ACCIDENT

Aircraft Type and Registration:	De Havilland DH53 Humming Bird, G-EBHX
No & Type of Engines:	1 ABC Scorpion II piston engine
Year of Manufacture:	1923 (Serial no: 98)
Date & Time (UTC):	1 July 2012 at 0842 hrs
Location:	Old Warden Aerodrome, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52
Commander's Flying Experience:	14,780 hours (of which 55 minutes were on type) Last 90 days - 151 hours Last 28 days - 56 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot lost control of the aircraft in gusty wind conditions during a re-familiarisation flight. There was insufficient height in which to recover and the aircraft impacted the ground, causing the pilot to receive fatal injuries.

History of the flight

The pilot planned to conduct a re-familiarisation flight and display practice ahead of an air display scheduled for that afternoon. The aircraft was positioned onto Runway 21 by the operator's ground crew. After signing the authorisation sheet for the flight, the pilot went to the control tower to discuss his requirements with the AFISO. He informed the AFISO that he would operate within gliding range of the aerodrome, initially over the southern end of the field for a few minutes, to re-familiarise himself with the aircraft, before positioning to the north to commence a practice display. The total planned flight time was about 10 minutes.

The pilot then walked towards the aircraft and on the way met the Chief Pilot. The two pilots had a brief discussion on a range of topics, including the current weather conditions. The Chief Pilot had considered that the conditions were unsuitable for some of the flying planned for the day and he had cancelled some aircraft and less experienced pilot combinations. However, he saw no reason to disagree with the accident pilot's own assessment that the weather was acceptable for the planned flight.

The aircraft's start, taxi and takeoff were without incident. The pilot flew to the southern end of the airfield where, at a height of between 600 ft and 800 ft, he performed a series of level turns. The Chief Pilot had watched the aircraft take off and conduct the initial turns; satisfied that all was well, he returned to his other duties. Another DH53-qualified pilot had also watched the takeoff and first minutes of the flight and, seeing nothing amiss, he too continued with other tasks. Several witnesses continued to watch the aircraft which, after a few minutes, flew downwind to the northern end of the airfield before descending to between 150 ft and 200 ft aal as it turned towards the airfield. The aircraft then established approximately along the Runway 21 centreline (Figure 1).

Witnesses commented that the effect of the wind made the aircraft appear unusually fast downwind and that as it turned upwind it appeared, from their perspective, to be almost stationary.

The aircraft continued to fly along the runway to position 'A' (Figure 1) before making a level turn to the left. This turn took the aircraft close to, and downwind of, a copse of tall trees. It is possible that the aircraft completed this turn before commencing a second turn; eyewitnesses were divided as to whether the aircraft had performed one or two turns away from the crowd-line prior to the accident. During the left turn preceding the accident, witnesses saw the left wing drop sharply; the aircraft then recovered to level flight after which the left

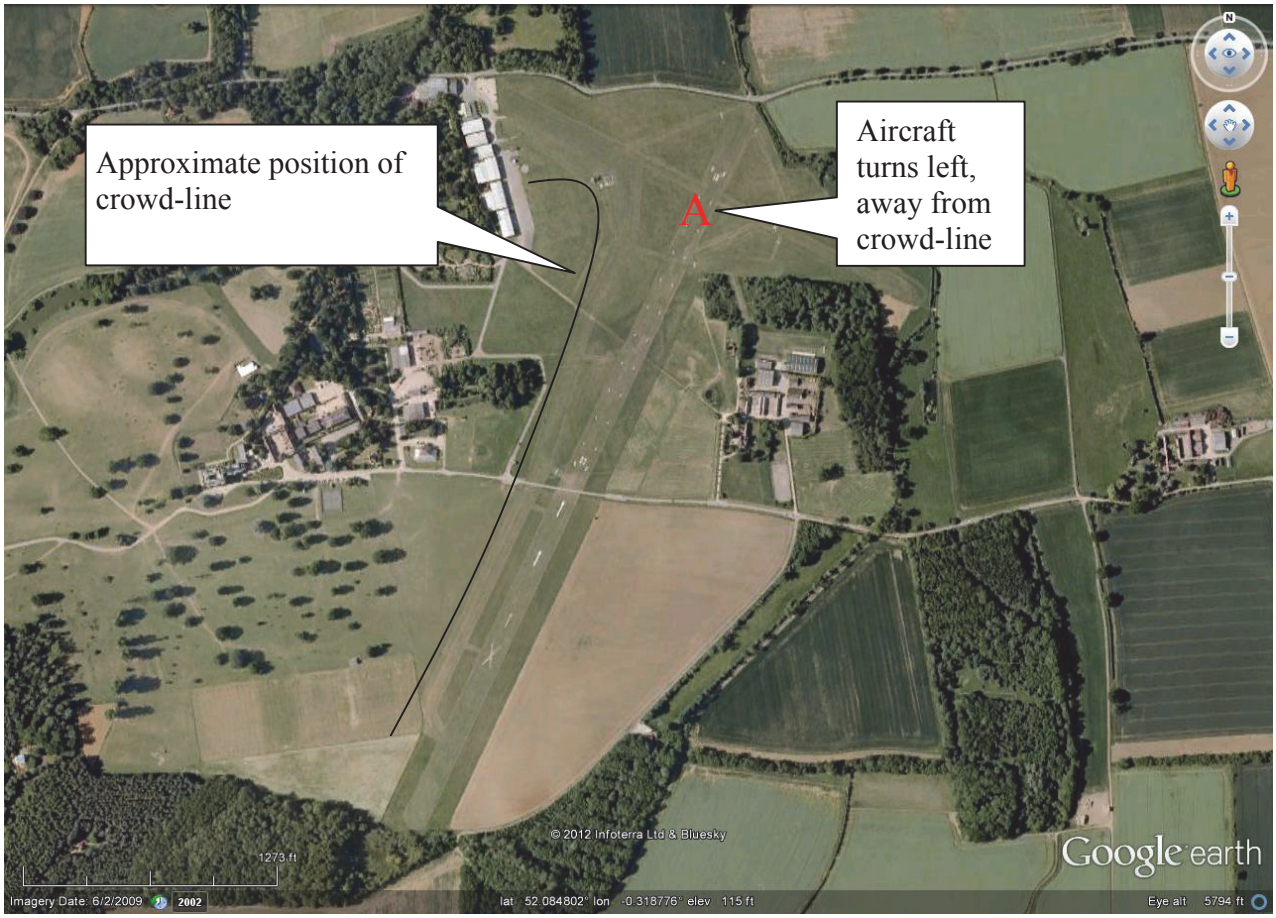

Figure 1

Approximate position of the turn away from the crowd-line

wing dropped again, with the aircraft rolling to a steep angle. The nose of the aircraft then dropped and the aircraft entered a very steeply descending left turn. It did not recover and struck the ground, near the intersection of Runway 25 and Runway 30, with a nose-down pitch attitude beyond the vertical. Witnesses estimated the total time from initial wing drop to the aircraft striking the ground as being two to three seconds.

A unit of the AFRS had been watching the practice display and witnessed the accident. They arrived at the aircraft within one minute but the pilot had already been fatally injured.

Pilot information

The pilot had joined the operator as a volunteer pilot in 1997 and had been the Chief Pilot between 2009 and 2010. He was qualified to fly almost all the aircraft in the operator's fleet and for a large number of types, only he and the current Chief Pilot were qualified on them. In addition to flying the operator's fleet he was employed by a major airline as a commander on passenger jets. He had previously been a military test pilot and was a graduate of the Empire Test Pilots' School. He also flew modern single engine piston light aircraft.

Organisational information

The operator was part of a charitable trust, the purpose of which was depicting the history of flight from the early 1900s to the 1950s. Its pilots, including the accident pilot, the majority of the ground staff and those with management positions, were volunteers. The organisation also employed qualified engineers.

The aircraft were of a vintage where available flying hours were severely limited. The operator commented that it operated a number of aircraft (of which the DH53 was one) that do not lend themselves from an organisational or financial perspective to regular use for display purposes, but which do need to be displayed from time to time in fulfilment of its charitable objective of public education. The accident pilot's limited total time on type was therefore not unusual among the operator's pilots. Where aircraft were flown infrequently, the operator's mitigating measures were: restricting flights to the area of the Old Warden circuit; limiting the number of pilots qualified on infrequently flown aircraft; selection of the most widely experienced pilots such as the accident pilot to fly such aircraft; and the undertaking of pre-display currency flights, as was the case on the accident flight.

The operator divided the aircraft into groups of similar vintage, performance and handling characteristics. The DH53 was one of a group of very light aircraft with low power margin and no systems such as brakes or hydraulics. The accident pilot was qualified on all the aircraft within this group and was one of four pilots qualified on the accident aircraft. However, he had not flown the accident aircraft since 2010, when he completed a 10-minute air test. Prior to that, his last flight in the DH53 had been in 2004. On the day of the accident he was intending to conduct a short refresher flight, including a practice display, before flying in the public display in the afternoon.

Meteorological information

The Luton Airport TAF issued at 0500 hrs on the day of the accident gave a forecast wind from 230° at 12 kt, with a 30% probability, between 0900 hrs and 1500 hrs, of wind temporarily from 240° at 17 kt, gusting 27 kt.

The airfield was not, nor was it, required to be equipped with approved and calibrated aviation weather observation equipment. However, the observation equipment that was installed was audited by The Met Office in 2011 and found to be fit for purpose.

Immediately after the accident the AFISO recorded an unofficial local weather observation, noting the wind as being from 240° at 15 kt. Other pilots reported that the wind appeared to be varying in direction by about 30° and included some "hard-edged gusts."

The Met Office provided an aftercast of the weather for the accident area. Wind data came from surrounding airfields and a wind profile at the Cardington meteorological balloon launch site 3.8 nm to the north-west of the accident site. The Met Office summarised:

> *'The weather…was generally fine, with good visibility and cloud bases mainly between 2000-3000FT. The surface wind was in the process of increasing because the temperature to trigger convection had been reached within the previous hour. This meant that there was mixing occurring within the boundary layer, allowing the 2000FT wind to be brought down to the surface as gusts. The wind increase is reflected in the local METARs and in the TAFs for the local airports as well. The 2000FT winds in the area appear to have been around 250 20-25KT and the 1000FT winds around 240 20KT....would suggest the surface wind given in the post crash observation of 240 15KT is likely to be correct, with gusts reaching values of 22-25KT. The winds at around 200FT are likely to have been about 15KT.'*

Aircraft information

The DH53 is an open-cockpit, single-seat light aircraft of wooden construction with a fabric covered wing and empennage. G-EBHX was powered by a single-ignition 34 hp ABC Scorpion II engine driving a two-bladed fixed pitch wooden propeller. A fuel tank mounted in the fuselage between the cockpit and engine firewall provided gravity fuel flow to the engine.

The aircraft was equipped with conventional flight controls operated by a non-adjustable control column and rudder bar, with the rudder and elevator control cables running externally. There were no trimming devices fitted to the control surfaces and the aircraft was not equipped with a radio.

The airspeed indicator fitted to G-EHBX was of similar vintage to the aircraft and had a speed scale ranging from 40 to 160 mph. The scale was compacted at lower speeds, with a 10 mph range represented by a 13° arc, and expanded at the higher speed ranges, where a 10 mph range occupied a 38° arc.

G-EBHX was the only remaining airworthy example of its type, having been rebuilt and re-engined in 1960 and donated to the operator's fleet. Since then the aircraft had accumulated a total flight time of 23 hrs and 55 minutes. Valid records prior to 1960 were not available.

Maintenance history

The aircraft possessed a valid LAA Permit to Fly and had been maintained in accordance with a CAA approved maintenance programme.

The aircraft's engine was not considered by the operator's engineers to be particularly reliable and in the past the aircraft had suffered a number of engine power losses during engine ground runs and also in flight, resulting in significant damage to the aircraft. As a result, the operator's policy was to only operate the aircraft within gliding range of the aerodrome. The engine was last overhauled in 1992. The problems experienced were predominantly associated with

engine ignition and carburetion. The carburetion issues were attributed to possible fuel foaming in the carburettor associated with the high levels of vibration to which the engine was prone, and the engine mount rubbers were replaced in an attempt to address this. The carburettor was also re-worked, re-jetted and the float levels reset.

The magneto was overhauled in 2003 after failing during an engine ground run. Following reinstallation, engine start performance and subsequent ground runs were noticeably improved. G-EBHX did not fly during the period August 2004 to April 2010, but during part of this time the magneto was installed on another aircraft, on which it operated normally. The magneto was refitted to G-EBHX in February 2010 and the subsequent engine ground runs were carried out satisfactorily.

A test flight was carried out in April 2010 for the purposes of revalidating the Permit to Fly and there were no engine-related findings. The aircraft completed a further four flights in 2010 and one flight in 2012, with no engine issues recorded in the aircraft technical log.

The most recent maintenance performed on the aircraft was an annual inspection for the purposes of the LAA permit renewal on 2 April 2012, at 23 hrs 45 mins flight time. An engine ground run was carried out successfully and the magneto contact breakers were checked for cleanliness.

There were no relevant defects in the technical log prior to the accident flight.

Accident site

From examination of the wreckage and ground marks, it was determined that the aircraft had impacted the ground with a pitch attitude that was slightly beyond vertically nose-down and with the wings approximately level; the aircraft's trajectory prior to impact was predominantly vertical, with no appreciable lateral speed.

The engine compartment had separated from the fuselage at impact and the engine was partially buried in the impact crater. Both propeller blades had fractured chordwise close to the hub at impact; a single, shallow horizontal propeller strike on the ground was made by the leading edge of one of the propeller blades.

The cockpit structure was severely disrupted during the impact. The remainder of the aircraft, largely intact, was situated approximately 5 m from the initial impact point.

Detailed wreckage examination

General

Examination of the wreckage revealed that all damage to the airframe and flight controls had resulted from the impact with the ground and there was no evidence to suggest that the aircraft had not been structurally intact prior to the accident.

The engine was stripped and inspected and no evidence was found of pre-impact mechanical failure. The body of the carburettor was significantly damaged in the impact and there was no fuel remaining in the float chamber. The carburettor was dissembled and no anomalies were evident.

Magneto

The magneto was removed for testing. The cover on the contact breaker points had been damaged in the impact, allowing debris to become lodged in and around the breaker points. However, the unit itself was largely undamaged and, after removal of debris, the magneto was placed on a test rig. Excessive sparking was noted at the contact breaker points. Sparking at the breaker points results in a weaker spark being generated at the high tension leads and can result in rough running and reduced engine performance. It was noted that one of the breaker points was platinum and the other tungsten. The tungsten point was observed to have small amounts of oxidation on the surface. Oxidation is a known issue on tungsten contact breakers; it can be common on magnetos which are not used often and can lead to excessive sparking at the contact breakers. Residue on the breaker points from the debris may also have contributed to the sparking. After cleaning the points and retesting the magneto it performed satisfactorily.

The magneto was originally fitted with two platinum breaker points but at some point in the component's history they had been replaced by tungsten points. This was noted during the overhaul in 2003 and one of the tungsten points was replaced with a platinum one in an attempt to reduce excessive sparking at the points. The operator's engineers were aware that tungsten points were susceptible to oxidation and reported that all such breaker points were cleaned at the commencement of the flying season and after long periods of disuse.

Weight and balance

Although a weight and balance schedule was not completed for the accident flight, the April 2010 test flight was conducted by the accident pilot. The weight and CG annotated on the flight test schedule were within limits. As the only variable weight for this aircraft was the pilot weight (the aircraft was always operated with full fuel), it can be assumed that the weight and CG on the accident flight were also within the permissible limits.

Photographic evidence

Photographs taken from or near the crowd-line were provided to the investigation. However, there was a 14-second gap in the provided imagery during which the aircraft departed from controlled flight. Imagery then resumed one second before the aircraft struck the ground and the photographs from this point showed no signs of damage to the aircraft. The externally mounted portions of the rudder and elevator control runs were visible and intact, the pilot's head and hands were clearly visible and he appeared to be conscious. It did not appear that any control inputs were being made.

Pilot's notes for the DH53

In the aircraft were a set of laminated flight reference cards for the DH53 which had been issued by the operator. The operator had also produced a set of pilot's notes for the aircraft.

The pilot had on his person a set of typed notes which included the following points: the need to be prepared for an engine failure at any time; that vibration made the instruments hard to see; and that the pilot should firmly hold the ailerons central as the aircraft had a tendency for *'aileron tramping[1] near the stall giving symptoms of catastrophic wing drop.'*

Footnote

[1] Aileron tramping is movement back and forth of the ailerons (and thus the control column) caused by varying aerodynamic effects at the control surface.

The flight reference cards noted the relevant operating speeds for the aircraft as:

> *'Takeoff: 45 mph*
> *Cruise / Climb / Approach: 55 mph*
> *Stall: 42 mph'*

During the April 2010 flight test the accident pilot's report on stalling noted a wing drop of 10° in calm conditions using a 1 mph/sec deceleration. He also noted: *'Altimeter u/s….altimeter is of small scale type which is of little practical use to the pilot at low levels.'*

Medical and pathological information

The pilot held a current JAA Class 1 medical certificate. A post-mortem, conducted by a specialist aviation pathologist, found no evidence of pre-existing disease. Toxicology did not detect any drugs, drug metabolites or alcohol. The pathologist commented that the pilot had sustained a very severe head injury which would probably have been instantaneously fatal. Although the pilot's cloth flying helmet afforded little protection from impact, due to the specific nature of the head injury it was considered unlikely that a more protective helmet would have altered the outcome of this accident.

Discussion

Engineering aspects

All damage to the airframe and flight controls was consistent with the impact with the ground. There was no evidence to suggest that the aircraft was not structurally intact prior to the accident.

Although low levels of oxidation were observed on the tungsten contact breaker point of the magneto, had this level of oxidation existed prior to the accident flight, engine performance would have been noticeably degraded during the engine start up and ground running. There were no indications that this was the case. Whilst the engine had been somewhat unreliable in the past, its performance was noticeably improved following the rework of the carburettor and magneto. The aircraft flew five times in 2010 and once in 2012 with no reported engine problems, suggesting that the previous engine reliability issues had been resolved.

It was not possible to determine conclusively if the engine was operating normally at the point of impact, but neither was there sufficient evidence to suggest that it was not. The engine note was distinctive and noisy; none of the witnesses reported being aware of a change in engine note during the flight. The shallow propeller strike on the ground is indicative of the fact that the propeller was rotating at the time of impact but no assessment could be made of the engine power being delivered.

Given the low power rating of the engine, the wooden construction of the propeller, the hardness of the ground and the predominantly vertical trajectory of the aircraft at impact, it is uncertain whether the propeller would have made a more substantial propeller strike even if the engine was operating at full power.

Aircraft handling

The weather at the time of the flight was changing from a moderate constant wind to conditions including significant gusts of 22 to 25 kt.

The aircraft's normal operating speed was 55 mph and its stalling speed was 42 mph. Therefore in normal conditions there would have been a 13 mph margin above stalling speed. With a steady wind of 15 kt (17 mph) and gusts of 22 kt (25 mph) to 25 kt (28.7 mph), the

gust would comprise between 62% and 88% of the available speed margin.

The margin of 13 mph occupied a very small portion on the available speed scale on the airspeed indicator, represented by an arc of approximately 15°. With the known vibration of the aircraft the small display range of the airspeed indicator would have made accurate reading of the airspeed difficult. A lack of clear, usable airspeed indications in gusty conditions would have made the aircraft more challenging to operate. The turn at point 'A' took the aircraft downwind of the treeline at a height at which it was possible to encounter turbulent airflow in the strong winds, particularly given the developing gusts.

The aircraft had, by modern standards, low stability and power margins and poor flight instrumentation. The aircraft was known to be prone to aileron tramping close to the stall and the eyewitness accounts describe a departure from controlled flight consistent with a stall followed by a significant wing drop. It seems likely that the loss of control was the result of a combination of the challenging operating/handling characteristics of the DH53, the turbulent effect of the trees and the gusty wind conditions.

Safety actions

The operator conducted a comprehensive internal safety review following the accident. Although many aspects covered did not relate directly to this accident, the operator highlighted actions they intend to consider further or take action on. These included:

- analysing the effect of wind over the trees on the east side of the airfield and whether those trees could be reduced in height;
- provision of on-site AFRS and medical services during all flying activity, not just during displays;
- a review of the safety equipment worn by the organisation's pilots;
- a review of the current provision of meteorological information and consideration of installing a certificated anemometer;
- consideration of the imposition of total wind and gust limits for individual aircraft;
- addition of modern flight instruments, particularly airspeed indicators and slip balls to all aircraft capable of mounting them;
- fitting and use of radios in the operator's aircraft**.**

Conclusion

The aircraft departed from controlled flight for reasons that could not be fully determined. Technical failure of the aircraft and pilot incapacitation were considered, but ruled out as causal factors. Given the prevailing weather conditions and the challenging operating/handling characteristics of the aircraft, it is considered that the most probable cause of the accident was handling related.