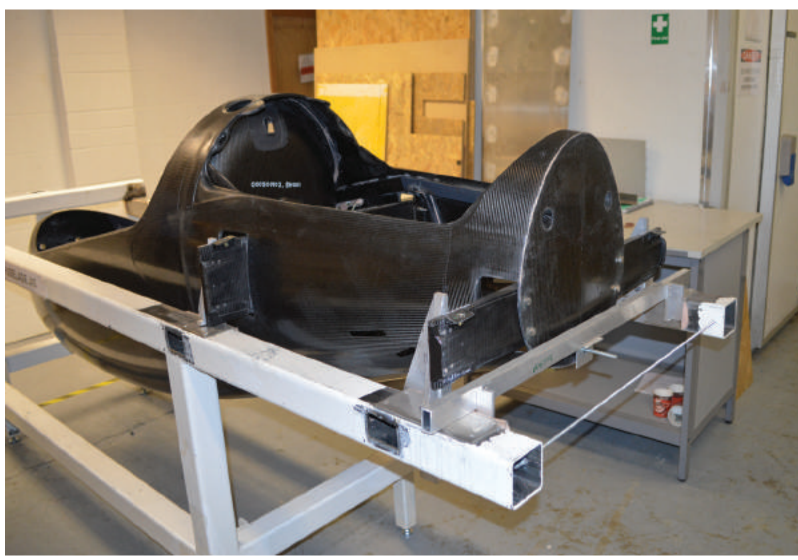
The prototype was sitting in the factory with its covers off and reveals the amount of effort that has gone into proving the airframe. Strain gauges have been placed around the airframe to see how it fares in flight, the data logger also keeping track of engine performance. The inside of the rear fuselage is a non-electrician's nightmare but the company is geared up to make its own wiring loom for production aircraft, which will have less complex electronics as the company's own ECU is a single box instead of Rotron's two. There will be no requirement for the flight test data boom and most of the strain gauges will not be included.

Changes to the systems in the production aircraft include the throttle, which will be a conventional lever/cable rather than the 'fly by wire' potentiometer in the prototype, and an electric rather than manual trim system. The trim is actually a spring bias system on the stick, although the spring is in fact a carbon/glass fibre rod. The change to the throttle is primarily because it will save an awful lot of hassle when they seek airworthiness approval for the aircraft.

The prototype has a good few camera mounts and certainly wears the battle scars of a development aeroplane as changes have inevitably been made along the way as new ideas are tried. It did, however, fly well from the outset and anyone who has seen it displayed will have been impressed by

(Left) **A completed wing assembly and, behind, the substantial mould/jig.**

(Bottom left) **Giotto Castelli, the young Italian designer of the e-Go.**



(Below) **The fuselage forms an effective safety cell. The carry-through spars are bolted rather than glassed into the tub. As shown (seat mould also installed) it weighs about 12kg but is incredibly stiff. [Photo: Brian Hope]**

The glider style canopy and low sill height make entry and egress very easy.

e-Go displays its agility but it's equally at home at cross-country flying.

its agility and ability to perform in a very small display box. It will, for instance, turn through 360° in just seven seconds. Unfortunately test pilot Keith Dennison was out of the country at the time of my visit but the production aircraft numbers and characteristics are pretty well established.

Empty weight of the aircraft will be 138kg and maximum all up weight is 270kg. This provides +4/–2 utility category stress margins and allows a useful load of 132kg, up to 110 kg of which can be the pilot (minimum pilot weight is 60kg). There is space for up to 15kg of baggage behind the seat.

With the production aircraft being considerably 'cleaner' than the prototype, it is expected that the initial rate of climb at all up weight will be 700fpm and the cruise will be 90kt at 7,000rpm (a 2.75:1 belt reduction drive converts that to a prop speed of 2,550rpm). Reducing to 6,700rpm only loses a few knots on the cruise speed but fuel burn at this setting is a miserly seven litres an hour. The carbon fuel tank, mounted on the back of the seat bulkhead, holds 30 litres, providing a normal cruise range of well over 300nm. Oil tank capacity is 2.1lt.

Max straight and level speed may be just over 90kt and VNE 120kt. A ballistic chute is an option, as is a purpose designed road trailer.

The main wing is set at zero angle of incidence when the aircraft is sitting on the ground, so it is necessary to get the aircraft rolling fast enough on the take-off run to provide the canard with sufficient lift to raise the nose, whereupon the aircraft pops off the ground immediately as the main wing starts to provide lift. Typical take-off run on a hard runway is 120m but it can be significantly longer on grass. On the production version, the main wheels have been moved 11cm farther forward to reduce the weight the canard needs to lift to get the mainplane flying, and thus reduce the take-off roll. Landing roll is of the order of 100m.

Keith has reported that the ride quality of the aeroplane, even in fairly turbulent conditions, is surprisingly good despite the low wing loading. The lower wing loading of the e-Go has meant that the aerofoil of the canard, which provides 50% of the aircraft's required lift at 90kt, is not as sensitive to insects or rain as some higher wing loading canards.

Flight testing has shown that in typical canard fashion, when the stall is reached the aircraft nods down to keep the main wing unstalled. In fact, when Keith holds the stick fully back with the engine at idle, the aircraft descends at just 300fpm as the canard stalls and unstalls, and the aircraft will even turn in this condition without drama. It does sound like it is an aircraft that will look after the pilot, even ham-fisted ones!

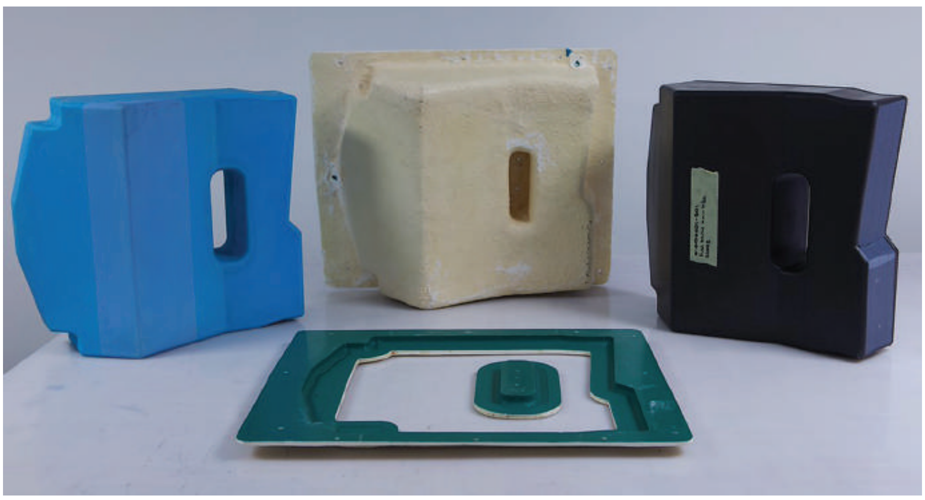
Optimum L/D is in the order of 16:1 at 45kt, which means that unlike many SSDRs it does not lose penetration as soon as the throttle is closed, which on one hand makes the approach easier. However, it also means that it has a quite flat approach, although you can use the rudders together, as per Rutan designs, to create drag and thus steepen the approach. One thing you must do though is have the aircraft wheeled on before the stall because you certainly don't want the canard to stall and dump the front wheel onto the ground while the main wheels are still in the air.

In terms of usability, the glider style canopy and low mounted canard give unrivalled visibility, and the shoulder width of 60cm (23.5in) is pretty generous. The wings can be removed by moving a single lever each side with the aileron controls connecting and disconnecting automatically. Likewise the canard fits and removes without the need to touch the elevator controls. The rudder pedals are adjustable and differential brakes are fitted (the nose wheel castors).

Initially at least, the e-Go will be available in any colour as long as it is white, and the chances are that it will be vinyl-wrapped rather than painted; this will allow a known weight of 'finish' (the prototype had 4kg of additional paint added to cover paint blemishes), and will also overcome the issue of surface pin holes which require a lot of filling and preparation to eliminate prior to painting.

I certainly wish the e-Go team well. They have designed, developed and productionised a British light aeroplane, and there aren't too many people who can say they've done that in the last 40 years.

It remains to be seen how the market responds. There has been a high level of interest in the UK and the US, and I hope that is translated into firm orders when the first customer orders are filled and we see examples of the aircraft at fly-ins and rallies (it would certainly be great to see at least one at Sywell for our 70th anniversary Rally). Plans are to complete three aircraft this year and step up production slowly from 2017. ■



Here we see basic component process – from the left, the fuel tank plug, the polyester mould and the finished carbon fuel tank.

e-Go SPECIFICATIONS

DIMENSIONS

Length: 3.79 m
Wingspan: 7.99 m
Height: 1.80 m
Wing area: 11.5 sq m
Empty weight: 135kg
MAUW: 270kg

PERFORMANCE

Manoeuvring speed (Va) 70kt
Vne 120kt
Climb rate 700fpm @ 50 - 55kt
High cruise 90kt
Range 330nm plus reserve

Engine: Rotron 30hp Wankel rotary
Manufacturer: e-Go aeroplanes
www.e-goaeroplanes.com

Lift to drag ratio is 16:1 at 45kt so the e-Go doesn't lose momentum as soon as you close the throttle.