ACCIDENT

Aircraft Type and Registration:	i) Cessna 152, G-BNXC ii) Aerotechnik EV-97 Eurostar, G-GHEE
No & Type of Engines:	i) 1 Lycoming O-235-L2C piston engine ii) 1 Rotax 912-UL piston engine
Year of Manufacture:	i) 1981 ii) 2001
Date & Time (UTC):	18 December 2005 at 1218 hrs
Location:	Moreton in Marsh, Gloucestershire
Type of Flight:	i) Training ii) Private
Persons on Board:	i) Crew - 1 Passengers - None ii) Crew - 1 Passengers - 1
Injuries:	i) Crew - 1 (Fatal) Passengers - N/A ii) Crew - None Passengers - None
Nature of Damage:	i) Aircraft destroyed ii) Substantial damage to engine and forward fuselage, left wing and landing gear
Commander's Licence:	i) Student Pilot (JAA Class 2 medical certificate) ii) Private Pilots Licence
Commander's Age:	i) 34 years ii) 62 years
Commander's Flying Experience:	i) 52 hours (of which 10 were on type) Last 90 days - 7 hours Last 28 days - Nil hours ii) 265 hours (of which 92 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

A student pilot was flying Cessna 152, G-BNXC, on a cross-country navigation exercise. His planned route took the aircraft overhead the disused airfield at Moreton in Marsh. The pilot of the Aerotechnik EV-97 Eurostar, G-GHEE, had a passenger on board and flew towards Moreton in Marsh where his passenger intended taking photographs. After the Eurostar had completed about 270º of turn over the disused airfield, it rolled out on a northerly heading and very soon afterwards collided with the Cessna 152 which was flying on a

west-south-westerly track. The weather was fine with good visibility. The investigation concluded that the accident was caused by neither pilot seeing the other aircraft in sufficient time to take effective avoiding action. One safety recommendation was made, concerning guidance on medication.

History of the flights

Cessna 152, G-BNXC

G-BNXC was coloured predominantly white with blue markings, and was equipped with a single red anti-collision beacon. The student pilot was nearing completion of the required training for the issue of a Private Pilots Licence (PPL) and had planned to fly the aircraft on a cross-country navigation exercise. He had arrived at his flying club at Coventry Airport at about 0900 hrs that morning where he met with his flying instructor who was to authorise the flight. They discussed the exercise, which was to consist of a flight to Gloucestershire Airport near Cheltenham, where the aircraft would land, and then a return flight to Coventry. The details of the route itself had been discussed previously and so conversation concentrated on particulars such as weather information and aircraft technical status. It was a fine Sunday and the instructor specifically briefed the probability that many pilots would be taking advantage of the weather, making a good lookout essential. As part of the authorisation and briefing process the instructor issued a "Solo Cross Country Briefing Certificate" which acted as a checklist of items to be covered in the briefing such as weather, route, destination and emergency procedures. The certificate included an annotation of the altitude to be flown as "2500 QNH".

The pilot took off from Coventry Airport at 1136 hrs, and departed on a south-easterly track towards a turning point at Silverstone race circuit. Turweston Aerodrome is adjacent to Silverstone, and the pilot contacted the Air/Ground radio operator there to advise him of his presence and route, but did not state his altitude. From Silverstone the aircraft turned onto a westerly track towards Banbury, and from there turned on to a track of 253º(M); a direct course for Gloucestershire Airport. This track took the aircraft directly overhead the disused airfield at Moreton in Marsh, the site of the Fire Service College and the location of the subsequent collision with G-GHEE. The pilot did not contact any other ATC units, remaining instead on the Turweston frequency. At about the time of the accident, the Air/Ground operator and other aircraft in the Turweston area heard a brief, clipped transmission of "MAYDAY, MAY...", which was later presumed to have been made by the pilot of G-BNXC.

Aerotechnik EV-97 Eurostar, G-GHEE

G-GHEE was a three-axis microlight aircraft, coloured predominantly silver with blue markings, and was not equipped with an anti-collision beacon. The pilot, who also owned the aircraft, had planned to fly two friends from a private airstrip which was situated a few miles to the east of Cheltenham. The first flight was uneventful and lasted 50 minutes. After a change of passengers, the pilot took off again at 1205 hrs, at about the time G-BNXC was approaching Banbury. The flight was intended to be a scenic flight for the benefit of the pilot's passenger, who was an inexperienced flier. The pilot first flew to his passenger's house, which was close to the airstrip, and circled for a few minutes while the passenger took some photographs. The pilot then set course for Moreton in Marsh, where the passenger intended to take more photographs.

During the cruise to Moreton in Marsh the aircraft maintained an altitude of 1,800 to 1,900 ft amsl, which equated to about 1,000 ft agl over the Cotswold Hills. As the aircraft approached Moreton in Marsh from the south-west, the terrain beneath it reduced in

elevation and the pilot commenced a descent until the aircraft was again maintaining about 1,000 ft agl. The aircraft flew north of the town before turning right to approach the Fire Service College buildings from the north-west. It then flew a right-hand turn, taking it to the east and then south of the College buildings whilst the passenger took two photographs. At some point the passenger asked the pilot if he could make a further orbit and the pilot agreed. The pilot estimated that the aircraft was now at about 800 to 1,000 ft above the disused airfield, which has an elevation of 436 ft amsl. The pilot rolled wings level for a brief period on a track of about 350º(M), with the intention of making a further right turn to take the aircraft around the College buildings once again.

Suddenly, the pilot and passenger became aware of the Cessna 152 in very close proximity, ahead and, possibly, slightly to the right. The pilot later assessed that it was at less than 50 yards range and described it as "filling the windscreen". The pilot instinctively pulled back on the control column, and the Cessna 152 was lost from view as the Eurostar pitched up, just before the collision. From his brief view of the Cessna 152 prior to the collision, the pilot of the Eurostar thought that the Cessna 152 pilot had not seen his aircraft, as he did not appear to be taking any avoiding action.

At the point of collision the canopy of G-GHEE flew open. Being a forward hinged canopy it was not lost, but the passenger was able to reach up and pull it closed, a position he held until the aircraft had landed. There was severe vibration which prompted the pilot to shut down the engine and prepare for a forced landing. The aircraft was flyable but the pilot twice experienced a wing drop to the right which he was able to correct. With the aid of some ground smoke he was able to assess the surface wind and carried out a forced landing in a field just to the north of the disused airfield's perimeter fence. Although the aircraft sustained some further damage in the landing, neither of the occupants was injured.

After the collision the Cessna 152 entered a dive and crashed on the disused airfield, within the grounds of the Fire Service College. The emergency services, alerted by the pilot of G-GHEE and several witnesses, arrived on scene soon afterwards. An air ambulance also attended the scene, but it was confirmed that the pilot of G-BNXC had sustained fatal injuries.

Pilot information

The 34 year old pilot of G-BNXC had commenced flying training in November 2003. His training had proceeded normally, though at times continuity had been affected by poor weather and aircraft availability. He was nearing the end of his training and was scheduled to undertake his final flight test within the following two weeks. He had logged 51 hours 55 minutes of flight time, which included 13 hours 40 minutes of solo flight time. The majority of his training had been flown on the Piper PA-28 aircraft, though he had flown 6 hours 35 minutes dual and one hour 55 minutes solo on the Cessna 152. He had last flown the Cessna on 17 September 2005, and his last flight, in the PA-28, was on 5 November 2005. The pilot's instructor stated that the pilot had been made aware of the effect of the aircrafts' configurations on lookout (one type is a 'high wing' configuration, the other is 'low wing') and had demonstrated an effective lookout in both types.

The pilot had twice before attempted to complete the cross-country navigation exercise, the previous flights being abandoned due to poor weather on one occasion and an aircraft technical problem on the other. He was well thought of by the club instructors who judged his

handling skills to be slightly above the average and considered that he was building a good, appropriate level of confidence and airmanship.

The 62 year-old pilot of G-GHEE had started flying training on microlight aircraft in 1994 and qualified in 1995. At the time of the accident he had accumulated 265 hours of flight time, all of which was on 3-axis microlight aircraft. He acquired G-GHEE in 2001, with its first flight being in May 2002. Since that time he had flown 92 hours in the aircraft. The pilot had flown a 50 minute flight on the morning of the accident; his last flight before that was on 7 December 2005.

Aircraft wreckage

Collision debris

Collision debris from both aircraft was distributed over a region extending some 200 m north eastwards from a point slightly west of the (disused) main runway intersection, consistent with the direction of the prevailing wind that day. The debris comprised:

1. *From the Eurostar* - two large pieces of lower engine cowl, together with a number of smaller fragments of cowling.
2. *From the Cessna 152* - numerous small fragments of left wing tip fairing, fragments of skin panel and internal structure from the left outer wing; a large segment of the left aileron; fragments of aileron hinge.

It was evident from the distribution of airborne debris that the collision occurred almost overhead the runway intersection.

Eurostar

The Eurostar landed in a field of vegetables that had been recently cropped, providing firm and even ground conditions, some 900 m to the north of the point of collision. Except for an overload failure of the left landing gear strut attachment, and associated collapse of the gear, all of the damage to the Eurostar was caused by the collision. This damage comprised:

1. Break-up and separation of most of the lower engine cowl.
2. Extensive damage to the engine, its mount frame, and associated firewall attachment bolts leaving the powerplant hanging from the firewall by a single bolt.
3. Rearward bending of the nose landing gear strut beneath the fuselage.
4. Separation of the outer sections of two (of the three) propeller blades.
5. Numerous pieces of the Cessna's outer left wing structure embedded in the engine compartment and jammed around the upper section of the nose landing gear strut, including fragments of wing tip fairing, pieces of wing skin and internal structure.
6. Deformation and penetrations through the outermost 80 cm of the left wing leading edge, confirmed subsequently as having been caused by sequential strikes by the aft face of the Cessna's propeller.

Cessna 152

The Cessna crashed within the boundary of the Fire Service College, approximately 400 m southwest-by-west of the point of collision, tracking in a southerly direction. At the time of impact it was travelling at high speed, in a shallow descent, and banked to the left. The initial contact between the left wing and the ground caused the aircraft to cartwheel violently to the

left before the primary impact occurred, causing severe damage to the forward fuselage and cockpit. Thereafter it slid rearwards, shedding debris as it did so, before finally coming to rest facing the direction from which it had come, approximately 100 m from the point of initial ground contact.

The circumstances of the accident, based on a substantially consistent set of witness accounts, did not suggest that a technical problem had played any part in the collision. Further examination of the aircraft remains was therefore confined to a detailed study of the impact damage sustained by each aircraft, with a view to determining how the two had come together.

Recorded information

The track of G-BNXC was captured by the Air Traffic Control radar at Clee Hill and the recorded data was available for the investigation. The same radar also captured what is believed to be parts of the track of G-GHEE, being mainly that part as the aircraft flew towards Moreton in Marsh and before it commenced its descent. The radar also recorded other aircraft tracks in the area, including tracks which crossed each aircraft prior to the collision and the track of an eyewitness' aircraft. Although limited radar data was available for G-GHEE, the aircraft carried a GPS receiver which provided track data for the whole flight. There was no recorded altitude information for either of the accident aircraft; the Secondary Surveillance Radar return for G-BNXC did not include altitude information, and the GPS equipment on G-GHEE did not record height. The tracks of the two aircraft in the minutes before the collision are shown at Figure 1.

G-GHEE approached the area from the south-west with an average recorded groundspeed of 88 kt, equating to an airspeed of about 73 kt. G-BNXC flew a fairly steady track from Banbury towards Moreton in Marsh at an average groundspeed of 74 kt, approximately equating to the pilot's planned airspeed of 90 kt.

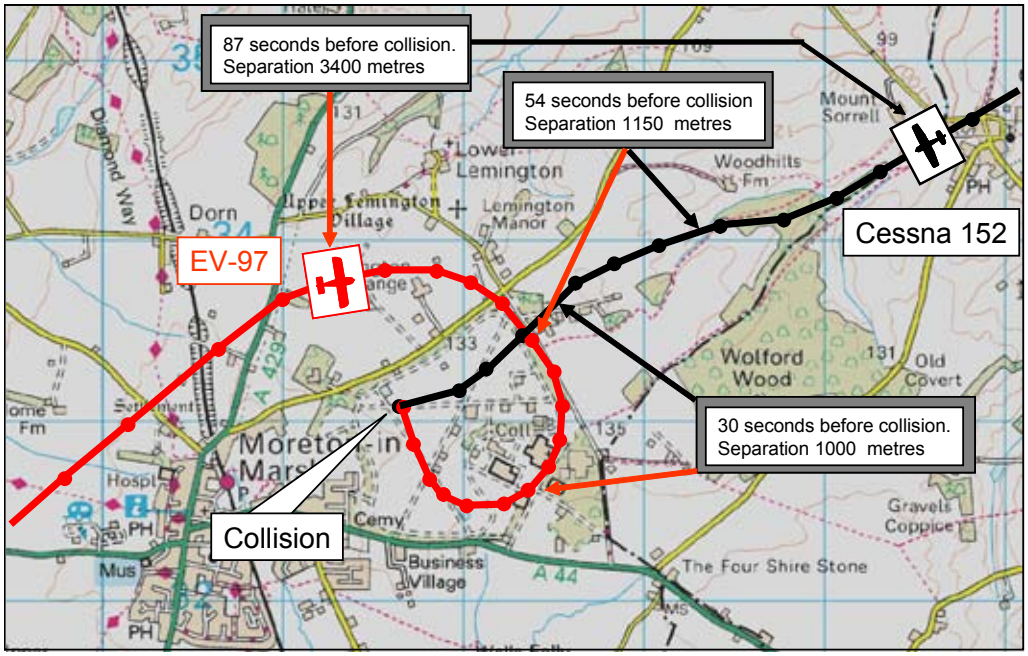


Figure 1

Tracks of the two aircraft, derived from GPS and radar information

At 2 minutes 20 seconds before the collision the aircraft were approaching the accident area from opposite directions, being approximately head-on to each other at a range of 7.6 km. As the Eurostar started its right turn in the accident area, 87 seconds before collision, the two aircraft were 3,400 m apart. The Cessna was directly ahead of the Eurostar at this stage, which would have been just to the right of the Cessna's nose. Shortly after, some 54 seconds before collision and just as the Eurostar crossed its intended track, the Cessna was seen to have altered course to the right by 20º to 25º. At this point the two aircraft were 1,150 m apart. The Eurostar then continued its right-hand turn while the Cessna turned back to parallel its original track for a short while before turning again to track directly for the centre of the disused airfield. The Cessna then resumed its original track whilst the Eurostar continued to turn right until it rolled out on a track of about 350º(M). At this point the aircraft were some six seconds from collision, the crossing angle was about 100º and the aircraft were between 300 and 350 metres apart.

Whilst there was no electronically recorded altitude information for G-BNXC, some information was recovered from the pilot's flight planning paperwork. The pilot's navigation log for the flight recorded a planned altitude for each leg of 2,000 ft amsl. This was at variance with the altitude of 2,500 ft amsl which was entered on the briefing certificate issued by his flight instructor. The pilot had flown the route on a previous occasion, but had to curtail the exercise due to an aircraft unserviceability. The navigation log for that flight was recovered and showed that the pilot had planned to fly at an altitude of 2,500 ft amsl.

Radar data also showed that another aircraft had crossed the track of the Cessna about one minute before the collision. Minimum lateral separation was about 350 metres, but corrected SSR Mode C altitude information for the crossing traffic showed that it was at 2,750 ft amsl. The aircraft was traced and found to have been on a dual training exercise; neither the instructor nor his student had seen the Cessna 152.

Eyewitness information

The two aircraft were seen in close proximity by a number of people on the ground and in the air, some of whom witnessed the actual collision. One witness was flying a light aircraft in the area at about 3,000 ft and receiving an air traffic service from RAF Brize Norton. He stated that there was a thin cloud cover between about 3,000 and 3,500 ft, with good visibility. He did not consider that the position of the sun presented a problem in terms of lookout. The two aircraft were some way below him, perhaps about 1,000 feet agl, and some two or three miles distant. Although he did not see the actual collision, the witness recalled seeing the Cessna pitching up rapidly to what he thought was about 15º to 20º of pitch, possibly with the left wing low. It appeared to gain altitude before yawing and rolling to its left and pitching nose down. However, the aircraft then seemed to start to recover from the rolling manoeuvre just before it hit the ground. The witness notified RAF Brize Norton of the accident and, at their request, remained circling overhead whilst passing further information to ATC until the arrival of the emergency services.

All of the ground witnesses reported that both aircraft appeared to be flying normally, in straight and level flight, and that there was no significant manoeuvring by either aircraft prior to the collision. Most reported seeing wreckage falling immediately after the collision. All witnesses recalled that, at the point of collision or immediately after it, the Cessna yawed and rolled before entering a steep descent. Those that were aligned with the Cessna's track did not report any pitching motion, but

the closest witness, who was at some 45º to the Cessna's track and about 500 m from the point of collision, recalled an initial pitch-up and roll to the left, similar to that reported by the airborne witness. The same witness was also approximately in line with the Cessna's final descent and impact. He reported seeing the top surface of the aircraft as it descended steeply towards him, and being aware of the red anti-collision beacon (mounted on top of the fin). He thought he heard the engine cut out during the descent, and had the impression that the pilot was starting to recover from the dive but had not done so before the aircraft disappeared behind trees, after which the witness heard the sound of the ground impact.

Limitations of lookout

Maintaining an effective lookout for aircraft and other hazards is a prime task for a pilot, particularly when flying in uncontrolled airspace without positive radar assistance from Air Traffic Control. However, there are limitations in the human visual system that serve to make collision avoidance difficult by visual means alone.

The capacity of the human eye to resolve detail is not distributed evenly across the retina. The most central part of the retina is termed the fovea, and is composed only of cones - the light sensitive cells used for day vision. Cones provide high visual acuity, colour vision and contrast discrimination. Although there is good resolving power at the fovea, this ability drops rapidly only a few degrees away from it. Normal visual reflexes adjust the direction of gaze to ensure that the image of an observed object falls on the fovea for optimum resolution. Such vision, sometimes termed 'focal' vision, requires a stable image and the viewer's attention.

Away from the fovea, the density of cones reduces, and that of cells called rods increases. Rods are more sensitive to light than cones, and are used for day, night and low intensity vision. Rod vision is monochromatic and of low acuity, giving only outlines or shapes. It is, however, responsive to movement. It does not require the same degree of attention as focal vision and is important for spatial orientation and 'flow vision', which gives a sense of speed. Rod vision is sometimes referred to as 'peripheral' vision.

A distant aircraft will be perceptible to a pilot so long as it is acquired at or near the fovea. As an area of sky is scanned by the pilot, the eye naturally makes a series of jumps, or saccades, with intervening rests. The scene is only interrogated by the brain during the rest periods. A very small object may therefore be 'jumped over' or fall on an area away from the fovea – in either case it will not be detected. Each saccade-rest cycle takes a finite time and a full scan of an area of sky will take some seconds. An object missed early in the scan may have sufficient time to approach hazardously close or even collide before that area is scanned again by the pilot.

Two aircraft on a collision course maintain a constant relative bearing to each other until the moment of impact. The colliding aircraft will therefore appear in the same place on the aircraft's canopy unless the pilot makes a head movement. As the colliding aircraft is not moving relatively, it does not necessarily attract the attention of the peripheral vision system. The rate of increase in retinal size of the approaching aircraft is not linear and the image stays relatively small until very shortly before impact. Additionally, small targets may be hidden behind canopy arches or struts until very late. For these reasons pilots are taught not just to look around them, but to positively move their head as they do so.

Meteorological information

Information on the actual weather conditions was obtained from the Met Office, from the passenger's

photographs and from the airborne eyewitness. At the time of the accident there was a weak ridge of high pressure covering England and Wales giving generally fine weather, though with broken or scattered cloud at 3,500 to 4,000 ft amsl, ahead of a weak warm front which was approaching from the west. Visibility at the surface would have been 25 to 40 km, and airborne visibility likewise appears to have been good. The elevation of the sun at 1218 hrs was 14º and its azimuth was 184º. The surface wind was from 230º(M) at 5 kt, the wind at 1,000 ft was from 240º(M) at 15 kt and the wind at 2,000 ft was from 250º(M) at 20 to 25 kt.

Medical and pathological information

The 34 year old male student pilot of G-BNXC held a valid JAA Class 2 medical certificate, with no limitations or restrictions and no requirement to wear corrective lenses. A post mortem examination confirmed that the pilot died from multiple injuries consistent with having been caused by the ground impact. Toxicological examination revealed the presence of two therapeutic drugs, the presence of which may have been significant.

The first drug was either Ephedrine or Pseudoephedrine (it was not possible to distinguish between these two closely related drugs). Both drugs were available without prescription, being commonly used as nasal decongestants and bronchodilators. Concentration levels were within the normal therapeutic range. Both drugs have a range of potential side effects including headache, dizziness, anxiety, tremor and potential abnormalities of heart rhythm. According to the Civil Aviation Authority (CAA) Medical Department, these drugs, and the underlying reason for taking them, would normally be disqualifying for flight.

The second drug revealed by the toxicological examination was Scopolamine, at levels consistent with it having been taken at some time within the previous 48 hours. Scopolamine is also a non-prescription drug and can be used for the treatment of motion sickness as well as gastrointestinal disorders. The pilot had previously declared a medical condition to the CAA; the drugs he had been taking were acceptable to the CAA. However, Scopolamine has a wide range of potential side effects including drowsiness, fatigue, dizziness, blurred vision and the potential to affect many cognitive processes including visual functions. Scopolamine is also not acceptable to the CAA as a medication which may be used by someone in sole control of an aircraft.

The 62 year old male pilot of G-GHEE held a National PPL medical declaration form valid until 29 March 2008. The medical standards required for the countersignature of the form by the holder's general practitioner are equivalent to DVLA group 2 standard for professional driving. The pilot did not need to wear spectacles to meet these standards.

Medical requirements

The training syllabus for the issue of a Joint Aviation Authorities (JAA) PPL includes training in human performance and limitations. This training, under the section '*flying and health'* includes awareness training of drugs, medicines and their side effects. The pilot of G-BNXC had passed the ground examination in the above subject on 8 January 2005.

Medical requirements for holders of JAA licences are contained in Joint Aviation Requirements – Flight Crew Licensing 3 (JAR-FCL 3). JAR-FCL 3.040 *"Decrease in medical fitness"* deals with general medical advice to holders of JAA medical certificates, as well as the circumstances in which the holder of a medical certificate must seek advice from an authorised medical person. It also deals with significant injuries and illnesses, and

pregnancy. Further explanatory material is also given concerning medication, drugs, other treatments and alcohol.

JAR-FCL 3.040 includes the following paragraph:

> *"Holders of medical certificates shall not take any prescription or non-prescription medication or drug, or undergo any other treatment, unless they are completely sure that the medication, drug or treatment will not have any adverse effect on their ability to perform safely their duties. If there is any doubt, advice shall be sought from the AMS, an AMC, or an AME."* [1]

The CAA has reproduced much of the content of JAR-FCL 3.040 in various publications, including an Aeronautical Information Circular (AIC 99/2004) which dealt with medication, alcohol and flying and 'Safety Sense' leaflet number 24 – '*Pilot Health'* . An extract from JAR-FCL 3.040 is also reproduced on the rear of the CAA's JAA medical certificate, though this is limited to the need to notify the Authority when becoming aware of the need for the regular use of medication. The CAA's LASORS publication, which is aimed at providing general aviation pilots with a reference document on safety and licensing matters, also contains medical information, although it does not include any reference to occasional medication or self medication.

Rules of the air

The Air Navigation Order contains the Rules of the Air Regulations applicable to flights within the United Kingdom. In respect of powered aircraft, Rule 17 (2)(b)(i) states:

> *'... when two aircraft are converging in the air at approximately the same altitude, the aircraft which has the other on its right shall give way.'*

Rule 17(1)(a) states:

> *'... it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft.'*

Previous accidents and Recommendations on conspicuity

The AAIB investigated two mid-air collisions which occurred in 2004. The first involved two gliders from Lasham airfield on 26 April 2004 (AAIB Bulletin 5/2005), and the second involved a Robinson R22 helicopter and a Hybred 44XLR microlight aircraft, which occurred overhead Welham Green in Hertfordshire on 6 July 2004 (AAIB Bulletin 4/2005).

During the course of the investigations the AAIB made the following recommendations to the CAA:

Safety Recommendation 2005-06

It is recommended that the Civil Aviation Authority should initiate further studies into ways of improving the conspicuity of gliders and light aircraft, to include visual and electronic surveillance means, and require the adoption of measures that are likely to be cost effective in improving conspicuity.

Safety Recommendation 2005–08

It is recommended that the Civil Aviation Authority should promote international co-operation and action to improve the conspicuity of gliders and light aircraft through visual and electronic means.

Footnote

[1] Aeromedical Section, Aeromedical Centre, and Aeromedical Examiner.

The relevant extracts from the CAA's responses were as follows (in respect of gliders, the CAA has no regulatory powers to require the adoption of any recommended measures):

Extract from CAA's response to Safety Recommendation 2005-06

The CAA does not accept this Recommendation. However, the CAA will review its ongoing work on the use of visual and electronic measures to enhance the conspicuity of General Aviation aircraft, particularly in the light of impending wider transponder carriage. The review will be completed by 31 December 2005 and the CAA will then consider whether the adoption of such measures should be required."

Extract from CAA's response to Safety Recommendation 2005-08

"The CAA does not accept this recommendation insofar as it is directed to light aircraft. The promotion of international co-operation and action to improve the conspicuity of light aircraft through visual and electronic means will depend upon the outcome of the review noted in Recommendation 2005-06".

A CAA working group undertook a review of conspicuity enhancements for General Aviation (GA) aircraft. The working group reviewed statistical data, previous CAA studies and emerging technological developments related to GA aircraft collision and avoidance. The review determined that UK-registered aircraft had been involved in a total of 30 mid-air collisions in the period 1995 to 2004, resulting in 27 fatalities from 14 fatal accidents. Previous studies, both in the UK and in Europe had generally promoted 'see and avoid' principles as the most effective remedy, with various aircraft colour schemes and lighting systems also being proposed.

The working group reviewed aircraft colouring, aircraft lighting and light detection systems, and active systems for electronic aircraft detection. It noted that the most common colouring on civil aircraft is white, which affords some contrast against the surface and the sky, but which studies suggest may not be as effective as the contrast provided by dark and light colours together. For example, many civil police helicopters have adopted a yellow and black colour scheme to make their aircraft more visible and thus reduce the collision risk.

The working group also noted that, whilst technological alerting systems may be useful in supplementing the pilot's own lookout, their use may introduce other human factors issues such as reliance and resource management, whilst there were also installation costs and other practical considerations for aircraft owners. The potential introduction of wider carriage of transponders[2] in the UK from 2008 would provide an opportunity to reduce the risks of mid-air collisions, whether by direct detection or interrogation of the transponder, or by rebroadcast of transponder based information by a ground station. It was noted that a forthcoming Directorate of Airspace Policy Regulatory Impact Assessment (RIA) would include the wider use by GA aircraft of transponders and electronic traffic awareness systems, and it was considered that this process would be the most effective way of assessing GA community concerns in this area.

Footnote

[2] An aircraft transponder is a receiver – transmitter that generates a reply signal upon proper electronic interrogation by an Air Traffic Control ground station or other suitably equipped aircraft. The reply signal can be used to carry specific information relating to the aircraft in which it is fitted.

The working group identified areas worthy of further research and recommended that:

1. The use of contrasting colour and reflecting surfaces to improve the conspicuity in GA aircraft is investigated,
2. Increased publicity is given to the use of the 'see and avoid' principle and transponders,
3. Full support is given to the Directorate of Airspace Policy's RIA covering GA carriage of transponders and electronic traffic awareness systems.

Analysis

General

From eye witness accounts and recorded data it is clear that both aircraft approached each other in broadly straight and level flight, and that neither was in any obvious difficulty prior to the collision. Neither the Eurostar's pilot nor passenger saw the Cessna until it was too late to prevent a collision, and the flight path of the Cessna suggests that its pilot also did not see the other aircraft in time to influence the outcome, if at all. Rules of the Air Regulations require certain actions by pilots in order to avoid collisions. However, such actions are only possible if the pilots concerned are aware of the other aircraft's presence.

The Cessna pilot

The aircraft's flight paths were such that the Eurostar would have been in the forward field of view of the Cessna pilot during the entire time his aircraft was tracking towards the eventual collision site. As the Eurostar crossed ahead of the Cessna, the Cessna pilot initiated a slight turn to the right which, as his planned route took him directly overhead the airfield, would be unusual. There are two likely explanations for this.

One explanation is that the Cessna pilot saw the Eurostar crossing his flight path ahead and deviated to the right to ensure that he would pass safely behind the other aircraft, in accordance with the Rules of the Air. If such were the case, the Cessna pilot probably did not realise that the Eurostar was in fact turning, albeit gently, when it crossed ahead of him. Once the Eurostar had crossed ahead of the Cessna, the separation between the two aircraft was never greater than about 1,000 m, so the Cessna pilot should have had no difficulty keeping the Eurostar in sight. The fact that he subsequently lost visual contact with the Eurostar suggests that the Cessna pilot perceived the Eurostar to be flying on a track which would take it clear of the area, and he therefore ceased to monitor it.

An alternative explanation is that the pilot of G-BNXC turned deliberately to afford a better view of the disused airfield, and with the pilot occupying the left seat, this would naturally have been a turn to the right. The Fire Service College used a number of old aircraft and other vehicles for training purposes, and these were distributed about the site. Together, they presented an interesting collection and it is possible that the pilot wished to get a better view of them. Had this been the case, the pilot's lookout could have been less effective as he approached the accident area.

Based on eyewitness information, the Eurostar pilot's report, and the photographs taken by the passenger, it is probable that the collision occurred at between 800 and 1,000 ft above the disused airfield, which equates to between 1,236 and 1,436 ft amsl. The pilot of the Eurostar intended to operate at this height, but it is not clear why the Cessna was at such a relatively low height during a cross-country navigation exercise, particularly as the Cotswold Hills lay only 5 nm ahead on his track, with terrain rising to above 1,000 ft amsl. The pilot was

authorised by his instructor to fly at 2,500 ft amsl, which would have taken the aircraft over Moreton in Marsh at about 2,000 ft above the ground. The pilot had apparently planned to fly at 2,000 ft amsl, and although he did not report his altitude to the Air/Ground operator at Turweston, it is likely he would have been at or above 2,000 ft amsl at that point, as his track passed over the Turweston Air Traffic Zone, with an upper limit of 2,000 ft. Even at 2,000 ft amsl, the Cessna would have passed over the accident site in excess of 1,500 ft above ground level.

It is also unlikely that the Cessna pilot would have flown over Banbury at less than 2,000 ft amsl, so in all probability the pilot descended as he was approaching the disused airfield. It is unlikely that a technical problem caused the pilot to descend with a view to landing on the disused airfield as the runways, although clearly defined, were obstructed by buildings and other equipment, and the aircraft was not manoeuvring in a manner which suggested that the pilot had any intention of attempting a landing. In view of the aircraft collection on the ground at the Fire Service College, it is more likely that this was the reason behind the pilot's descent. If the Cessna were descending as it approached the disused airfield, it would have made visual detection of the Eurostar more difficult, as it would have been against a background of ground features rather than the sky.

The brief 'MAYDAY' which is presumed to have been made by the Cessna pilot after the collision, and the description of the aircraft's pitch up and final descent, suggests that the pilot had not been incapacitated in the collision but was attempting to recover the aircraft to controlled flight after it had stalled and rolled left into a steep dive. The damage to the aircraft's left wing and flying controls was such as to make a successful recovery uncertain from any height, and it is unlikely that the aircraft could have recovered in the relatively low height available.

The Eurostar pilot

As the Eurostar approached from the south-west, the Cessna would also have been in the pilot's forward field of view, and this would have been the case until the time that the Eurostar crossed the Cessna's projected track. From that time until about 30 seconds before the collision, the Cessna would have been in a rear quarter of the Eurostar, and thus unlikely to be detected, though it should be noted that the aircraft's raised 'bubble' canopy afforded good all-round vision.

However, from the moment that the Eurostar pilot commenced his right turn over the airfield, his attention would probably have been focussed to some degree towards the features on the ground which he knew his passenger wished to photograph, and away from the area to his left from which the Cessna was approaching. Even when the aircraft rolled wings level after its turn, part of the pilot's attention may still have been on the ground features, since the passenger had requested another orbit to take more photos.

Collision parameters

Simple 3D CAD models were created for both aircraft involved, in sufficient detail to allow the relationship between the patterns of damage sustained by each aircraft to be explored; in particular, the character and orientation of scrapes and paint smears observed on the Cessna's left outer wing and the distribution damage to the Eurostar's nose and engine. The analysis confirmed that the Eurostar had been tracking approximately at right angles to the Cessna, approaching the Cessna's left side, and that the lower segment of its propeller arc, lower engine cowl, and the upper part of the nose landing gear strut had impacted the Cessna's left wing end-on, approximately as illustrated in Figure 2. The precise attitude of the Eurostar in roll and pitch could not be determined, but neither was extreme.

Figure 2

Initial impact

The propeller damage on the outer leading edge of the Eurostar's left wing was consistent with it having made a glancing contact with the rear face of the Cessna's propeller disc. In order for this to occur, the aircraft must have yawed rapidly relative to one another during the collision sequence so that their flight paths were approximately parallel. The Eurostar's occupants report that during the collision sequence the canopy burst open. The absence of any collision damage to the Eurostar's (open) canopy or fin, together with the absence of any contact between its right wing and the Cessna's fin and rudder, suggest that the Eurostar had rolled to the left somewhat (relative to the Cessna) and *climbed over* the top of it before contacting its propeller, in the manner illustrated in Figure 3.

Pilots' field of view

In the final seconds preceding the collision the relative bearings between the aircraft were constant, meaning that each aircraft would have appeared to the other pilot to be stationary in the canopy or windscreen. The 3D computer models were also used to assess each pilot's field of view during the seconds before the collision.

Figure 3

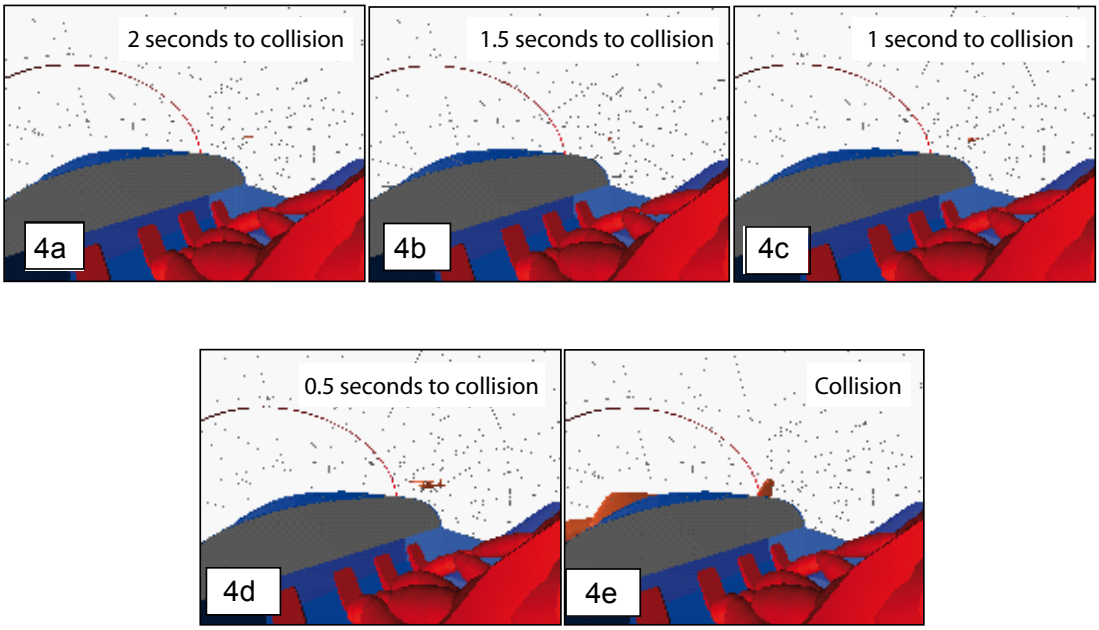
Final contact

This analysis suggested that, unless the Eurostar had been banked to the left, its pilot would have had a direct line of sight to the Cessna and that it would not have been obstructed by the instrument panel, cockpit surround or any other part of the aircraft. However, the angle subtended at his eye by the Cessna (ie the size of image formed on his retina), would have been very small and would have changed very little until the final second or so before the collision. If the Cessna had been in the Eurostar pilot's peripheral field of view, where visual acuity is poor and *rate of change* (movement across, or growth of image size on, the retina) is the primary factor in triggering a response, it is unlikely that he would have registered its presence in time to take effective avoiding action. Figures 4a through 4e mimic the images that would have been produced if a camera with a standard lens was positioned at the Eurostar pilot's eye position, pointed towards the Cessna, and the shutter triggered at half-second intervals during the final 2 seconds prior to the collision. The small size of the Cessna in relation to the overall field of view, even up to a very late stage, is clearly evident, as is its rapid rate of growth during the final half second.

A similar analysis to assess the Cessna pilot's probable field of view suggested that the Eurostar was likely to have been hidden behind the left screen pillar until about half a second prior to the collision, as shown in the sequence of *photo images* in Figures 5a through 5e. Had this been the case, then no effective avoiding action could have been taken by him in the time available.

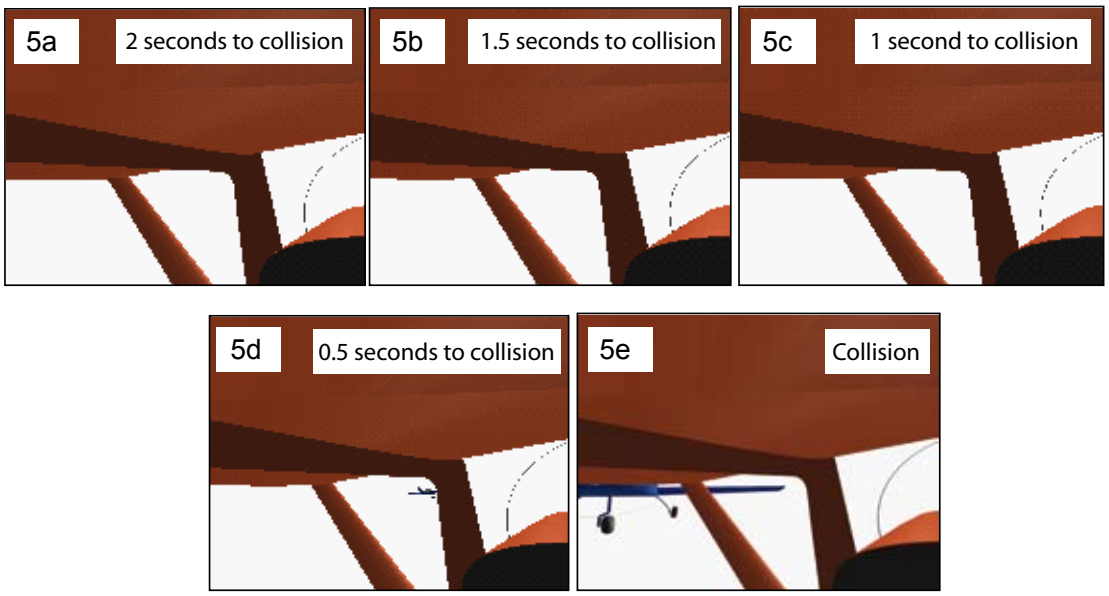
Pilot self-medication

The pilot of G-BNXC was found to have been taking two non-prescription drugs which may have affected his ability to operate his aircraft safely. The pilot would have been aware of the hazards of self medication, as these were covered during his ground training. However, the pilot had previously been taking medication, for a declared medical condition, which was approved by



Figures 4a to 4e

Simulated view from the Eurostar, G-GHEE



Figures 5a to 5e

Simulated view from the Cessna 152, G-BNXC

the CAA. He may have been unaware that other drugs used to treat the same condition did not carry the same approval. It is not known if use of the drugs themselves contributed to the accident, but the nature of their possible side effects, which include drowsiness and impairment of visual functions, is such that their use represents a potential contributory factor in the accident. Therefore the following Safety Recommendation is made:

Safety Recommendation 2006-117

The CAA should review the guidance that is contained in LASORS, such that the regulations regarding occasional medication, rather than just the regular use of medication, are emphasised.

Conclusions

The accident occurred because the pilots involved did not see each other's aircraft in sufficient time to take effective avoiding action. Each pilot's attention may have been focussed to some extent on ground features at the expense of lookout, and the Eurostar may have been obscured behind the left screen pillar of the Cessna. The geometry of the collision and the limitations of the human visual system are such that detection of the other aircraft by either pilot would have been difficult once they had each become established on a collision course.