The M108 is a particularly attractive take on the popular Avid/Kitfox theme

This month we are featuring the latest type of kit to be accepted by LAA's Engineering Department, the Mission M108. This aircraft has been designed by youthful Belgian LAA member Filip Lambert and manufactured through his company, Lambert Aircraft Engineering, which is based on Kortrijk-Wevelgem Airfield, situated just a few miles from the WWI battlefield at Ypres.

My first encounter with Filip was through his entry of an own-designed four-seat, low-winger in a Royal Aeronautical Society design competition in the 1990s. The competition was run by the RAeS Light Aircraft Group and was one of a series of such challenges intended to stimulate new design activity in the light aircraft field. Designed initially while Filip was undertaking a Cranfield MSc course, the Mission M212 won the Aeronautical Society competition in 1995 as a pure design study. Filip and his brother Steven then built the prototype under the PFA scheme (now LAA) and it first flew in 2004, achieving its full Permit to Fly after a satisfactory flight test programme carried out by Cranfield's then Chief Test Pilot, Roger 'Dodge' Bailey.

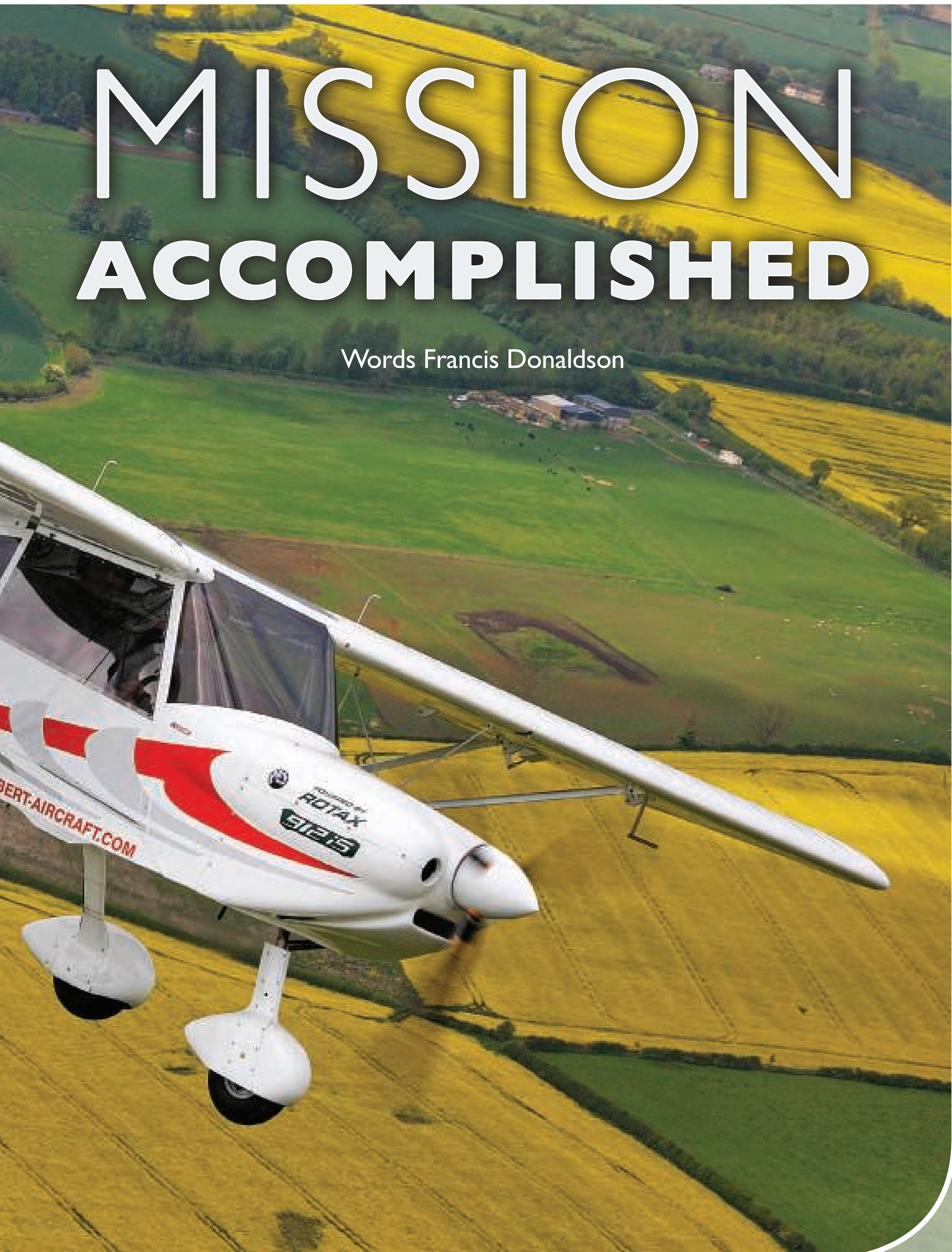
While the all-composite, female-moulded Mission M212 flies well enough with a Lycoming O-320 engine, it was designed around the infamous Zoche diesel which promised outstanding performance statistics but sadly, despite many assurances, never quite made it to production. This left the Lycoming-powered M212 as a slightly lacklustre performer and sales were few. Faced with the need to make a living, the Lambert brothers set up Lambert Aircraft Engineering as an aircraft maintenance company and it quickly developed into a flourishing concern, taking up most of Filip's energies. Consequently the thoroughly practical M212 has been on the back-burner awaiting a powerplant that will release its full potential as a 'full-sized' composite kitbuilt four-seater to compete with the all-metal RV-10, and potentially as the basis for a future fully-certified aircraft for the training and touring role.

EARLY YEARS

Knowing Filip's enthusiasm for moulded composite construction, come the mid 'noughties' it was a surprise to find him promoting a small fabric-covered two-seat high-winger which he had designed. He had apparently set out to help a friend design such an aircraft on a spare-time basis, but the VW-powered prototype, built in the Slovak Republic, turned out so well that Filip decided to develop it as a factory-built microlight. Keeping the Slovak ›

MISSION ACCOMPLISHED

Words Francis Donaldson



connection for parts manufacture, from 2007 Lambert Aircraft Engineering produced a batch of eight of these microlights as the Mission M106, powered by the four-cylinder locally-produced UL Power 260i.

Microlight aircraft in the 450kg category (472kg with a ballistic chute) are all very well but despite the best intentions, in practice, they tend to push the weight limit and a few minutes studying the numbers often shows a disappointingly low payload for crew and fuel. With the increasing popularity of the US Light Sport Aircraft category with its more generous 600kg max gross weight, Filip and Steven decided to develop a more robust 600kg version of the aircraft which would offer substantially greater payloads and, for those so inclined, allow a less Spartan fit-out.

To preserve adequate performance at the higher weight, more power would be required. After much consideration and not a little soul-searching, the Lamberts opted to abandon the locally-made UL Power engine and standardise on the newly-introduced top-of-the-range Rotax 912 iS engine for the 600kg MM108 variant. As with the M106, the M108 was to be available either with a nosewheel or tailwheel-type undercarriage, both using cantilever composite main undercarriage legs rather than the bungee-sprung tripod units (reminiscent of an Auster or Taylorcraft) that had been used on the earlier examples of the M106.

While the microlight model had been supplied factory-finished under Belgian ULM rules, to sell within Europe a 600kg factory-built would have required an EASA-type certificate, which the Lamberts have chosen not to pursue in the foreseeable future. Instead, to keep costs down, the M108 is supplied in kit form for amateur construction, and Filip sought LAA approval of the new design on the basis that this is the key not only to the UK market but to several other European countries which accept LAA approval as proof enough of airworthiness without further investigation. The M108 is also designed to meet the US ASTM standards as a Light Sport Aircraft, should Lambert choose to pursue that route. The Wevelgem-based factory prototype of the M108 has appeared at several LAA annual Rallies and was previewed in flight tests carried out at Cambridge by the very experienced John Brownlow, whose previous exposure to Avid-type aircraft was particularly worthwhile with the similarly configured M108.

Readers of this magazine will have been aware of the 'UK prototype' of the M108 being built by LAA'er Steve Kember, who has kept us informed of his progress through regular contributions to Project News. Steve chose to use the Lambert's factory assist programme to help him build the aircraft, allowing him to build the kit in Belgium at the Wevelgem facility under the watchful eye of the designer and his fellow employees, whilst still qualifying under the 51% rules. The aircraft has recently completed its flight tests in the hands of LAA's Chief Test Pilot, Dan Griffith, and a full Permit to Fly was issued early in 2015.

Having, unusually, not been involved in the flight test process for the Mission M108 at any stage, or flown the earlier M106, I was particularly interested to see how Steve's aeroplane had turned out and was quick to accept his offer of a flight when it was brought to Turweston for a photo-shoot sortie in early May of this year.

Approaching the Mission M108, one cannot help but see similarities with types such as the Eurofox, Kitfox and Escapade, all of which undoubtedly share common inspiration from designer Dean Wilson's Avid Flyer of the mid-1980s. All feature a high strut-braced fabric-covered wing of two spar configuration, both panels of which are arranged to fold back along the fuselage for compact storage. Other common features are a fuselage of welded steel tube truss type, seating two side-by-side in an enclosed cockpit, and a high-set tailplane braced by struts to its under surface, leaving the space above the tailplane unobstructed by bracing and allowing the folded wings to rest close to the fin, minimising the folded width.

CONSTRUCTION

As with the Avid and its other protégés, the tail surfaces are of welded steel tube construction, while the wing spars are made from large diameter but relatively thin wall, aluminium alloy tube, the wing ribs being routed from plywood. A series of internal diagonal drag/anti-drag tubes brace the wings fore and aft, attached to the spars with neat welded end-fittings. Unusually among this class of aircraft, like the Escapade the M108 has separate flaps and ailerons rather than combined flapperons, the ailerons being cable-driven like the rudder. The elevator is pushrod operated. Fuel is contained in twin wing tanks feeding a header tank behind the seats, giving a 110lt total capacity 'PK has the long range option, standard tanks being 78lt). The aircraft looks well presented, the front end in particular being set off very nicely by a beautifully shaped set of moulded composite engine cowls enclosing the 912 iS.

Coming up close, it was good to see that Steve's aeroplane had been built to a very high standard of finish and it was difficult to fault the quality of workmanship on this, his first foray into the world of amateur aircraft construction. Opening up the cockpit side doors revealed a very tidy interior, trimmed in a calming grey, with a massive baggage area to the rear. Most noticeable is the instrument panel, which is of very modern format, substantially all 'glass'

The quick-fold wing system provides the opportunity for reduced price hangarage or even keeping the aircraft in a trailer or container

without a traditional instrument to be seen. Eager to push the M108 as a thoroughly modern design and cast off any 'retro' image, Lambert Aircraft Engineering have pioneered the use (on an LAA application, at least) of an all glass cockpit with back-up for the essential ASI and altimeter being provided by another electronic instrument, in this case the dedicated LX BU57 by LX Navigation which Steve has mounted directly adjacent to the TL Electronic TL-6624 primary instrument. The BU57 is a very simple and compact unit containing an internal back-up battery so that it can operate independently of power from the aircraft's busbar if needs be, and relying only on external pitot static pipe connections as would apply with conventional separate mechanical instruments. A separate mechanical compass is also fitted to allow for navigation with failed 'glass'. The only other traditional dial on the panel is a rather classy analogue clock on the right-hand side, which builder Steve admits is something of an aberration on his part.

Again unusually amongst aircraft in this class, the M108 features individually fore-and-aft adjustable seats to suit pilots of different leg lengths, best positioned whilst standing alongside the aircraft. Once seated, you find yourself with what seems an unusually high sitting position conferring a commanding view over the aircraft's nose (at least on the nosewheel version, as tested) and your head close to, but not quite touching the transparent overhead roof panel. Conventional sticks fall easily to hand and the rudder pedals, linked directly to the nosewheel steering, have a

Owner Steve Kember with designer Filip Lambert and the LAA's Francis Donaldson

reassuringly firm feel to them with very little springiness under foot. A single central plunger type throttle control is provided, a small adjacent button providing ECU start-up power to the 912 iS, conveniently positioned to minimise the fumble factor during this electrically dependent engine's unfamiliar start-up routine. Overhead and slightly behind the pilot, there's a mechanical flap control lever, while on this nosewheel undercarriage example the hydraulic wheel brakes are operated simultaneously by a small hand lever sprouting between the seats. In contrast, the tailwheel undercarriage version uses conventional independent toe brakes for ease of directional control. The mechanical elevator trim control falls conveniently to hand between the seats, position reference being provided by the lever itself. Having had some experience of doors coming open in flight on early marks of Kitfox, it was good to see that the M108 has a more sophisticated door catch arrangement which looks thoroughly up to the job, yet easy to operate.

Emphasising the modern format of Steve's all-glass M108, the aeroplane leads you through its start-up routine and run-up checks by scrolling through detailed electronic checklists which flash up on the right-hand glass panel. The electronic fuel-injected 912 iS calls for the ECU start-up power button to be depressed a few seconds before cranking the engine on the key switch, the already-warm engine coming to life willingly. Reminding you of its dependence on electrical power, the checklist leads you through tests on each of the twin ('A' and 'B') fuel pumps, as well as the dual ignition systems.

Taxying the nosewheel-equipped M108 is a cinch thanks to the excellent forward view over the nose, direct nosewheel steering and simple combined brake lever, the only potential difficulty being knowing where your wing tips are when taxying through narrow gaps - your head being between the wing roots, the wing tips are out of sight so this becomes a depth perception task.

Checks complete and opening up for take-off, I was pleased to find that there was very little tendency to swing; Rotax-powered aircraft usually tend to swing quite hard to the left which can catch pilots out, especially with a left crosswind exaggerating the tendency. In this case the 912 iS engine has been mounted with a degree or two of right side thrust to counter its torque and P-factor effects, so ›

The Rotax 912 iS Sport engine is the standard fit for the M108

The luggage bay is cavernous but care will need to be taken to ensure the C of G remains within limits. Note the adjustable leather seats.

The all-glass display even includes an electronic back-up altitude and airspeed unit. The only mechanical instruments are a clock and a back-up compass.

swing has been successfully minimised – such a shame that all manufacturers don't trouble to do this.

Lifting off as the speed passed through 45kt, Filip had warned that the combination of the high seating position and low cowling line meant that pilots seeking a normal 'picture' tended to over-rotate the aircraft and climb out at too high a nose-high attitude. Pre-warned, it was certainly noticeable that the nose seemed low during the climb out at 65kt indicated.

UP AND AWAY

Up and away, as one expects with this class of machine, the aircraft was responsive yet with satisfactory control forces that made it reasonably pleasant to fly. In particular, the pitch control forces were heavier than on most competing aircraft but this was seen as a positive contribution to safety, conferring an overall 'feel' more aligned to that of a certified aircraft such as a Cessna 152 and this would ease the problems for a newcomer transitioning to the M108 from the typical trainer. Stability in all axes was reasonably good, with positive stability being exhibited for all points tested, except for the spiral stability which was neutrally stable.

The directional stability was weak and masked to a degree by rudder circuit friction, no doubt affected to a degree by the coupled nosewheel steering. When making large aileron inputs, the aircraft did exhibit a significant amount of adverse yaw, the nose swinging away from the direction of bank quite markedly unless compensating rudder inputs were made. This feature is common in this class of aircraft, as well as in vintage machines but given the modern aspirations of the M108, the directional characteristics would benefit from stronger stability and less adverse yaw, particularly as Lambert are looking to achieve an IFR clearance on the M108 in due course.

Performance-wise, fitted with the DUC Swirl three-bladed propeller, the flight tests for the Mission showed a max gross weight sea level climb rate of 800fpm at a 'best rate' climb speed of 55KIAS. Best angle of climb was found to be achieved at 48KIAS. This quite modest (but perfectly adequate) climb rate should be qualified by the fact that at 600kg max gross weight, ›

THE MISSION M108 DESIGN PACKAGE

Of course, as with every new aircraft type that's introduced to the LAA, there's more to gaining type acceptance than a flight test evaluation. The amount of technical substantiation required is variable, depending on the scope of the aircraft, any commonality with previously accepted designs and the amount of 'in-service experience' that it has clocked up in other countries by way of establishing 'proof by usage'. In the case of the Mission M108, while there was much in common with the M106 design from which it had been developed, the flight loads at up to 600kg gross weight would be considerably more than in the earlier microlight variant, so there could not be much structural read-across. Filip therefore set out to prove the structure was up to the job mainly by load testing rather than by presenting stress calculations, although calculations had been done to size most of the components in the design phase.

The work was presented to the LAA in the form of an initial test proposal, a substantial A4 ring binder describing in detail what tests would be performed and what the various loads would be that needed to be applied to prove compliance, with the applicable paragraphs of the design code – in this case CS-VLA. The load cases presented were fairly uncontroversial because Filip chose to use the so-called 'simplified' load cases from the Appendices to CS-VLA, which provide a short-cut, eliminating a great deal of calculation, albeit resulting in loads that are generally a few percent higher than might result from a full-blown classical analysis. Once LAA Engineering had agreed the proposal, the tests were carried out by Lambert Aircraft Engineering over a period of several months, each one being carefully documented and verified by photographs.

To test even a simple aeroplane in this way is no small undertaking because of the many load cases to be proven, relating to different possible flight conditions. The wings, for example, inevitably see highest load under positive g conditions but in a high-wing strut-braced aircraft it will be the lesser, reversed loads under negative g that are likely to create the critical cases for the wing struts buckling in compression. Depending on the aircraft's airspeed and the position of the control surfaces, the wing will experience different amounts of torque, generally trying to twist each wing more nose-down at the tip, and this torque affects the way the lift loads are distributed between front and rear spars, and (if there are two wing struts each side) the front and rear struts. So there are at least four different cases to be considered for the wings even before taking into account different flap and aileron positions, or conditions that place greater loads on one wing than the other, putting substantial horizontal shear forces into the fuselage centre section.

Of course, load tests normally need to be carried out both to the design limit condition (the maximum loads expected in service while operating within the permitted flight envelope) and to the ultimate condition, generally 50% higher than limit load, to ensure that the structure can carry an adequate extra safety margin without collapsing altogether. For the test engineer, the challenge is that even if the structure doesn't collapse at ultimate load, it will most likely suffer some permanent distortion and minor damage (this is allowed above limit load) which may render the test article (in other words, the sacrificial airframe) useless for any remaining tests in the programme – or at best, in need of repairs. A skilled aeronautical engineer will choose the order in which to do the tests so that the test article remains in good shape until the final, most punishing test where destruction coincides with the last test on the schedule.

In the case of the Mission M108, a sacrificial airframe was load tested with sand bags in the time-honoured fashion, including separate tests on the wings, fuselage, tail surfaces and flight control system. Drop tests were carried out to prove the undercarriage, while supporting calculations were provided dealing with the seat belt mountings. In addition to the structural submission, as part of the MM108 package Lambert Aircraft Engineering provided a full set of drawings and manuals for the aircraft, as well as a compliance checklist which lists each paragraph in turn of the design code (CS-VLA). Against each one of these it states whether the aircraft complies or not and how compliance has been demonstrated/achieved.

An additional report was called for by LAA Engineering describing how the aircraft could be demonstrated to meet the 51% rule requirements. This is basically a list of all the main operations required to build the aircraft, each one being allocated to either the kit manufacturer or the amateur builder as appropriate, and a summing up of the number of operations put down to each party to show that the amateur carries out at least half the total operations. Of course, in reality this approach is somewhat flawed because the significance of some operations is a great deal more than others (assembling a wing is more of a task than fitting a wiring loom, for example), so a degree of common sense has to be applied to make sure the spirit of the regulation is complied with – that being to make sure that the amateur builder ends up with a full hands–on involvement in building the aircraft, not just in finishing off what is basically a factory-built product. In the case of the Mission M108, compliance with the 51% rule had to be demonstrated both for the standard kit version supplied for the amateur builder to construct at home, and separately for the construction of the kit through the builder-assist scheme, where the use of factory jigs and fixtures reduces the amateur builder's involvement in certain aspects of the build. This has to be balanced up by requiring him or her to carry out more of the earlier build operations, albeit with the confidence that comes from these extra stages being carried out under factory supervision.

Photographic evidence of an ultimate wing-loading test was part of Lambert's approval package for the M108

Steve's M108, which has an empty weight of 368kg, is lifting a payload of 232kg, enough for two 'standard weight' 86kg crew plus fuel for more than five hours in the air, yet still has a margin for overnight baggage. In cruise flight, max level speed was recorded as 102KIAS at 5,380rpm burning 26lph (max continuous on the 912 iS is 5,500, indicating that the aircraft was somewhat over-propped), while economy cruise was measured at 12lph at 82KIAS (87kt) and a very leisurely 4,500rpm.

Turning to the slow speed characteristics, the stall qualities were benign and at a very low indicated airspeed of just 32kt power-off and clean, reducing to 28kt power off with full flap. In stalls from level flight, provided the slip ball was centred at entry, wing drop was negligible. In turning stalls, wing drops into or out of the turn of around 20° were noted, although this was exaggerated when the slip ball was not centred. Given the ease with which the directionally rather weakly stable aircraft could be flown with an unintentional slip, the stall quality was considered acceptable for VFR operations but would need to be improved for an IMC clearance.

The aircraft's straightforward behaviour is emphasised during the approach and landing phase, being easy to trim on the approach at 60KIAS and the nose-low attitude giving a brilliant view of the touchdown point all way through the flare, the nosewheel undercarriage with its direct steering making the whole experience thoroughly stress-free.

Reflecting on the Mission M108 after this short introduction, I was struck by how very far we have come with this class of aircraft since the original bare-bones Avid Flyer of 30 years ago with its cramped cockpit, smoky two-stroke engine and back-country homespun image. Like the EuroFOX, which has been an extremely popular type in recent years in the LAA, the Mission M108 brings modernity, sophistication and a level of finish to this class of aircraft, and we wish Filip and Steven well with their entry into this still-flourishing market. It just goes to show that you don't have to fly particularly fast or far to appeal to the grass strip flyer. ■

DEVELOPMENTS

The aircraft's very low indicated airspeeds at the stall (32kt power-off and clean, reducing to 28kt with full flap) are a clear pointer to ASI position errors rather than an amazingly effective wing and indeed during the flight testing, the pressure errors (PECs) at low airspeeds (high angle of attack) were found to not meet CS23 or CS-VLA requirements in all configurations tested. However, Lambert intends to develop a new pitot/static system for future aircraft and will offer it for retrofit on Steve's machine once it has been tested and finalised. As CS23 / CS-VLA are only being used as guidance material for this aircraft, and the PECs were known and approach speeds correctly adjusted, the PECs were considered acceptable as an interim measure. This was with the proviso that should the pitot-static system be changed, the indicated Vne airspeed value would need to be reassessed so as not to exceed 114KCAS, which had been set by LAA during the test programme based on providing a safe margin below the onset of elevator tab flutter. During the high-speed testing up to 126KCAS, the original pitch-trim tab had suffered from flutter and as a result the tab was reduced in size and satisfactorily re-tested.

To date, the other major development of the aircraft has been the all-new installation of the 912 iS engine, Steve Kember's aircraft being the first M108 to feature this powerplant. Since the flight test on Steve's aircraft, Lambert Aircraft are trialling a new type of propeller which they are very pleased with, it appearing to significantly benefit all round performance. A new differential aileron control system, which should reduce the adverse yaw, is ready to be test flown on the next aircraft. Lambert will then pursue an IFR clearance on the type.

LAMBERT M108 MISSION SPECIFICATIONS

DIMENSIONS

Length: 6.10m (20ft)
Height: 2.15m (7ft 1in), TD / 1.95m (6ft 6in), NW
Wing span: 9.32m (30ft 6in)
Width folded: 2.60m (8ft 7in)
Wing area: 11.8m² (127ft²)
Cabin width: 1.08m (43in)
Empty weight: 725-770lb (330-350kg)

PERFORMANCE

Max. all up weight: 1,320lb (600kg)
Max. level speed at S/L: 105kt (195km/h)
Max. S/L rate of climb: 950ft/min (4.75m/s)
Cruise speed: 85-90kt (160-170km/h)
Stall speed, full flaps: 39kt (72km/h)
VNE: 120 kt (222km/h)
Fuel consumption: 12-15lph
Range (20 min res): 460nm (850km)
Engine: Rotax 912iS 73kW (100hp) at 5,800rpm
Manufacturer: *www.lambert-aircraft.com*
From UK: 03300 500 108
Price: £39,500 standard kit (excl VAT), £45,000 advanced kit (excl VAT)
Kits include engine, propeller and instruments

(Below) **Smart cowling and graphics accentuate what is already a very pleasing design. The doors swing up under the wing from almost the lower longeron provide uninterupted entry and exit.**