ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ACDJ
No & Type of Engines:	1 de Havilland Gipsy Major 1C piston engine
Year of Manufacture:	1933
Date & Time (UTC):	18 August 2005 at 1034 hrs
Location:	Remenham (Berkshire), near Henley-on-Thames
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	289 hours (of which 107 were on type) Last 90 days - 9 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

During a pleasure flight in good weather conditions the aircraft was observed to enter a spin to the right from which it did not recover. The pilot and passenger both sustained fatal injuries. Despite extensive investigation, the cause of the accident could not be established.

History of the flight

On the morning of the accident, the aircraft had been flown from its maintenance base to White Waltham, in order that some associates of one of its owners could be taken on some short local flights. The accident happened on the second of these flights. As is customary in the Tiger Moth, the passenger was in the front seat and the pilot in the rear. Both were wearing glass-fibre flying helmets with intercom microphones and headphones, enabling them to speak to each other and to communicate with Air Traffic Control.

The aircraft was observed to start up, taxi normally and take off without incident. It then flew west to the River Thames and over Henley-on-Thames, before adopting a north-easterly track. Witnesses described seeing the aircraft on this track, and hearing the sound of the engine reduce markedly, after which the aircraft entered a steepening turn to the right. The aircraft was observed descending rapidly in a tight 'spiral' before hitting the ground in a field just south of the village of Remenham. The field (Figure 1) was large and unobstructed, with a slight slope and a surface mostly of rough pasture. The description of the descent and subsequent examination of the wreckage showed that the aircraft struck the ground in a spin to the right.

Figure 1

Photograph showing accident site

Members of the public were soon at the crash site and the emergency services were called. The pilot was conscious and lucid; the passenger was alive but unconscious; both had extensive injuries. An air ambulance helicopter from White Waltham and a police helicopter, which was also equipped as an air ambulance, both landed at the accident site. Paramedics treated the pilot and passenger at the scene, and the two helicopters took them to local hospitals. The pilot was able to communicate clearly during his treatment and transfer to hospital. The paramedic asked him questions about the flight and the accident, but he had no recollection of it. Both the pilot and passenger died of their injuries in hospital.

Pilot information

The pilot obtained his Private Pilot's Licence in 1995, having flown a total of 57 hours on Piper Cherokee aircraft. He flew regularly in the years that followed, and began to fly tailwheel aircraft such as the Piper Cub and the de Havilland Tiger Moth. He was a member of a syndicate which owned the accident aircraft and had flown it regularly since the summer of 2001. In 2005, he completed a biennial check and a renewal of his Single Engine Piston class rating with an examiner, flying a Piper PA-22 Caribbean. The examiner described the pilot as being "an average pilot with a good attitude towards flying", going on to state that he was "a steady pilot who achieved a reasonable standard of flying and knew his limitations".

During the renewal flight, the examiner put the aircraft into a spin, and the pilot recovered with the examiner talking him through the recovery. The recovery was correct with no problems. The examiner then suggested that the pilot should carry out a spin entry and recovery, but the pilot declined, saying that he was not keen on spinning. The syllabus for the renewal flight did not require spinning to be undertaken.

Aircraft information

G-ACDJ was first registered on 6 February 1933 having been built at de Havilland's site in Edgware. During 1990 and 1991 the aircraft was subject to a major overhaul, and a new certificate of airworthiness was issued on 17 October 1991. The engine was removed and overhauled to 'zero time' in July 1993.

Key information for the support and continued airworthiness for Tiger Moths, such as modifications and inspections, is published by de Havilland Support in a series of Technical News Sheets (TNS). Whilst there are modifications that date from 1933, the TNS system has been actively updated in recent years. There is also a Gazette which is issued for the guidance of operators and engineers of de Havilland aircraft and engines and this is distributed to all TNS subscribers.

Some examples of Tiger Moths have anti-spin strakes and auto-slats fitted, however these are not mandatory and were not fitted to G-ACDJ.

The aircraft had been subject to a 150 hour inspection on 20 July 2005 and an annual inspection the day before the accident. At the time of the accident 7,520 aircraft hours and 769 engine hours had been logged.

Meteorology

An aftercast supplied by the Met Office indicated that at the time of the accident a very slack airflow was affecting south-east England, with haze thinning between 1000 hrs and 1100 hrs, after which the visibility was 12 to 18 km, the sea level pressure was 1013 mb and the cloud was one or two octas of cumulus, with a base at 4,500 ft. The wind and (calculated) temperature are shown in Table 1.

Radar data

Radar recordings of the Tiger Moth's flight were consistent with witness recollections. The recordings showed that the aircraft's ground speed decreased by approximately ten knots over a period of several minutes during the latter part of the flight, but prior to the accident manoeuvre. At about 1031 hrs, the aircraft was recorded entering a right turn of slightly more than 360°. Radar contact was then lost as the aircraft descended above the accident site.

The recording also contained data relating to the flight of the Air Ambulance helicopter which attended the scene. Although the Tiger Moth was not equipped with an altitude-reporting transponder, the base of radar cover was established reasonably accurately by comparing the primary radar return of the helicopter with its Mode C altitude reporting[1]. This indicated that the base of primary radar cover at the accident site was approximately 800 ft amsl.

Examination of the wreckage at the crash site

The aircraft wreckage was contained within a small area consistent with a low impact speed and typical of a spinning accident. The left tip of the horizontal tail plane had dug into the ground, and the wooden fin post had broken so that the fin and rudder were angled to the left of the aircraft. One blade of the wooden propeller had broken away from the hub and lay next to the aircraft's nose, and the tip of this blade (20 cm in length) had been thrown 17 m forward of the aircraft's nose. Scuff marks, consistent with propeller rotation, were clearly evident on the blade that had broken away. No such scuff marks were found on the other blade, or the spinner. It was concluded that the engine was probably rotating at low speed at the time of the impact.

Footnote

[1] Mode C is a means by which an aircraft transmits its altitude such that it can be displayed alongside the aircraft's primary radar return on the ATC radar display.

Height (ft agl)	Wind Direction (° True)	Wind Speed (kt)	Temperature (°C)	Dew Point (°C)	Relative Humidity (%)
Surface	Variable, mainly easterly	5	25.5	14	49
500	100	5-10	24	12.5	49
1,000	100	5-10	20.9	10.9	53
2,000	100	10	18.4	9.9	58

Table 1

The nose of the aircraft had impacted the ground causing significant damage to the engine and the forward fuselage. Both lower mainplanes were damaged along their leading edges, and the upper mainplanes and the fuel tank had been thrown forward in the impact. The fuel tank was damaged and was leaking but was still about 20% full approximately 90 minutes after the accident.

A preliminary check on the continuity of the controls to the ailerons, rudder and elevator made at the wreckage site showed that there was no disconnection in any of the three primary flying controls prior to the impact.

The right hand lap straps of the 'Sutton harnesses' for both occupants had failed in the webbing material. The attachment cable for the rear occupant's shoulder straps had failed in overload and the fuselage structure in the vicinity of the front occupant's shoulder harness attachment cable had been disrupted. Thus both shoulder and lap restraint had been compromised for both occupants.

Detailed examination of the wreckage

Engine

The engine was removed from the wreckage and taken to a maintenance facility which had extensive experience with Gipsy Major engines. The strip inspection and examination included the carburettor and the magnetos as well as an internal mechanical inspection. Apart from the damage caused by the impact, nothing abnormal was found and the engine appeared to have been serviceable prior to the impact.

An attempt to assess the throttle position at impact was inconclusive since the throttle pushrod had been damaged extensively in the impact.

Fuel and fuel system

The fuel tank on the Tiger Moth is situated between the two upper mainplanes and forms the centre section of the upper wing. On the underside of the tank was a fuel ON/OFF valve and this was connected to a lever, the 'cock', in the cockpit by a series of pushrods and cranks. A mandatory modification to incorporate a locking device for the fuel ON/OFF cock had been incorporated in June 1999. The pushrods had been heavily deformed in the accident; however it was considered likely that the fuel ON/OFF valve was open at impact. An analysis of the fuel confirmed that it was AvGas 100LL and that it was fit for purpose.

Aircraft structure

The fabric covering material was removed from much of the aircraft and the structure was inspected. Included in the inspection were control hinges, primary structural members and bracing wires. The airframe appeared to have been in a serviceable condition prior to the accident, and there was no evidence of an in-flight malfunction or failure.

Flying controls

The primary flying controls consist of rudder, elevator and ailerons, the latter are on the lower mainplanes only.

The lower end of the rear occupant's control stick on the Tiger Moth is attached to aileron control cables and these cables form a closed loop system that runs between two sprocket wheels, one inside each of the lower mainplanes. The two parallel cables are attached to lengths of chain through adjustable and wire-locked turnbuckles such that the chains sit on the two sprocket wheels. When the control stick is moved sideways, the cables move causing the sprocket wheels to rotate and pushrods attached to the sprocket wheels move the ailerons. The sprocket and chain assemblies are effectively built into boxes, with the upper surface being formed by fabric, the lower surface by two aluminium cover plates on the wing lower surface and the sides are wood.

In 1943 the Air Ministry, on behalf of the de Havilland Aircraft Company, introduced Mod 125 to:

> *'introduce an improved aileron sprocket chain guide arrangement to reduce the possibility of the chain riding on the sprocket due to sagging of slack cables, and a reduction in the length of the slot in the cockpit floor to prevent the chain shackles riding on the sprocket when the control column is in the fully over position. The modification includes the deletion of the existing fixed chain guard and replacement by a spring guard and the introduction of Guide Plates to prevent chain sag'.*

TNS No 5 for the Tiger Moth issued in January 1990 listed three CAA mandatory modifications, and Mod 125 is included on this list.

A pair of wooden stops are attached to the underside of the fuselage beneath the control column, to reduce the length of the aileron slot, and hence the aileron movement. Whilst the underside of the fuselage of G-ACDJ was disrupted as a result of the impact, both stops were found to be present and their length and the likely gap between them were consistent with Mod 125.

The two cover plates were removed from the lower surface of each lower mainplane and the fabric was cut away from above the aileron control mechanisms. The aileron box in the right wing was found to be intact and the chain was properly located on the sprocket wheel. However, in the left wing the aileron box had been disrupted, most probably in the impact, and there was a crack up to 6 mm wide on the forward side of the box. The spring guard was flattened and the chain was derailed from the sprocket and sitting around the inner part of the sprocket assembly – see photograph in Figure 2.

Mod 125 also requires the fitting of a chain guide plate in both lower mainplanes. This plate is 18 cm long and has a shallow inverted channel section. It is attached to the wing lower surface structure by four wood screws and it requires spruce packing of the correct thickness to be inside the section to ensure the correct gap between the guide plate and the plane of the sprocket wheel. On G-ACDJ the guide plate in the right lower mainplane was found to be securely attached, however the guide plate on the left lower mainplane was found attached but with no evidence of any packing strip, and with the

Figure 2
Photograph showing derailed aileron chain in lower left mainplane

three retaining screws only part way in (Figure 3). The fourth retaining screw was found loose inside the box structure. Further inspection of the guide plate on the left wing revealed no evidence of any of the screws that secure the packing strips to the wing structure. This would suggest that the packing pieces were not present prior to the impact, and hence the plate might not have been securely in place before the accident.

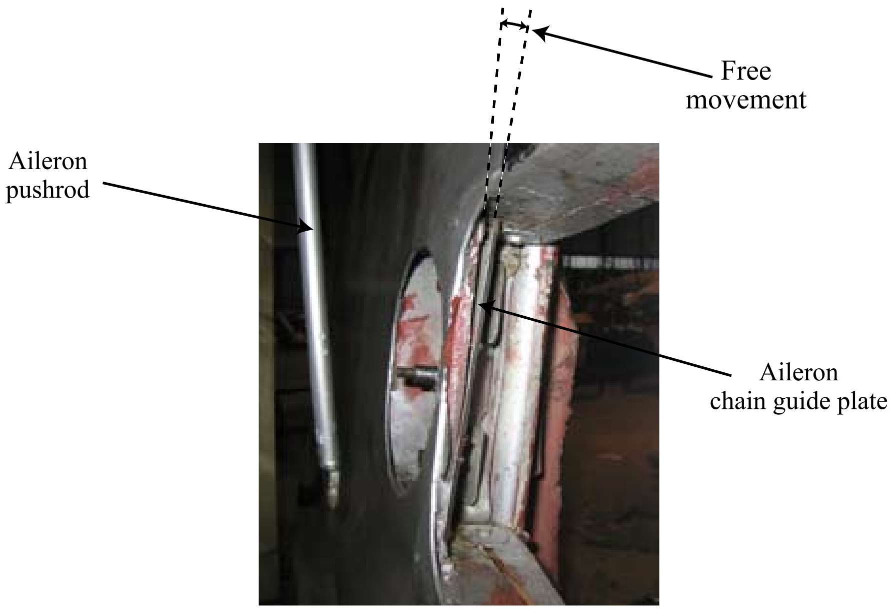

Figure 3

Photograph showing loose guide plate in lower left mainplane

Inspection of the chains, sprockets, guide plates and the loose screw showed no evidence of any marks that would indicate a control problem. Attempts were made to derail the chain from the sprocket assembly under a variety of conditions. Even with the flattened chain guard and low cable tension the chain would not come off the sprocket wheel. Also, with the chain derailed as found on the left mainplane, the shape of the crank and sprocket assembly was such that some restricted movement of the aileron did occur.

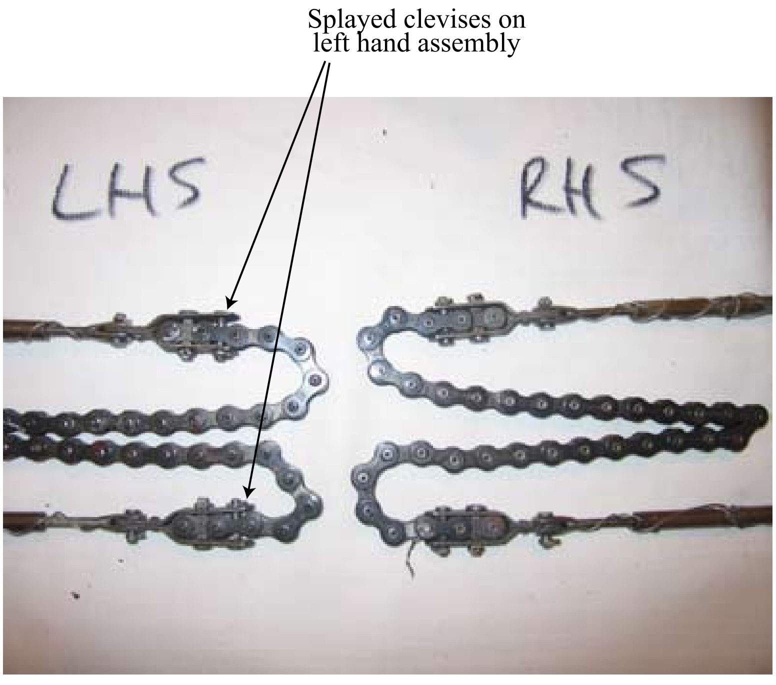

Figure 4

Photograph showing left and right hand aileron chains.

The left and right chains were compared, see Figure 4, and the clevises on the left chain were found to be splayed, consistent with a significant load being applied. The bracket which attaches the rear spar of the lower mainplane to the fuselage was found to have suffered a significant upward load, thus supporting the evidence that the left wing, including the aileron cable, was subject to an abnormally high load in the accident.

Further investigation of the flight control system, in particular the rudder, elevator and the mechanical linkages under the cockpit floor, revealed no evidence of foreign objects or control restrictions which might have caused a control problem.

Aileron system inspections

The aileron system on G-ACDJ was checked as part of both the 150 hour inspection on 20 July 2005 and the annual inspection on 17 August 2005. Interviews with the maintenance engineer and the signing licensed engineer confirmed that the cable tensions, the integrity of the cable assembly and the aileron movement were satisfactory on both occasions. However neither of the engineers checked the integrity of the guide plates as part of these inspections.

The aileron systems in two other Tiger Moths were inspected and in one of the aircraft there were no guide plates fitted. Whilst it is clear from Technical News Sheets that the fitting of guard plates is part of a mandatory modification, it would appear that there has been more than one instance of inadequate inspection of guide plates on Tiger Moths.

Pathology

An expert in aviation pathology carried out post mortem examinations on both the pilot and passenger. He concluded that both had died as a result of multiple injuries sustained in the accident. Toxicological tests revealed nothing of significance in either case.

Examination of the pilot identified pre-existing medical conditions, affecting his heart and brain. The heart was found to have approximately 70% occlusion (narrowing) of coronary arteries, and the pathologist reported that this degree of abnormality was sufficient to produce: *'an abnormal heart rhythm, chest pain, collapse, or even sudden death'*.

However, no evidence of an acute coronary event was found. The pilot had undergone extensive cardiological review in 2004 following an Electrocardiogram (ECG) examination but had been assessed as fit to hold a Class 2 medical certificate [1].

A tumour (meningioma) was found adjacent to the frontal lobe of the pilot's brain. A consultant neurologist with experience of aviation medicine was asked to give an opinion on this tumour, and he reported that: *'this meningioma with surrounding oedema could well have caused an epileptic fit, which… would lead to a sudden incapacity. It is possible that it could have caused some more longer term personality change, but I suspect, given its unilateral nature and relatively small size that this would not be the case. Family members may be able to give more information on this possibility'*.

The pilot's family reported that there had been no change in the pilot's personality in the months before the accident. The pathologist indicated that whilst it would be unlikely for a private pilot with an undiagnosed meningioma to suffer a first epileptic seizure during the brief time in a given year that he was involved in operating an aircraft, the possibility could not be excluded.

The examination also identified minor injuries to the pilot which suggested that the pilot's left hand was on one of the aircraft controls at the time of impact, and therefore, that he was not unconscious.

Harnesses inspection and webbing material testing

Sutton harnesses were fitted to the aircraft and each occupant's harness consisted of two lap and two shoulder straps made from canvas webbing reinforced locally with leather. Set within the leather

Footnote

1 Class 2 medical certificates are commonly held by holders of Private Pilot's Licences. Professional pilots are required to hold Class One certificates, which have more stringent requirements.

reinforcements were a series of eyelets and to secure the harness an occupant threaded a pin through the appropriate eyelet from each of the four straps before securing the pin with a sprung clip. The shoulder straps were fixed to the aircraft by a cable running across the fuselage, and the lap straps were attached to the fuselage.

Sutton harnesses were the subject of the following TNS:

a) TNS 37 issue 2 in 2000: A CAA mandatory TNS which specifies the fitting of higher strength transverse cables for the attachment of shoulder straps.

b) TNS 33 issue 2 in 2002: A CAA mandatory TNS which specifies a nine year harness life from initial fitment. Since production of Sutton harnesses had ceased many years ago, replica harnesses, known as 'alternative' harnesses, had become available and were described in Mod No 160 issue 2 in 2002. As part of the certification process for the alternative harnesses ultimate load testing was required to confirm that the harnesses met the original specification.

The fitting of the higher strength cables to G-ACDJ was documented in the log book and dated September 2001. The attachment cables were inspected and, apart from the overload failure for the rear cable, they appeared to have been in good condition prior to the accident and they both had valid part numbers.

Whilst the harnesses on G-ACDJ were installed before the alternative harness certification date they were effectively exactly the same as the certificated alternative parts. The original harness was designed to '*keep the wearer firmly in his seat*' when subject to certain loads and the relevant drawings dated 1943 called for '*Khaki webbing of tensile strength not less than 1,100 lbs approximately 3/32 inch thick'*. As such the harness was not part of an integrated crashworthy aircraft design in which energy absorption and survivable space were considered to the extent that they are for more modern aircraft.

As a result of the failure of the webbing material in both right lap straps the harnesses were removed from the wreckage for further examination. To ascertain if the webbing material had performed to its specification various samples from the harnesses fitted to G-ACDJ were subject to ultimate load tests and the results were compared to the data from the harness certification tests that were performed in December 2001. In the tests all the samples were from the same batch of webbing material. The strength of the webbing material declines with age due to a variety of factors including wear, humidity and any high loads encountered in service. The results of the three tests of samples from G-ACDJ all exceeded the manufacturer's 1943 specification.

Additional information - spinning

A spin is a manoeuvre in which an aircraft describes a descending spiral, in a stalled condition, whilst yawing, pitching, and rolling simultaneously throughout. In a spin, an aircraft loses height rapidly, but airspeed is low.

In order for an aircraft to enter a spin, certain criteria must be met. First, the aircraft's wings must be stalled. To achieve this intentionally, the aircraft must be pitched nose up, usually, by the pilot moving the control column rearwards and holding it in a rearwards position. Yaw must also be present as the wing stalls, or approaches the stall. In aircraft such as the Tiger Moth, this yaw may occur as a result of deliberate pilot control input or as a result of an absence of accurate control of the aircraft to arrest undesired yaw, particularly if one wing drops approaching a stall, which is common. Some aircraft, notably some with swept wings, exhibit different characteristics in this respect.

Another circumstance in which yaw must be controlled is following changes in power. When power is reduced, a Tiger Moth will yaw and then roll to the left. The pilot must apply right rudder to prevent this yaw, if balanced flight is to be maintained.

Some aircraft require constant application of pro-spin controls to maintain a spin, and recover as soon as the controls are released. Other aircraft types continue spinning, even if the controls are released, and require the correct action to be taken to recover to normal flight.

As the aircraft exits the spin manoeuvre, the speed increases rapidly, and the aircraft enters a steep dive. Recovery from this dive involves significant loss of height.

Some accounts of the characteristics of the Tiger Moth suggest that the early stages of a spiral dive are remarkably similar to a spin. However, the low speed of the accident aircraft at the time of impact indicated that the aircraft was spinning, and not in a spiral dive, prior to impact.

The investigation made use of a Pilot's Assessment of the Tiger Moth aircraft, written by a professional military test pilot for the Royal Australian Air Force Museum. This document gave a thorough description of the aircraft and its characteristics. In the section *'Spinning'*, the report stated:

> *'The effect of abandoning the controls during the spin was examined during one left and one right spin. For each direction of spin, releasing the controls did not effect a recovery after a further four turns…'.*

It may be inferred that positive action on the controls is necessary to effect a recovery from a spin in the Tiger Moth.

Another report, commissioned following a fatal accident to a Tiger Moth in Australia, stated:

> *'It is difficult to get the DH82 to enter a fully developed spin without applying and maintaining application of a lot of rudder whilst keeping back pressure on the stick'.*

Recording equipment

The aircraft was fitted with equipment, carried in a case behind the rear seat, which was capable of recording images from cameras fitted around the aircraft and sound from the interphone and VHF radio onto a small cassette tape. This equipment was used by the company which sometimes used the aircraft for pleasure flights, to provide passengers with a recording of their flights. Prior to the accident flight, the equipment had not been activated.

Analysis

From the engineering investigation, it appears that the aircraft was serviceable before the flight with no pre-existing defect which contributed to the accident, and that no defect occurred during flight which caused the aircraft to enter the spin.

The pilot was correctly qualified to carry out the flight and had reasonable prior experience on the aircraft.

Whilst not in very current flying practice, he had renewed his Single Engine Piston rating with an Examiner, approximately six weeks before the accident.

The weather conditions were entirely suitable for the intended flight and the pilot would have had uninterrupted visual contact with his environment and the ground beneath him, with a good horizon as a reference.

The flight appeared to have progressed normally until the aircraft had passed over Henley-on-Thames. Following analysis of the radar recordings, and with the assumption that the aircraft may have lost height in the right turn recorded on radar, it may be estimated that the Tiger Moth was at an altitude of approximately 800 ft plus the height lost in this turn, if any, prior to its final manoeuvre. The elevation of the ground at the accident site was approximately 180 ft, and less in the river valley between the accident site and Henley-on-Thames.

The first significant event immediately prior to the accident was the reduction in engine power, described by the witnesses. This reduction in power may have resulted from a reduction in the throttle setting by the pilot, or could have been caused by some failure of the engine or its systems. The engineering investigation did not identify any reason why the engine should have failed, but the possibility remains that a failure occurred which could not be identified in the post-accident investigation, or that carburettor icing (which may leave no trace for accident investigators) might have caused the engine to lose power.

Carburettor icing is usually associated with a gradual power loss and rough running, and although the aircraft's average groundspeed (derived from radar) had reduced gradually in the period leading to the accident, the manner of the change in the engine note, which the witnesses described as being quite sudden and definite, suggested that the change in power was not caused by carburettor icing. Moreover, the ambient conditions were such that there was not a high risk of carburettor icing at cruise power. Had the pilot identified that the engine was gradually losing power, and decided to land as a precaution against a total power loss, it seems reasonable to expect that he would have made a radio call to inform others that he was carrying out a forced landing, and that he would have used the remaining power to fly a controlled circuit of a possible landing site prior to commencing a circuit to land.

After the power reduction, the aircraft entered a turn to the right and then began descending. When power is reduced, the effect of the propeller slipstream and engine torque causes the Tiger Moth to yaw and roll to the left. Therefore, there must have been a control input to cause the aircraft to turn to the right. Given that the Tiger Moth does not enter a spin readily, it must also be concluded that a control input was made which caused the spin entry. These control inputs may have been deliberate, for example, an entry into a right turn to manoeuvre for a forced landing, or may have been unintentional, for example, caused by incapacitation, or an input made by the passenger following recognition of the pilot's incapacitation. If the control inputs were deliberate, mis-handling (itself perhaps caused by distraction or partial or subtle incapacitation) could have caused the aircraft to depart into the spin.

The pathology report indicated that the pilot had two medical conditions, either of which could have caused sudden incapacitation. The fact that the pilot was conscious and lucid when the rescuers arrived at the accident site indicates it is unlikely that he had suffered a major epileptic or cardiac event, but it does not entirely exclude the possibility of a transient episode causing partial incapacitation.

In the event of incapacitation of the pilot, the passenger might have attempted to gain control of the aircraft and carry out a landing. However, she would first have had to establish that the pilot was incapacitated, and as the pilot was seated behind the passenger, incapacitation which caused him to lose consciousness would not have been immediately apparent to the passenger, except that the pilot would not have been able to communicate by intercom. In the event of such communication ceasing, the passenger might have concluded that the intercom system had failed or that the pilot was occupied with tasks which prevented his conversing, rather than coming immediately to the conclusion that he had become incapacitated.

It is noteworthy that this pilot, who had significant coronary artery disease, had been pronounced fit following investigation of his abnormal ECG, and this reflects the imperfect nature of some medical screening tests.

If the passenger had identified that the pilot had become incapacitated, it is possible that she might have attempted to gain control of the aircraft. However, she had received no flying training, and would not have known how to fly the aircraft. It is considered that an untrained individual would not be able to carry out a safe landing in these circumstances, and any attempt to take control of the aircraft would be likely to result in loss of control.

Once the aircraft was established in the spin, reports indicate that recovery action would have been necessary to regain 'normal' flight. One of the first consequences of such recovery would be an increase in the aircraft's forward speed, and the manner of the impact suggests that the speed was very low, and therefore it seems that recovery action was not being taken.

Both occupants died from multiple injuries. Whilst the lap straps failed in both the harnesses, tests concluded that the webbing material met its design specification. It is thought likely that the accident would not have been survivable had the harnesses remained intact and secured, although this is a somewhat subjective view based on a discussion with the aviation pathologist.

The impact with the ground was the most likely cause of the derailed chain and the flattened spring chain guard. This was substantiated by the significant damage to the left lower mainplane, the fact that the system was inspected the day before the accident and the absence of any reported defect on the day of the accident. Even if the left aileron chain had become derailed in flight it would seem likely that the pilot would have retained some aileron control due to the shape of the crank on the sprocket wheel, or the aileron would have adopted a constant position as a result of floating up under aerodynamic loads. Adequate control of the aircraft would have been available in both of these scenarios.

The absence of any of the wood screws for the packing strips and the lack of any evidence from inspection records would strongly suggest that the packing strips were not present and that the left plate had been loose, but attached, prior to the accident. No evidence of a problem with the flying controls could be found. It is therefore unlikely that the loose left guide plate contributed to the accident. As a result of the high probability that the left aileron guide plate was loose prior the accident, the following Safety Recommendation is made.

Safety Recommendation 2006-055

It is recommended that de Havilland Support remind pilots and maintainers of Tiger Moths of the importance of the embodiment and periodic inspection of the mandatory modifications for the aileron system described in Technical News Sheet No 5.

Conclusions

Witness accounts and radar evidence, together with the results of the wreckage analysis, allowed the investigation to determine the aircraft's final manoeuvres with some accuracy. However, it was not possible to determine a cause for the reduction in engine power or for the aircraft's entry into the spin. A significant number of theories might be constructed to account for these events, but none stands out as more or less probable than the others.

It is notable that the recording equipment fitted to the aircraft would, had it been activated, have provided very valuable evidence to the investigation, and might have allowed the cause of the accident to be determined.