ACCIDENT

Aircraft Type and Registration:	Team Minimax 93, G-CBPL
No & Type of Engines:	1 x Mosler CB 40 piston engine
Year of Manufacture:	2002
Date & Time (UTC):	18 May 2012 at 1720 hrs
Location:	Field adjacent to Newnham Way, Ashwell, Herts
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	UK CAA Private Pilot's Licence (Aeroplanes)
Commander's Age:	62 years
Commander's Flying Experience:	363 hours (of which 0 were on type) Last 90 days - 2 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft struck the ground in an erect spin and the pilot was seriously injured. The pilot had flown flexwing aircraft for several years but had very little experience flying three-axis aircraft. The investigation considered the differences between various control systems used in microlight aircraft, and one Safety Recommendation is made concerning pilot licensing.

History of the flight

The aircraft was based at a grass airstrip near Newnham, Hertfordshire, where its owner (who was also the pilot involved in the accident) had prepared it for flight testing for a permit to fly. A Permit Flight Release Certificate (PFRC) had been issued by the Light Aircraft Association (LAA) naming a pilot, with experience on the type, who was to undertake the testing. The pilot named in the PFRC was not the owner. Nonetheless, the owner had conducted a number of taxi trials with the aircraft, including tail-up taxiing.

Very little is known of the circumstances leading to the accident except that the owner was flying the aircraft and received serious injuries when it crashed in a field, near the airstrip, having entered a spin from which it did not recover.

Several eye witnesses (see Figure 1) may have seen the aircraft before the accident. Two witnesses (witnesses 1 and 2) saw an aircraft flying near the airstrip close to

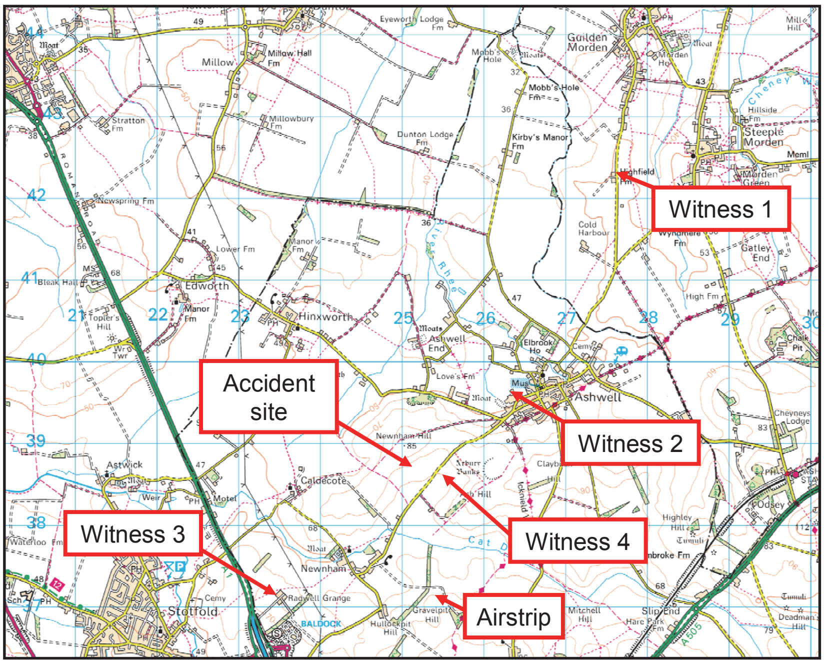

Figure 1

Local area map showing, eyewitness locations, etc

the time of the accident flying at a relatively low height, but straight and level, with the engine sounding “rough” or unusual. Witnesses 3 and 4 saw the aircraft’s final manoeuvre, describing an aircraft descending in an erect spin to the left.

The owner could not remember any details of the flight but he did confirm that it was his intention to fly the aircraft that day.

Meteorology

The Met Office provided an aftercast of weather conditions near the accident site which stated that:

> *‘The accident site was approximately 12 nm north-east of Luton and 16 nm south-west of Cambridge. METARs for both airport indicated that the wind was light and south-easterly, visibility was in excess of 10 km, and there was no cloud below approximately 3,000 ft amsl. The temperature and dew point were 13° C and 10° C at Luton and 14° C and 9° C at Cambridge respectively.’*

Piston engine icing

A possible cause of power loss in piston engines is carburettor icing. The CAA Safety Sense leaflet, entitled ‘*Piston engine icing*’, included a graph illustrating the likelihood of carburettor icing in various conditions of temperature and dewpoint. Appropriate values for Luton (elevation approximately 500 ft, and therefore approximating the flight altitude) at the time of the accident were entered into the graph. The graph indicated that there was likely to be *‘Serious icing’* at *‘any power’*.

It was understood that the engine in G-CBPL was probably running on MOGAS rather than AVGAS. The leaflet also stated:

'Testing has shown that because of its greater and seasonally variable volatility and higher water content, carb icing is more likely when MOGAS is used.'

Engineering

Accident site details

The aircraft crashed into a cereal crop approximately 1 nm southwest of the village of Ashwell. It was a compact site, with the disposition of the wreckage indicating that the aircraft had struck the ground in a steep, nose-down attitude, whilst banked to the left. The ground marks indicated that the left wing contacted the ground first, closely followed by the nose, after which the aircraft came to an almost immediate halt. The main force of the impact had been taken on the nose of the aircraft, as evidenced by extensive disintegration of the forward fuselage, which had effectively been destroyed as far back as the rear of the cockpit. The rear fuselage, rudder and tail surfaces had remained relatively intact. The short ground slide suggested a low horizontal velocity component. This was supported by witness evidence, which indicated that the aircraft had been in a spin prior to impact. The damage to the left wing, together with its associated ground mark, indicated that the direction of the spin was to the left.

The wooden propeller had broken into numerous fragments which were scattered close to the nose/engine impact area. The heavy clay soil and the standing crop resulted in an incomplete recovery of the fragments but, the two tip portions were found. It was considered that the degree of fragmentation was indicative of power being developed at impact, although it was difficult to quantify.

The engine and fuel tank (which had been mounted in the nose) had broken away during the impact, with the latter containing a quantity of fuel, although it was clear that some had leaked out via broken fuel lines. The gascolator bowl had also broken off but was not recovered.

The flying controls comprised Teleflex-type cables for the elevator and full span 'flaperons' (combined ailerons and flaps,) with the rudder being operated by conventional cables attached to the rudder pedals. It was established that the control connections had remained intact during the impact.

Following an on-site examination the wreckage was recovered to AAIB's facility at Farnborough for detailed inspection.

Aircraft history

The Minimax is a wood and fabric, shoulder-wing monoplane that can be built either from a kit of parts or from drawings. In the United Kingdom, construction is carried out under the oversight of the LAA. In this process, at its initiation, the project is registered with the LAA Engineering Department. The owner/builder must then find a local LAA approved Inspector who will provide advice and certify, at various stages of construction, the work that has been carried out. On successful completion a further inspection will result in the issue of a PFRC issued by the LAA, which will allow a designated test pilot (which could be the owner/builder if he has the relevant type experience) to fly the aircraft in accordance with a test schedule appropriate to the aircraft type. Only after successful completion of the flight testing, which typically takes around five flying hours, will the LAA recommend to the CAA that a full Permit to Fly be issued.

In the case of G-CBPL, the log book indicated that the aircraft was built in 2004, with a Certificate of Registration issued in May 2002. However, construction of the aircraft was not completed and the log books indicate that the current owner acquired the aircraft during 2009. It was subsequently registered in his name on 11 June 2011. The first engine ground run was recorded as having occurred in 2004, with the next one, conducted by the new owner, not carried out until September 2009. The engine was subsequently run on numerous occasions up until the time of accident, when it had achieved in excess of 25 hours. The first 'tail up' taxi took place on 22 May 2010.

The new owner had appointed a local LAA Inspector who had overseen completion of the aircraft. This had culminated in the issue of the Permit Flight Release Certificate on 30 April 2012, valid for 30 days. This stated that it covered flights made only for the purpose of the issue of a Permit to Fly, and additionally named the test pilot, (who was *not* the owner), who was to conduct these flights.

A flight was attempted on 5 May 2012 but was abandoned due to a problem with leakage in a hose that formed part of the engine induction manifold. This was repaired with a new piece of hose and was written up and signed for by the LAA Inspector in the engine log book.

A few days later another attempt at the first flight was made, although no written record was found. On this occasion, a gust of wind during the takeoff roll caused the pilot to make a sudden, large rudder deflection that resulted in significant distortion to the left rudder pedal hinge. This was detected by the pilot and the takeoff was abandoned. The hinges were made of brass and it was decided to replace them with higher strength, steel components, which in fact is a normal modification for this aircraft type. These were fitted by the owner and were subsequently found in the wreckage. However, as this work had involved disturbing the flying controls, a duplicate inspection by the LAA Inspector was required. This had not been done, although, according to the Inspector, arrangements had been made with the owner and test pilot to conduct the inspection and first flight on Monday 21 May 2012, which was a date dictated by the test pilot's non-availability during the preceding weekend. However, the owner decided to fly the aircraft on Friday 18 May,

Detailed examination of the aircraft

The aircraft was complete prior to impact, with no evidence being found of a pre-impact structural failure.

The full-span flaperons embodied a droop mechanism that enabled them to operate as flaps whilst retaining their aileron function. This comprised a flap-operating torque tube installed laterally across the fuselage floor and which could be set at one of four positions by means of a lever located on the right hand side of the cockpit. The positions were reflex (6º up), neutral, flap 1 and flap 2 (16º), and were selected by placing the lever into one of four hooked detents in a slotted alloy guide that was bolted to the cockpit wall. Examination of the lever and guide failed to reveal any reliable witness marks that may have indicated the flap position at the time of impact.

It was found that the left rudder pedal had broken close to its attachment to its hinge, although it had remained attached to its cable. The pedal was made from plywood and the fracture appeared clean and was considered to be an impact feature, possibly resulting from the force of the pilot's foot during the impact. A bracket attached to each pedal underside was connected both to the rudder cable and a balance spring that in turn was attached to the floor; the purpose of the springs was to apply a centring force to the rudder system. Each spring actually comprised two separate springs that were hooked together at their ends. It was noted that the left pedal springs were not connected together, with the hooks showing no evidence of distress under load. However it could not be determined whether the disconnect was a result of the impact, or possibly a result of the springs not being reconnected following the hinge replacement.

The engine was of a simple design, with two horizontally opposed, air-cooled cylinders. Examination of the engine controls indicated that the carburettor heat was selected to COLD and the choke was IN. It was also observed that the throttle control was pushed firmly against the instrument panel, in the full power position, although it was considered that this was not necessarily a reliable indication of the pre-impact setting. Finally, the fuel selector was found in the ON position.

Only a small quantity of oil was found within the engine, although it had become inverted during the accident and it was clear that considerable leakage had occurred via two breather tubes on top of the crankcase. The repair to the inlet manifold hose, referred to in the aircraft documentation, was found to be intact. The engine could be turned over by hand and it was noted to be smooth in operation, with the valve mechanism operating correctly. The single magneto produced sparks at the plugs when the engine was turned. A borescope inspection revealed that the engine appeared in good condition internally, with honing marks clearly visible on the cylinder walls, consistent with the low number of operating hours. The engine was equipped with a gear-type oil pump, which was driven from the crankshaft. This was noted to operate correctly, with the internal components being in good condition.

Other information

As noted earlier, the subject aircraft was equipped with flaperons. Evaluation of the first examples in the UK by the LAA concluded that the flap function:

> *'..has not, in general, been found to be beneficial, ... causing a reduction in aileron effectiveness when flaperons are drooped.'*

A modification became available, which locked out the droop mechanism. However, later examples of the aircraft retained the flap function and it is estimated that around half of the approximately 60 aircraft flying in the UK are so configured.

The pilot

The pilot began learning to fly flexwing aircraft in 1991, and bought his own aircraft shortly thereafter. He obtained a UK CAA Private Pilot's Licence (Aeroplanes) (PPL(A)) with a Microlight rating in 1997. At the time of the accident, he owned two flexwing aircraft, and had flown them regularly. His log book showed evidence of several flights in three-axis aircraft, annotated *'Pu/t' (pilot under training)*. The pilots of those aircraft stated that, although the accident pilot had manipulated the controls in cruising flight and may have made some gentle turns, climbs, and descents, the flights were not instructional. The pilot had had one flying lesson in a three-axis aircraft in 2010.

The pilot was interviewed in hospital some months after the accident, when he had recovered sufficiently to give an account. He had no recollection of the accident flight, but did recall that he had intended to fly. He explained that he had not undertaken any training to fly three-axis aircraft, but had spent considerable time using a flight simulator programme on his home computer (which was fitted with replica controls), to rehearse the control inputs necessary for flying three-axis aircraft.

The pilot's log book showed four previous flights in G-CBPL, totalling 1 hour 50 minutes. The pilot did not recall having flown the aircraft before the accident flight, and it is possible that the 'flights' in his log book were in fact records of taxi trials.

Other pilots who knew the accident pilot, and were aware of his self-tuition using his personal computer, stated that they had advised him to take proper training before flying a three-axis aircraft solo.

Pilot licensing

Control systems

The pilot's licence entitled him to fly microlight aircraft, as defined in the Air Navigation Order, regardless of control system. Such aircraft are typically of a flexwing or three-axis design. A few hybrid designs exist, and some powered parachutes are also classified as microlight aircraft. The three fundamental control systems are very different. (Powered parachutes are considered to be outside the scope of this report except insofar as distinct training is necessary to operate them safely.)

In the flexwing, the wing is articulated above a pod which accommodates the occupant(s) and engine. The pilot applies forces on a control bar attached to the wing to achieve the desired pitch and roll attitudes. There is no yaw control. Pedals are fitted to enable steering of the nose wheel during ground operations but they have no aerodynamic purpose in flight.

In a three-axis aircraft the pilot applies forces on a control column or yoke, which moves ailerons and elevators on the aircraft, providing control in roll and pitch. Pedals linked to the rudder provide control in yaw.

The senses in which control is applied are opposite: to pitch nose-up in a flexwing, the control bar must be moved away from the pilot; to pitch up in a three-axis aircraft, the control column is moved towards the pilot. To roll left, the flexwing's control bar is moved right; the control column in the three-axis aircraft is moved left. To steer to the left on the ground in a flexwing, pressure is applied with the right foot; to yaw left in a three-axis aircraft, pressure is applied with the left foot. Despite these differences, many pilots alternate between aircraft with different control systems without apparent difficulty.

Legislation

The BMAA is the governing body for microlight aviation in the UK, which is regulated by the CAA. Section 1 Schedule 7 of CAP 393 - *Air Navigation: The Order and the Regulations*' (ANO) in force at the time of the accident stated:

> *'Microlight class rating*
>
> *(1) Subject to paragraph (2) and to the conditions of the licence in which it is included, a microlight class rating entitles the holder to act as pilot in command of any microlight aeroplane.*
>
> *(2) (a) If the current certificate of revalidation for the rating is endorsed "single seat only" the holder is only 'entitled to act as pilot in command of any single seat microlight aeroplane.*
>
> *(b) (i) If the aeroplane has:*
>
> *(aa) three axis controls and the holder's previous training and experience has only been in an aeroplane with flexwing/weightshift controls;*

(bb) flexwing/weightshift controls and the holder's previous training and experience has only been in an aeroplane with three axis controls; or

(cc) more than one engine,

before exercising the privileges of the rating the holder must complete appropriate differences training.

(ii) The differences training must be given by a flight instructor entitled to instruct on the aeroplane on which the training is being given, recorded in the holder's personal flying logbook and endorsed and signed by the instructor conducting the training.'

The document did not define what constituted acceptable '*previous training and experience'*.

Previous accidents and AAIB Safety Recommendations

AAIB Safety Recommendation 98-62, made following a fatal accident to a Kolb Twinstar Mk III Microlight aircraft in July 1998, stated:

'This accident may have resulted from a loss of control by the pilot. The pilot had no training and limited experience on the type of aircraft control system that he was using. Given the fundamental differences between weight shift and 3-axis control systems, notably the diametrically opposed control movements for pitch and roll, it is recommended that the CAA should consider making the guidance [that differences training should be undertaken]… a mandatory requirement.'

Initially the CAA took the view that Alternate Control System training should be mandatory for pilots of microlight aeroplanes converting from weight-shift to three-axis control or vice-versa but it did not accept the recommendation.

Following an accident to Rans S-6 Coyote G-CCNB in 2005[1], the AAIB made the following Safety Recommendation:

Safety Recommendation 2005-128

The Civil Aviation Authority should require holders of the Private Pilots Licence (Aeroplane) (Microlights) converting from weight shift to three-axis control systems, or the reverse, to undertake adequate conversion training and pass a Flight Test conducted by an appropriately qualified microlight pilot examiner.

The CAA responded as follows:

'The CAA accepts this recommendation and proposes that the requirements at Schedule 8 Part A Section 3(7)(b) in respect of differences training between 3-axis and weight shift Microlights be moved to Schedule 8 Part B - Microlight Class Rating, and be revised to incorporate a skills test with an authorised Microlight Flying Examiner as part of differences training. This will require consultation with industry, regulatory impact assessment and an amendment to the Air Navigation Order. A date for possible implementation is likely to be end of 2007.'

Footnote

[1] AAIB reference EW/C2005/03/05 published April 2006.

Discussions with the BMAA and CAA established that the licensing mechanisms by which pilots may be qualified to fly microlight aircraft of different control systems were not straightforward; holders of some licences were required to undertake training while others were not, and for some there was no requirement to pass a test, despite the significant differences between control systems and their methods of use. The qualification routes for microlight instructors and examiners were similarly complex and lacked consistency. When implemented, changes to the ANO did not incorporate the requirement for a flight test.

Analysis

The aircraft

At the time of the accident, the aircraft had not completed test flying for a permit to fly, and therefore its handling, performance, and other characteristics had not been established to be satisfactory. The destruction of the aircraft was such that its pre-accident condition could not be established during the investigation. The investigation did not identify any pre-existing technical malfunction or deficiency. Flying undertaken by the pilot experienced on type named in the permit to test might have identified any shortcomings.

The accident flight

The aircraft impacted the ground in an erect spin. For spin entry, the aircraft must fly at high angle of attack, with yaw present. The pilot had little experience of three-axis flying, amounting to one flying lesson and some flight handling of other people's aircraft. His use of his personal computer flight simulator may have been of some value, but was not a substitute for proper training, especially with a flying instructor.

The departure from controlled flight, involving high angle of attack and undesirable yaw, highlights a crucial difference between flexwing and three-axis aircraft. Flexwing aircraft are not controlled in yaw, other than when steered on the ground. Three-axis aircraft generally require careful control in yaw, especially at high angle of attack. Because the sense in which the aircraft respond to pedal inputs is reversed, instinctive 'steering' inputs learnt in the weight-shift aircraft would exacerbate, rather than counteract, yaw in flight in a three-axis machine.

The weather conditions were suitable for flying, although the temperature and dewpoint indicated that serious carburettor icing was likely at any power setting. If the aircraft's engine was being run on MOGAS, the probability of carburettor icing would have been greater. However, different engines and installations have different susceptibilities, and it was not possible to evaluate the likelihood of icing occurring in this case.

If the engine failed, an instinctive rearwards motion of the control column (which would be appropriate on a flexwing control bar in the same circumstances) might have been the pilot's natural reaction. In the Minimax, this would have caused an increase in angle of attack towards the stall, rather than the desirable entry into gliding flight.

Whether following an engine malfunction or not, a simple handling error may therefore have caused the spin.

Pilot qualification

The pilot was not the pilot named on the permit to test and therefore it was not appropriate for him to have conducted this flight. The accident pilot's experience was almost exclusively on flexwing aircraft and it was not clear if he was qualified to fly a three-axis aircraft. Differences training was required for those pilots whose :

> *'previous training and experience has only been in an aeroplane with flexwing/weightshift controls.'*

However, because 'training and experience' was not quantified, he could have developed the view that he did not need to undertake training because his flying lesson in a three-axis aeroplane satisfied the requirement.

Safety Recommendation 2005-128 was issued by the AAIB to address pilot training on different control systems, and contained the words:

> *'undertake adequate conversion training and pass a Flight Test conducted by an appropriately qualified microlight pilot examiner'*

to ensure that not only was there a requirement for training, but also a requirement that the pilot should demonstrate competence, before being qualified to fly. The CAA accepted this Safety Recommendation but the flight test requirement was not implemented. Also, '*appropriate differences training*' referred to in CAP 393 was not defined. Accordingly, the following Safety Recommendation is made:

Safety Recommendation 2013-003

It is recommended that the Civil Aviation Authority should, in consultation with the British Microlight Aircraft Association, amend the relevant legislation to introduce distinct pilot qualifications for microlight aircraft of each control system, and to require pilots to undertake flight training and pass a flight test in order to gain those qualifications.

Engineering

The investigation indicated that the aircraft had been constructed in accordance with the LAA procedure and had been issued with a PFRC that allowed it to be flown by a designated test pilot. The test pilot, had he flown it first, may have been better equipped to deal with and subsequently advise upon any adverse characteristics of the aircraft.

The aircraft was observed to be descending to the ground in a spin, with the evidence at the accident site indicating that the direction of the spin was to the left. The appropriate corrective recovery action requires the application of right rudder. The left rudder pedal was found to be broken, possibly as a result of reacting pressure from the pilot's foot during the impact, but because the violence of the impact resulted in extensive disruption to the cockpit it was not possible to exclude another cause of this damage.

The investigation did not establish why the aircraft entered a spin after flying apparently normally earlier in its short flight. It is possible that the pilot may have started exploring flight with different flap settings. Had he done so, lowering the full-span flaperons would result in increased adverse yaw, in response to aileron application. The necessary use of rudder to counteract this would not have been intuitive to the pilot, again due to his flexwing background.

Some witnesses described an unusual engine sound. The aircraft was fitted with a two-cylinder, four-stroke engine of a comparatively rare type, the sound of which in flight may have been unfamiliar. There was some evidence of engine power being delivered at impact, although it could not be quantified. Whilst a partial power loss, due, for example, to carburettor icing, could not be discounted, an engine failure would not necessarily cause an aircraft in apparently level flight to enter a spin.

Finally, a disconnected balance spring was found on the left rudder pedal. Whilst it is possible this was an impact feature, it is also possible that the owner omitted to reconnect the spring following the pedal hinge replacement. The cramped area of the cockpit may have made the task difficult to accomplish as the springs would have been obscured by the pedals when viewed from above. The effect of a disconnected left pedal spring would have been to produce a right rudder bias. However, the tension in the circuit (produced by the force of the remaining spring) would have been so small as to be insignificant when the pilot's feet were on the pedals. Consequently, had the condition existed prior to the flight, it is unlikely to have had any bearing on the accident.

Conclusion

The investigation did not reveal any pre-existing mechanical defects that would have affected the flight. The accident pilot's ability to control the aircraft may have been influenced by his lack of training or experience in three-axis aircraft and by his greater familiarity with flexwing aircraft. The aircraft was only permitted to fly in the hands of a designated test pilot who, had he been given this opportunity, may have been able to identify any unacceptable characteristics.