ACCIDENT

Aircraft Type and Registration:	Replica Royal Aircraft Factory BE2c, G-AWYI
No & Type of Engines:	1 De Havilland Gipsy Major Mk 10-1 piston engine
Year of Manufacture:	1969 (Serial no:1)
Date & Time (UTC):	2 September 2020 at 1038 hrs
Location:	Sywell Aerodrome, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Severe damage to entire airframe
Commander's Licence:	Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	1,747 hours (of which 287 were on type) Last 90 days - 18 hours Last 28 days - 14 hours
Information Source:	Field Investigation

Synopsis

The aircraft was performing a flying display with several other vintage aircraft when the aircraft was seen to enter a descending right turn. The aircraft did not recover from the descent and struck the ground in a steep nose-down attitude.

It is likely that the aircraft entered a spin, although the possibility that the initial departure was a spiral dive could not be eliminated. The reason for the departure from controlled flight could not be determined. No pre-existing mechanical defects were found with the aircraft or engine.

History of the flight

The aircraft was taking part in a practice air display with five other vintage aircraft at Sywell Aerodrome in Northamptonshire. The display team had flown the same display sequence for a couple of years, but due to the Covid 19 pandemic, this was the first display practice of the 2020 season. During the display the six aircraft fly a series of choreographed manoeuvres and flypasts to simulate a first world war dogfight. To ensure safe separation between the aircraft during the display, the display area is divided into two halves by the B-axis[1] and into three height bands.

Footnote

[1] The B-axis is an imaginary line in the centre of the display area at 90° to the display line.

On the morning of the accident the six pilots met for a pre-flight briefing. This was followed by three walk-throughs of the display routine to ensure each pilot understood the planned display. One of the team then briefed the Flight Information Service Officer in the control tower on the planned display and agreed a display time.

The six aircraft took off at 1029 hrs and commenced the display. After the first few manoeuvres, G-AWYI and a Fokker DR1 were holding position flying orbits at 500 – 600 ft to the right of crowd centre. The plan was for the pair to position behind a Sopwith Tri-plane and another Fokker DR1 as they flew back down the display line. However, G-AWYI was seen to enter a descending right turn from 500 – 600 ft. The aircraft continued in the steep descending turn, completing two and half rotations, before it struck the ground. The accident occurred at 1038 hrs.

When the display leader realised an accident had occurred the display was stopped, and the five other aircraft landed safely.

During the display the airport fire service wait in their vehicles ready to react if an incident occurs. The fire crew saw the aircraft descending and started driving towards the area before the aircraft had struck the ground. They were on site quickly and were able to assist the pilot. The pilot was conscious and trying to get out of the aircraft. He was taken to hospital having sustained a fractured vertebra, broken ribs, severe face lacerations, a broken wrist and broken thumb.

Witnesses

Although many people were watching the practice display, G-AWYI was not the focus of the display when the accident occurred. So, whilst several people saw the aircraft descending to the ground, no one on the ground witnessed what happened before.

The pilot flying the Fokker DR1 which was orbiting behind G-AWYI at the time, saw the aircraft roll into the right turn. He recalled that they were orbiting at 600 ft waiting for the Sopwith Tri-plane and the other Fokker DR1 to fly down the display line so they could formate behind them as they turned. However, when he saw the two aircraft, he realised that G-AWYI and his aircraft were not in the ideal position and would need a large turn to formate behind them. When he saw G-AWYI roll into the right turn he recalled thinking that the roll was "a bit harder than normal", he commented that the pilot normally flew the aircraft very gently and this was just a bit more "spirited" than normal. He described seeing the wing drop and the aircraft entering what he thought was a spin. He recalled that the manoeuvre appeared to be very gentle and he expected to see the rotation stop and the aircraft recover. However, the rotation did not stop, and he saw the aircraft continue to descend to the ground.

Pilot's recollection

The pilot had a good recollection of the events prior to the flight and of the first part of the display. He recalled the aircraft was flying well with no problems. He was flying orbits at 500 ft and remembered seeing the Sopwith and Fokker flying along the display line. He was not in an ideal position to formate behind them and needed to make a large turn to get in position. He remembered rolling into the turn and the aircraft “just departing into a spin”. He applied full power and believes he applied out-of-turn rudder. He had a clear memory of pulling back on the control stick and the wing dropping again. His next memory was the “nose going straight down and the aircraft not responding” and feeling like “the aircraft wasn’t flying anymore”.

The pilot thought that the aircraft had entered a spin rather than a spiral dive as it did not feel like the aircraft was accelerating. However, he did not think that he had simply stalled the aircraft in the turn. He described how he flew the aircraft primarily on feel and had flown many hours on the aircraft. He did not think that he would have been too slow in the turn. He thought that the aircraft may have encountered some wake from his or another aircraft or that the aircraft could have been affected by a wind gust.

The pilot did not think there was any problem with the engine at any stage and did not think he had any control restrictions.

Recorded information

No radar recording was available for the aircraft. However, a spectator who was filming the display on a mobile phone captured the accident sequence.

In the first frame of the footage, G-AWYI is banked to the right with the fuselage in a roughly level attitude. The aircraft can then be seen descending in a right turn with the nose dropping into a steep nose-down attitude. After the aircraft turns through approximately 360°, the nose-down attitude appears to reduce slightly before the nose drops again, the rotation rate then appears to increase and the turn tightens. The aircraft continues to rotate until it struck the ground. The time from the first frame to the aircraft’s contact with the ground is 9 seconds. The time from the completion of the first 360° turn to the ground is approximately 5 seconds.

A professional photographer, who was at the airfield, also managed to capture several high-resolution photographs of the aircraft as it descended to the ground. The photographs taken capture G-AWYI in the latter part of its descent (Figures 1 and 2).

The control surface positions can be seen in the sequence of images in Figure 1. The ailerons appear to be neutral. The elevators appear to be trailing edge up suggesting the pilot was applying some aft control input. The rudder trailing edge was to the right (of the aircraft’s longitudinal axis) suggesting the pilot was applying some right rudder. It was not determined exactly how much elevator or rudder was applied but neither appeared to be at full deflection.

Figure 1

Four images of G-AWYI in the right descending turn showing control surface deflections (Used with permission and under copyright of the photographer)

Figure 2

Collage of images of the aircraft continuing to rotate to the right as it descended
(Used with permission and under copyright of the photographer)

Accident site

The wreckage of G-AWYI was located in a field inside the western boundary of the aerodrome (Figure 3). The ground was soft and contained several large mounds of waste earth and rubble from recent building work which restricted emergency vehicle access to the injured pilot and the aircraft.

Figure 3

Accident site at Sywell Aerodrome

There were no ground marks to indicate the aircraft had slid or bounced on impact. The front section of the aircraft and the engine were embedded in the ground at a steep nose-down attitude (Figure 4). One blade of the fixed pitch, wooden propeller had snapped off and fragmented. The remaining blade had cracked radially around the root but was still attached to the hub. The aircraft's wooden skids were embedded in the soft earth and the landing gear was severely disrupted and partially detached from the fuselage. Due to the steep angle of impact, the aircraft's rear fuselage and tail remained high in the air and leaning to the left. The airframe structure around the rear cockpit and aft of the cockpit floor was bent and deformed by the force of the impact (Figure 5).

Figure 4

G-AWYI at the accident site

To enable the rescue services to work around the aircraft safely, the aerodrome Rescue and Fire Fighting Service (RFFS) propped up the tail with a ladder to stabilise the aircraft structure.

Figure 5

G-AWYI showing deformed fuselage structure

Evidence from the impact marks on the wings indicated the leading edges of the left wings struck the ground as the aircraft rotated to the right. The lower right wing hit a large mound of earth which snapped the wing in half along the chord line approximately a third of the way along its length from the fuselage. The upper right wing had also struck the mound of earth but had remained in one piece. The forward interplane struts on both the left and right side had snapped, (Figure 6). Although the rear outboard strut had snapped at the connection to the upper wing, the inboard strut remained unbroken and connected. The left upper wing was removed by the RFFS to make it easier to provide medical treatment to the pilot and to extract him from the cockpit.

Figure 6

Damage to the lower right wing

With the exception of the centre wing section where the bracing wires had been pulled from their brackets by the impact, the wing bracing wires were intact and connected to their respective brackets. The bracing wires on the left upper wing were disconnected when the wing was removed by the RFFS.

During the impact sequence the front fuselage had compressed and the engine block had become embedded in the ground. The fuel tank, positioned behind the engine, had been crushed and punctured causing the fuel to leak out (Figure 7). The front cockpit structure was severely damaged but the rear cockpit, where the pilot had been seated, sustained significantly less damage.

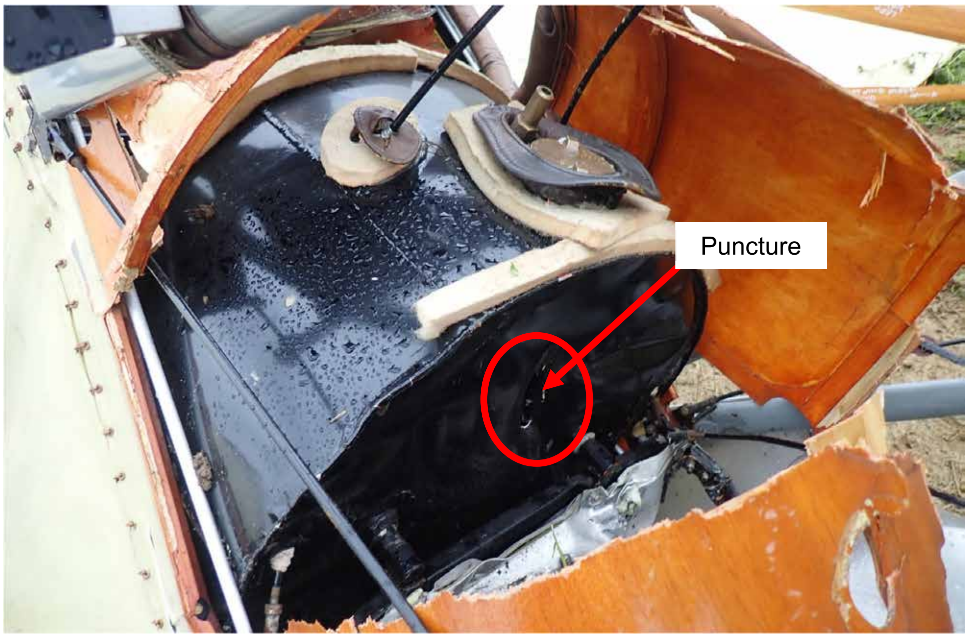

Figure 7
Fuel tank showing punctured surface

The rear cockpit instrument panel and support structure had broken away from the fuselage mounting and was hanging forwards into the front cockpit. The airspeed indicator on the left of the panel was dislodged, the glass face smashed, and the mechanism disrupted. The rest of the instruments were still in place and largely undamaged, although the panel was bent along a vertical axis to the left of centre (Figure 8). It is possible the pilot’s head, face and mask had contacted the instrument panel as the aircraft hit the ground causing his facial injuries and the damage to the panel.

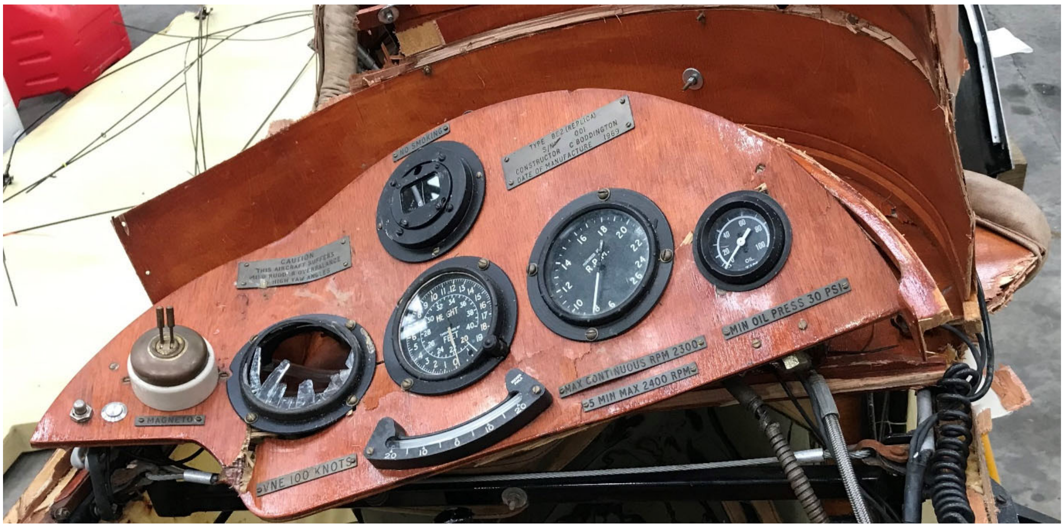

Figure 8

Rear cockpit instrument panel showing deformation

The base of the pilot's wooden seat cushion had cracked longitudinally but was still fitted over the metal bucket seat structure. A broken pen and a heavy black plastic solar charging panel were found on the cockpit floor, (Figure 9). The pilot later confirmed the solar panel had been placed in the canvass stowage compartment behind the pilot's head before the flight. Spare clothes and paper items were still contained in the canvass stowage bag.

Figure 9

Rear cockpit looking downwards showing solar panel case beside the seat

On site examination established that all the cables connecting the flight controls to the control surfaces remained intact and fitted to their respective attachment points.

When the engine's fuel gascolator was removed, it was found to be full of fuel, indicating that fuel was still being supplied to the engine prior to impact and had leaked out of the fuel tank when it was ruptured. The engine had broken away from its mounting frame and there was significant rupturing of the engine bay structure and pipework.

Aircraft information

Constructed as a replica Royal Aircraft Factory BE2c World War 1 observation biplane, the aircraft was designed and built in 1969 at Sywell Aerodrome for a feature film. It was one of several aircraft commissioned for the film, but funding ran out before the film could be made. After several years, the aircraft was sold to an American owner who flew it until 1977 when it crashed on takeoff. The wreckage remained in storage until it was purchased by the current owner and returned to Sywell for extensive restoration in 2005.

The aircraft was originally constructed using Tiger Moth components but was significantly modified to replicate a BE2c. The Tiger Moth wings, wing stagger and dihedral were retained but the wing sweep was removed. The single bay rigging of the Tiger Moth wing was modified to the double bay rigged biplane layout of the BE2c[2]. Interplane and cabane struts were lengthened to increase the gap between the upper and lower wings and new tail surfaces were constructed. A new undercarriage was manufactured and fitted, and forward wooden skids added. A new, directional tailskid was designed and rigged to the aircraft rudder system. No slats were installed on the wings, but the aircraft retained the Tiger Moth differential ailerons on the lower wings (with asymmetric down going aileron). The original BE2c design had ailerons fitted to both upper and lower wings.

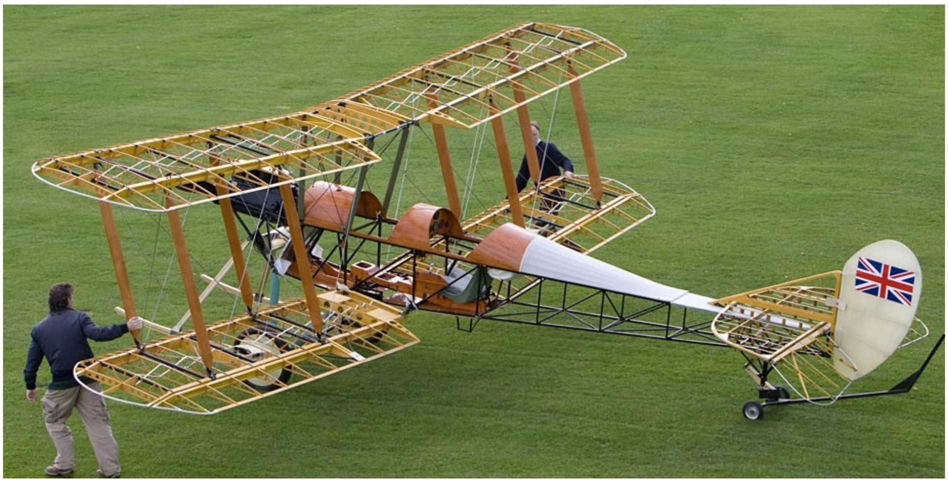

Figure 10
G-AWYI during its restoration

During the restoration, (Figure 10), the original design was modified to improve safety. Following structural load analysis, additional strengthening measures were taken. A four-point harness was added to the front and rear cockpit, additional control cables were added to the elevator control circuit, stronger bracing wires installed and structural strengthening to the tail section. The fin and rudder shapes and areas were altered to more closely replicate a BE2c, but no horn balance was fitted to the rudder. The original Tiger

Footnote

2 The space enclosed by interplane struts fitted between upper and lower wings is called a bay, an aircraft with one pair of struts between each wing is called a single bay. Two pairs of struts between each wing is called a double bay.

Moth rudder control system was also retained which consisted of rudder actuating cables attached to extensions to the rudder pedals bar. This arrangement means that a small input at the rudder pedals results in a large defection of the rudder. A minicom radio and intercom were installed in a narrow wooden box on the right side of the rear cockpit to provide air and ground communications.

The aircraft was fitted with a De Havilland Gypsy Major 10-1 piston engine. This engine was designed as an inverted engine[3]. In order to better simulate the engine installation of a BE2C, the Gypsy Major engine was modified to operate with the cylinders uppermost and fitted with an additional, dummy, exhaust system. The engine drove a wooden, two bladed, fixed pitch Hercules propeller. The fuel tank was moved from the centre section and installed between the engine and the front cockpit. A smoke generator tank was installed in the engine bay to simulate battle damage during flying displays.

Figure 11

G-AWYI earlier during the accident flight
(Used with permission and under copyright of the photographer)

Aircraft examination

The right vertical side of the airframe was bent inwards aft of the rear cockpit and the left vertical side of the airframe was also buckled inwards level with the back of the rear cockpit seat. This buckling was sufficient to cause a restriction in the elevator trim mechanism, however, there were no witness marks on the inside of the airframe to indicate that the trim mechanism had been in contact with the fuselage before the accident.

In the rear cockpit, the control column was wedged forward under the horizontal metal frame of the instrument panel. The lower right seat harness anchor bracket bolts had been pulled out of the airframe structure (Figure 12).

Footnote

3 An inverted engine is designed to be installed and operated with the crankcase uppermost and the cylinders below the crankcase.

Figure 12

Rear seat lower right harness anchor bracket bolts pulled out of frame

The upper, horizontal metal cockpit frame aft of the rear pilot's seat had bent (Figure 13) and the seat's mounting points were deformed.

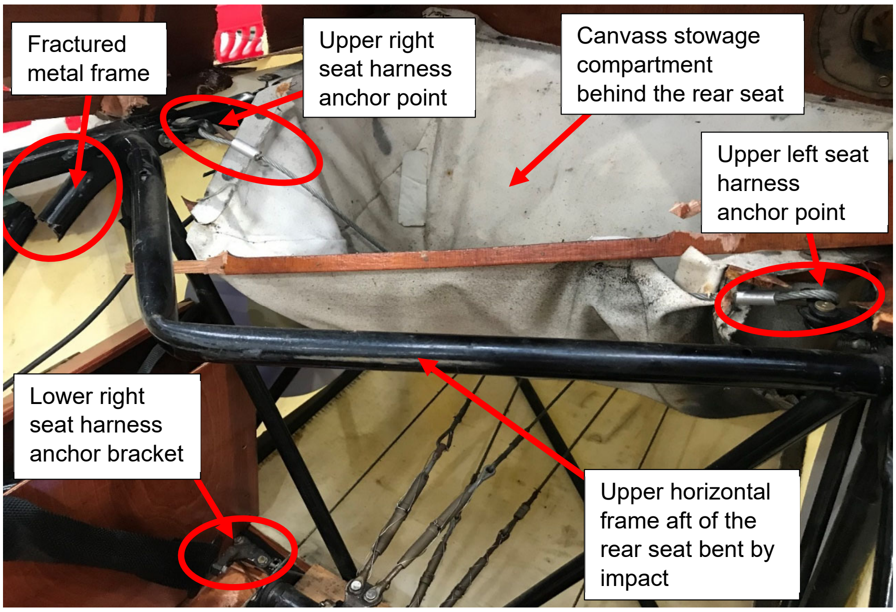

Figure 13

Airframe damage behind the rear cockpit seat – view looking aft and to the left

The position of the rear seat, after the accident, restricted rearward movement of the control column. A hole was found in the control column's leather gaiter where it had been worn away by contact between the control column and the seat (Figure 14).

Figure 14
Hole in the control column gaiter

The pilot later confirmed that, in order to prevent the tail from lifting in a prevailing wind during taxiing the pilot has to pull back hard on the control column, this results in contact between the control column and the seat, damaging the leather gaiter. Contact between the edge of the seat and the control column does not indicate an elevator control restriction because full elevator deflection is achieved before contact with the seat.

The engine's ignition harness was disconnected from its spark plugs and the spark plugs removed. The propeller rotated freely indicating that the engine crankshaft was still turning, and the engine had not seized during the incident. The piston combustion chambers, valve heads and piston crowns were examined by boroscope but no damage or anomalies were found. Oil was still present in the engine and the oil filter was free of debris.

All of the damage to the aircraft structure was consistent with the forces experienced during the impact and no evidence of pre-impact damage or defects was found during the examination.

Survival

The pilot was sat in the rear cockpit and although the aircraft struck the ground in a near vertical attitude distorting the fuselage structures, a survival space remained. There was no post-impact fire.

The rear instrument panel had fallen into the front cockpit reducing the survival space available, had the cockpit been occupied.

The pilot was wearing a kevlar flying helmet with a leather cover to make it look more authentic for a vintage aircraft.

Weight and balance

The aircraft's total weight was estimated to be 1,572 lbs (maximum AUW – 1880 lbs) and the centre of gravity was 7.67 inches aft of the datum[4].

Meteorology

At the time of the accident the flight information service officer recorded the observed weather conditions. He recorded the surface wind was 210° at 12 kt, cloud and visibility were CAVOK, the temperature was 17°C, the dew point was 8°C and the surface pressure was 1017 hPa.

Another pilot who took off approximately 5 minutes prior to the display team commented that wind conditions changed markedly over the next 45 minutes. He had to land at a farm strip approximately 8 nm north-east of Sywell due to the airfield closure after the accident. On takeoff he described the conditions as "perfect" but on landing there was "rough air", turbulence and windshear below 500 ft. He attributed the change in conditions to an approaching weather front.

Weather conditions at the airfield deteriorated in the afternoon with rain arriving at approximately 1430 hrs.

In 2013 the AAIB reported on a similar accident to a De Havilland DH53 Humming Bird which occurred at Old Warden Aerodrome, Bedfordshire[5]. The investigation found that it was likely that the wind conditions contributed to the accident.

Pilot information

The pilot held a private pilot's licence (both national and EASA) with a single engine piston (SEP) and aerobatic ratings. The pilot held a display authorisation for the replica BE2c. He also held a valid Class 2 medical.

The pilot initially learnt to fly in 1986 and had accumulated a total of 1,747 flying hours when the accident occurred. Most of that flight time was on vintage aircraft.

He had been flying G-AWYI since May 2011 when he completed the rebuild. He had accumulated 287 hours on the aircraft. He had last displayed the aircraft in early August at Old Warden Airfield and had flown 14 hours in the aircraft in the last 28 days. On the return flight from Old Warden to Sywell he had completed the test flight to renew the Certificate of Validity for the aircraft's Permit to Fly and reported there were no problems with the aircraft.

He had practiced spinning in various types, most recently in a Tiger Moth in June 2020.

Footnote

4 Forward cg limit – 6.0 inches aft of datum, aft cg limit -8.5 inches aft of datum.
5 AAIB Report G-EBHX – https://www.gov.uk/aaib-reports/de-havilland-dh53-humming-bird-g-ebhx-1-july-2012

Other information

Spinning

A spinning aircraft is best described as an aircraft whose wings are experiencing an aggravated stall and whose resultant aerodynamic force causes the aircraft to 'autorotate', a condition where the aircraft is continuously rolling, yawing and pitching. In a fully developed spin, the aerodynamic forces on the aircraft are balanced by the inertia forces created by the rolling and yawing motion. The flight path will normally follow a helix whose axis is orientated vertically. For a spin to occur the wing must stall and the nose must yaw. This can occur in an uncoordinated turn if too much up elevator (pitch up) is applied with either too much or too little rudder[6].

Spin recovery techniques vary between aircraft and it is important for pilots to know the correct recovery technique for the aircraft they are flying. However, generically they involve applying; out-of-turn rudder to stop the yaw, control stick forward (or neutral) to reduce the wing's angle of attack. and ailerons neutral. Once the rotation stops, the rudder is centralised and the pilot can recover from the ensuing dive. Applying power during the initial recovery tends to flatten the spin and can delay or compromise recovery. If the pilot attempts to pitch up too early or too aggressively the aircraft can enter a secondary stall or spin.

Spiral dive

A spiral dive is a steep descending turn with the aircraft in a nose-down attitude and with the airspeed increasing. It can look very similar to a spin but the significant difference is the wing is not stalled and the airspeed will be increasing as the aircraft descends. If a pilot rolls rapidly into a steep banked turn and allows the aircraft's nose to drop, they would have initiated a spiral dive.

A spiral dive flight test conducted in October 1989 in a Tiger Moth described the aircraft entering '*a steady rotation around the horizon almost identical in rate and motion to that displayed by the aircraft in a stabilised spin*'. After about 360° of turn the aircraft stabilised with '*a deep nose attitude of approximately 45 – 50 degrees nose-down, with a gradual increase in airspeed*'.

Flight test report

After G-AWYI was rebuilt a flight test was conducted, by a test pilot, as part the process of obtaining the aircraft's permit to fly.

During the flight test straight, turning and accelerated stalls were completed. Spinning tests were not conducted. The report stated that:

> *'The aircraft was benign at the stall for all tests performed. The stall was characterised by a gentle g brake; full back stick was not reached. There was no obvious stall warning, other than a general 'mushing' sensation.'*

Footnote

6 Wood, R. H., Sweginnis, R. W. *Aircraft Accident Investigation*.

The 1 g stall speed at maximum takeoff weight was 40 kt.

The aircraft's longitudinal stability was satisfactory at all speeds, but the longitudinal stick force required to manoeuvre the aircraft was relatively low. The stick force required to generate a 1.5 g vertical acceleration from trimmed flights was 5 lbs and for 2 g was 8 lbs.

Due to the small fin and large rudder, the aircraft was not directionally stable and could easily generate large sideslip angles. The rudder tended to overbalance so the pilot needed to keep his feet on the rudder pedals to hold a particular rudder position and to maintain balanced flight. The aircraft also exhibited a '*reasonable amount of adverse aileron yaw*'[7] which needed to be balanced with the rudder. The report stated that:

> *'In the yaw axis, the aircraft exhibited negative directional stability, which was common for the era. With feet resting on the rudder bars, the aircraft was reasonably conventional directionally. However, when sideslip was generated, or if feet were removed from the pedals, there was a tendency for the rudder to overbalance. Being a large rudder surface, it could generate large sideslip angles during steady heading sideslip tests, which required large angle of bank to keep the aircraft straight in the cross-controlled condition.'*

Since the flight test was completed the owners had added flow disruptors to the fin to improve the rudder overbalance. The pilot reported that this had improved the rudder characteristics.

Analysis

Whilst flying orbits at approximately 500 ft the aircraft entered a descending right turn. The aircraft descended in a steep nose-down attitude and continued to rotate to the right.

The pilot believed the aircraft entered a spin. However, from the available evidence it is not clear if the initial departure was a spin or a spiral dive. Previous tests in a Tiger Moth showed that a spin and a spiral dive can look and feel very similar. The pilot did not recall the airspeed increasing during the descent which would suggest it was a spin rather than a spiral. It is possible that the initial departure was a spiral and this transitioned to a spin as the pilot tried to pitch up.

The pilot believes that he initially made the correct inputs to recover from a spin and recalled the aircraft starting to recover. He remembered pulling back on the stick to climb away from the ground. However, he recalled the wing dropping again and the aircraft continuing to descend and rotate. It is understandable that the pilot would instinctively want to pitch up as the aircraft was passing approximately 300 ft with a very low nose attitude. However, it is likely that the aircraft had not recovered enough airspeed when he pitched up, leading

Footnote

[7] Adverse aileron yaw is the yawing moment that is caused by the differences in the lift and drag of the left and right wings when ailerons are deflected. The down-going aileron increases the local lift but also increases the local drag and this 'aileron drag' can result in a yawing motion in the opposite direction to the rolling motion commanded.

to a secondary stall. As the pilot felt the aircraft recovering, he would have centred the rudder. However, the rudder on this aircraft did not naturally self-centre and, due to the rigging between the pedals and the rudder, small movements of the pedals caused large deflections of the rudder. In this very dynamic situation, it is possible that he did not get the rudder accurately centred. If the pilot inadvertently moved the rudder past centre and slightly into the turn as the aircraft stalled again it would explain why the aircraft entered a secondary spin.

Photographs taken during the second part of the spin show the rudder was displaced into the turn and elevator was displaced up. These inputs are the opposite of those required to recover from the spin. However, at this stage the aircraft was very close to the ground. The time from the wing dropping again to the ground was approximately 5 seconds. It is unlikely that the pilot had time to process what was happening and to make the correct inputs. As the aircraft was approaching the ground it would be instinctive to pitch up. It is possible that the in-to-turn rudder was just where the rudder was after he initially tried to centre the rudder and he did not have time to make any further changes.

Once the aircraft entered a secondary spin it is unlikely there was enough altitude to recover.

There is not enough evidence to determine why the aircraft initially departed from controlled flight. The pilot was experienced at flying this aircraft and did not think that he simply stalled the aircraft in the turn. However, the aircraft requires quite low stick force to stall, the stick does not need to come fully aft and there is no marked stall warning. It is possible that whilst manoeuvring the aircraft slightly aggressively the pilot inadvertently stalled the aircraft. The adverse aileron yaw requires quite large rudder inputs to maintain balanced flight particularly if large aileron inputs are used. It is possible that this led to the aircraft being out of balance in the turn. The small fin and large rudder means that it is quite easy to generate large sideslip angles and yaw rates. This would lead to a spin if the aircraft was stalled. The aircraft was not fitted with leading edge slats which are fitted to the Tiger Moth to help reduce the aircraft's tendency to enter a spin when a wing drops at the stall.

It is also possible that the aircraft was affected by wake. The BE2c and the Fokker Tri-plane had been orbiting in the same airspace, so the BE2c may have flown back through its own wake or that of the Fokker. This could have contributed to the departure. It is also possible that the aircraft was affected by turbulence. Another pilot flying at the same time reported that the air was becoming more unstable around the time of the accident. It is possible that a lull caused the aircraft to lose airspeed and this may have contributed to the departure.

The pilot was experienced at flying this aircraft and had recently practiced spinning in a similar aircraft.

Engineering

All the damage found on the aircraft was consistent with the forces imparted during the accident. The impact marks and damage to the wings confirmed the aircraft was still rotating on contact with the ground. There was no evidence of any engine, structural or control problems that would have contributed to the accident.

Survivability

Whilst the aft seat harness remained secure, the harness mounting brackets partially separated from the airframe. Partial separation of the seat harness brackets and the distortion of the seat mounting structure allowed the pilots head to strike the instrument panel causing his head and facial injuries. The damage to the panel illustrated in Figure 8 is consistent with this possibility.

The heavy plastic solar charger was positioned in the storage bag behind the pilot's head prior to take off but was found on the floor of the cockpit after the accident. It is likely it was released by the force of the impact and may have struck the back of the pilot's helmet.

The rear cockpit instrument panel broke away from its mounting and was found in the front cockpit. Had the front seat been occupied it could have struck the front passenger and caused significant injuries.

It is likely the helmet prevented the pilot from suffering more severe head injuries when he made contact with the instrument panel or the solar charger struck his head. The addition of a four-point harness and the survival space created by the rigid cockpit framework also contributed significantly to the survivability of this accident.

Conclusion

Whilst orbiting at low-level it is likely that the aircraft entered a spin, although the possibility that the initial departure was a spiral dive could not be eliminated. It was not possible to determine the reason for the initial departure from controlled flight.

It is likely that the pilot started to recover but tried to pitch up before the aircraft had built sufficient airspeed leading to a secondary spin.

The pilot was wearing a kevlar flying helmet and it is likely this prevented him from suffering further serious injuries.

There was no evidence of any mechanical fault which could have contributed to the accident.

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