ACCIDENT

Aircraft Type and Registration:	Medway Microlights Raven X, G-MYVW
No & Type of Engines:	1 Rotax 447 piston engine
Year of Manufacture:	1995
Date & Time (UTC):	9 June 2006, between 1332 hrs and 1412 hrs
Location:	North of Cliffe, Kent
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Student Pilot
Commander's Age:	41 years
Commander's Flying Experience:	40 hours (of which 18 were on type) Last 90 days - 7 hours Last 28 days - 7 hours
Information Source:	AAIB Field Investigation

Synopsis

The student pilot was briefed to fly a solo general handling exercise over marshland on the south side of the Thames Estuary. He had not returned to the airfield by the time the aircraft's fuel was known to be exhausted and a search and rescue operation was initiated. Approximately 24 hours later the crew of the Police Air Support Unit helicopter located the aircraft and the fatally injured pilot. There were no eye-witnesses and no recorded evidence. The investigation was unable to determine the cause of the accident.

History of the flight

The student pilot, who was also the owner of the microlight, arrived at Rochester Airport expecting to conduct a solo cross-country flight. He was near to completing the microlight private pilot's licence syllabus and this was one of the few outstanding requirements. However, the crosswind was outside his limits for the cross-country destination airfields, so the flying school's chief instructor briefed him to fly a general handling flight in the local area. His brief was to fly north to an area of marshland on the south side of the Thames Estuary where he would practise stalls, tight turns and simulated engine failures. This was the flying school's normal area for general handling and an area with which the pilot would have been familiar. During the briefing the instructor also confirmed with the student that he intended to depart with a full fuel tank; this was 25 litres, which was equivalent to about 2 hours' flying time. On completion of the briefing, the student self-rigged the aircraft; his instructor reported that he was entirely proficient in this procedure. The student informed the Aerodrome Flight Information Service Officer (FISO) that he was departing for a local flight and at 1244 hrs he took off from Runway 02L and climbed away to the north. The radar heads at Pease Pottage and Debden recorded that element of the flight where the aircraft was higher than approximately 2,000 ft agl, but were unable to record any other vertical profile information. The aircraft was first recorded at 1255 hrs, just to the north of Rochester, routing directly towards the marsh area and then flying a series of manoeuvres in the pre-briefed area. The manoeuvres were all over land and the recording finished at 1332 hrs. At this time the aircraft was approximately 5 km east of the accident site and heading in a westerly direction. There were no other confirmed sightings of the aircraft airborne after this time. The crew of a Police Air Support Unit helicopter located the aircraft and the fatally injured pilot the following afternoon. The accident site was on a sand and pebble beach that was mostly overgrown with weeds, just above the high tide mark of the estuary and below a sea wall.

Search and recovery

The aircraft departed Rochester Airport at 1244 hrs and was known to have an endurance of about 2 hours. When this endurance had been exceeded, the flying school instructors decided to commence a search of the area in which the student pilot had been briefed to fly. This search commenced at 1525 hrs, with the pilot's instructor and the chief instructor using a microlight to search the area whilst maintaining radio contact with the FISO at Rochester Airport. After they had searched the area for 80 minutes without success, the FISO informed the Distress and Diversion (D&D) cell at West Drayton that the aircraft was overdue and had exceeded its endurance limit.

The D&D cell began tracing action and information gathering in an attempt to locate the aircraft. This included contacting the Kent police force and informing the Aeronautical Rescue Co-Ordination Centre (ARCC) at RAF Kinloss that the microlight was missing. This action was unsuccessful in locating the aircraft and the ARCC launched a search and rescue helicopter from RAF Wattisham in Suffolk. The helicopter was flown to Rochester Airport to collect the microlight pilot's instructor and the search commenced at 1935 hrs. The search of the area continued until 2230 hrs, using thermal imaging equipment and a possible trace from the pilot's mobile telephone signal, without success. The local coastguard teams and lifeboats conducted a search of the rivers and marshland, again without success.

The following morning, the Police liaised with the ARCC with regard to the continued search and decided to use the Sussex Police Air Support Unit based at Shoreham. Their helicopter commenced the search at 1200 hrs and the crew located the accident site at 1245 hrs. The pilot, who had been fatally injured, was found next to the aircraft wreckage.

Overdue Action

CAP 410B '*Manual of Flight Information Services*' (MFIS), Chapter 11 entitled 'Overdue Aircraft' states in its introduction that:

> *'Overdue action is not related solely to the filing of a flight plan. If at any stage of a flight, the pilot has made his intentions clear and subsequently does not arrive or report when expected, FISO's should seriously consider taking overdue action'.*

The Manual also states that, with regard to radio-equipped aircraft, such as the aircraft involved in this accident:

if the fuel carried by the aircraft is considered to be exhausted…the FISO shall inform the Area Supervisor that the aircraft is fully overdue'.

In practice, at this airfield, this would mean informing the Distress and Diversion (D&D) cell at West Drayton.

Meteorology

An aftercast from the Met Office showed a high pressure system situated over the North Sea with a light to moderate south-easterly flow covering Kent. There was no cloud below 5,000 ft agl and the visibility was between 15 and 25 km, reducing to between 3 and 5 km in coastal mist over the Thames Estuary. The microlight school's chief flying instructor was flying in the same area and at about the same time that the accident occurred. He reported that there was light turbulence in the area and believed that at very low level close to the sea wall, there could have been significantly more turbulence, due to the effect of the wall disrupting an otherwise smooth airflow.

Pathology

The post mortem report concluded that the pilot died as a result of the multiple injuries sustained in the accident. The nature and pattern of the injuries indicated a relatively low energy impact and there was evidence at the accident site which suggested that the pilot had been able to undo his harness and remove his helmet following the impact.

Toxicological examination suggested that the pilot may have been using cannabis within hours of the accident. The post mortem report stated that:

'Experimental studies have demonstrated a wide range of effects of cannabis on cognitive functions and psychomotor skills, including impairment of information acquisition, working memory, divided and sustained attention, reaction time, tracking and motor control. While it is impossible to say whether the pilot would have been impaired by the presence of cannabis metabolites at the time of the accident, the possibility that he may have been certainly exists.'

The report also commented that:

'complex tasks such as flying are particularly sensitive to the performance impairing effects of cannabis and impairment may continue for many hours after the subjective effects (those felt by the user) have worn off. In fact decrements on performance have been demonstrated on pilots for up to 24 hours following the use of cannabis.'

The Air Navigation Order (ANO), Article 65, states that:

'A person shall not, when acting as a member of the crew of any aircraft or being carried in any aircraft for the purpose of so acting, be under the influence of drink or a drug to such an extent as to impair his capacity so to act.'

Description of the aircraft

The Raven X is a two-seat, weight-shift microlight aircraft of conventional layout and structure. The aerofoil shape of the wings is maintained by tubular battens inserted into channels sewn into the upper and lower fabric. The upper battens are cambered and retained in the channels by pockets at either end. When the wing is tensioned they are securely located in the channel such that only failure of the fabric or of the batten itself, or a loss of wing tension could allow it to spring out of position. The lower battens are straight and the majority are retained in the channels simply by friction when the wing is tensioned. In other words, they can slide out rearwards when the wing is slack but are reportedly immovable when it is tensioned. The outermost lower battens are, however, provided with an elastic cord device which provides positive retention.

G-MYVW was not fitted with the more usual fibreglass 'pod' around the lower parts of the trike, so that the pilot was fully exposed to the slipstream and his feet would merely have rested on the ground steering pedals or hung beneath the aircraft.

On-site examination of the aircraft

The aircraft and its pilot lay on a sand and pebble beach just above the high tide mark of the estuary. The right wing was standing leading edge down whilst the left wing lay flat on the ground and partially folded across the right wing root. The trike, still attached to the wing, lay in an almost inverted attitude with the two mainwheels in the air and the nose landing gear separated from the rest of the trike, lying on the beach. It was evident that the pilot had undone his lap-belt and appeared to have rolled out of his seat, removing his gloves and helmet and seemingly extracting his mobile telephone from (presumably) a pocket in his flying suit: the mobile phone was switched on. His injuries would have precluded any attempt at walking. It was noted that a nearly-full, 20-litre jerry can of fuel had occupied the rear seat, and had been secured by tying the rear seat harness around it.

The wooden 2-bladed propeller had broken tips which, in both cases, had led to a breaking-away of the trailing edge, leaving the leading edge undamaged. In one case, the trailing edge was missing and not found but on the other blade the trailing edge remained loosely attached at the root. Also not recovered, despite extensive searching, was the pilot's right shoe.

The only items not present at the main accident site, apart from the propeller pieces and the pilot's shoe, were two right wing lower battens, one from the tip and the other from about third span from the root. The latter was found about 30 metres south of the wreckage, stuck into the earth at the top of the sea wall whilst the former was lying on the ground to the south-west, on the landward side of the base of the wall.

Examination of the various structural cables showed that the two rear flying cables running from the 'A' frame aft to attach to the wing keel had failed, as well as the cross-tube tension cable and its backup cable. In addition, one of the luff lines[1] and the right wing landing wire had failed, but apart from these all the other cables were intact (see Figure 1). Further information and discussion of the cables is contained later in this report.

Subsequent examination of the aircraft

The microlight was transported to the AAIB facility for further examination. This did not reveal any pre-impact anomalies but the failed rear flying cables were selected for detailed examination, since the failure mode of the swaged fittings did not appear to be that of a properly-made swage. Essentially, the terminations of the cables are constructed by doubling the cable back on itself around a looped fitting known as a 'thimble' (see Figure 2). Two copper ferrules are then crimped around the two strands of cable, normally using a hand tool which squeezes the ferrules down to a smaller dimension. This dimension is checked using a simple 'go / no-go' gauge – if the joint has been properly swaged, and using the

Footnote

[1] Luff lines are small-diameter cables which run from the king post to attach to the wing fabric at various points along the trailing edge. Their purpose is to prevent distortion of the trailing edge during certain flight manoeuvres. In-flight failure of one of these cables should not prove catastrophic.

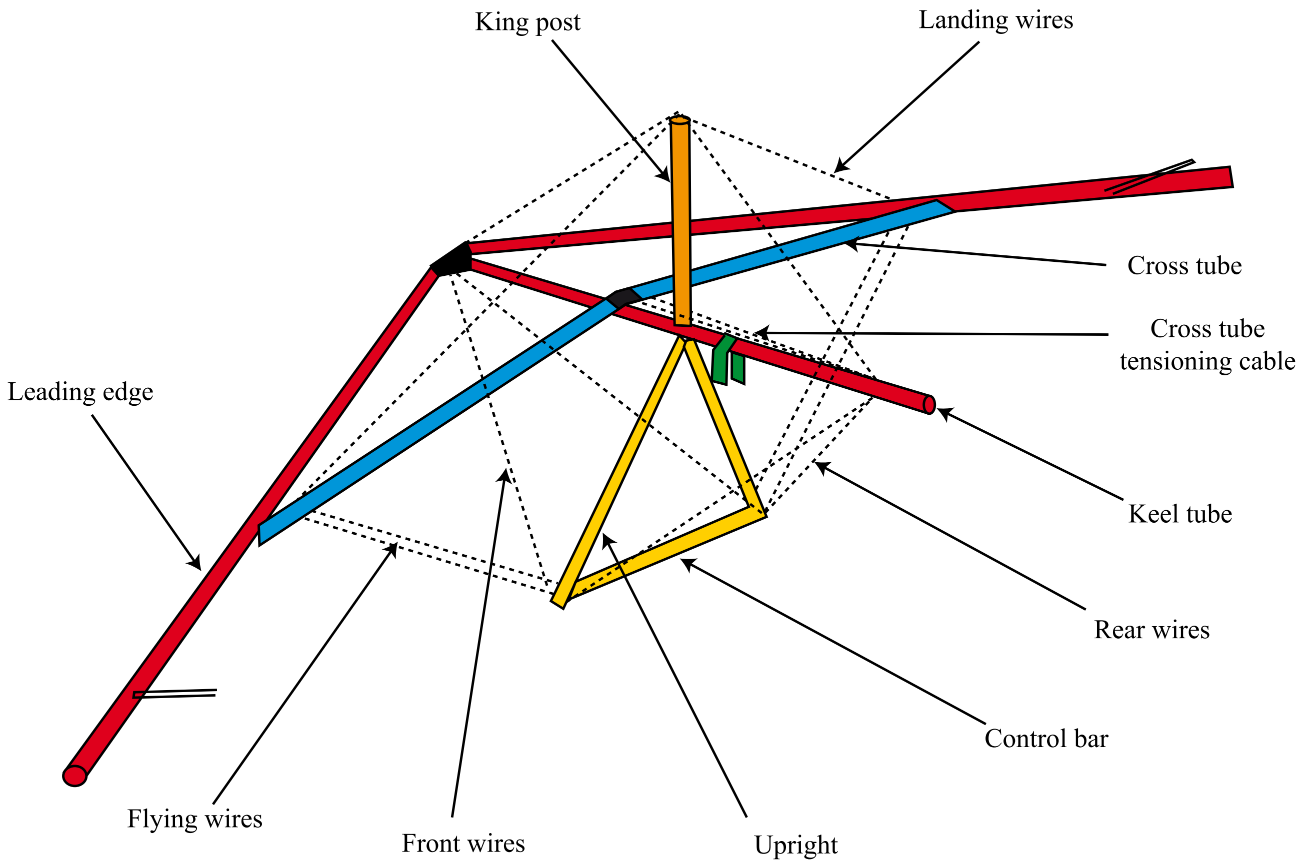

Figure 1

Sketch of generic weight-shift microlight wing to illustrate some of the nomenclature referred-to in the text

appropriate ferrule, it will fit into the gauge and should guarantee that the copper fitting has flowed closely up against the cable strands and gripped them tightly. A correctly formed joint should be stronger than the cable itself and thus a tensile overload force applied to the cable typically causes failure of the cable adjacent to the joint and not at the joint itself.

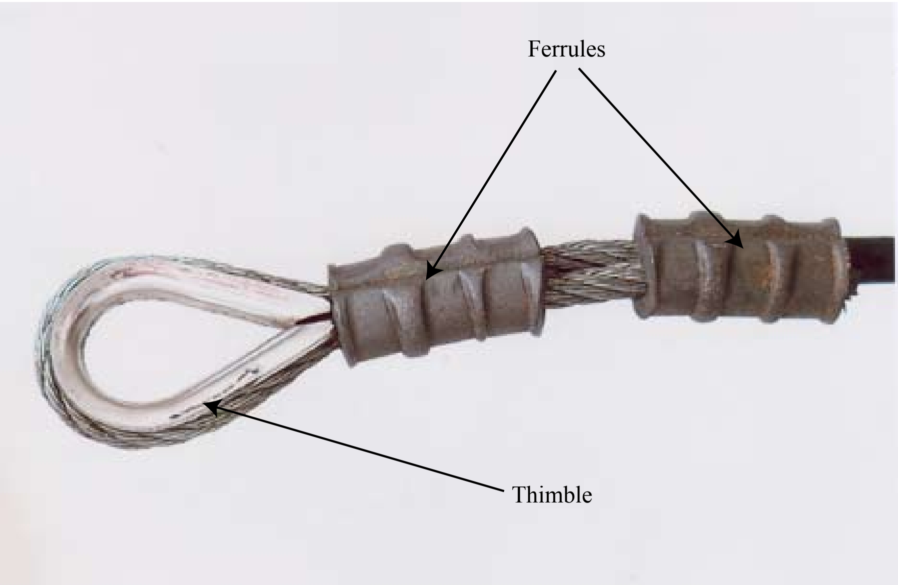

Figure 2

Intact swaged joint

In the case of G-MYVW, the rear flying cables had pulled through the swage fittings at one end (see Figure 3), leaving just a thimble attached to each side of the 'A' frame.

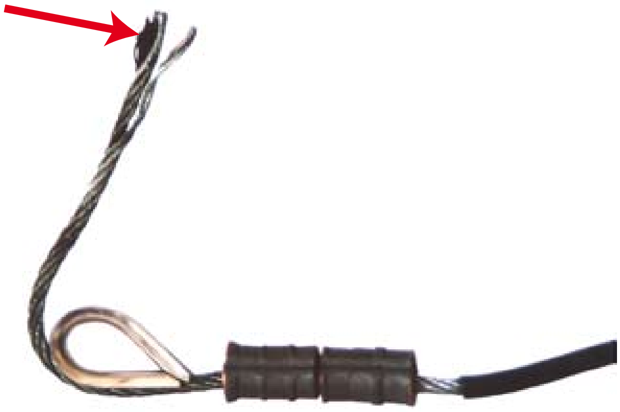

Figure 3

Broken rear cable from G-MYVW
Note that the cable has pulled through the ferrules and the fibre core (arrowed)

If these cables were to fail in flight, the aircraft would almost certainly be uncontrollable, since any attempt to put forward pressure on the control bar to raise the nose would have little or no effect. A recent case of failure of these cables on a different model of microlight, but of a similar layout, resulted in an accident. In that case, the free ends of the cables had also trailed backwards and struck the propeller.

There was absolutely no evidence that this had happened to G-MYVW, but the anomalous failure mode warranted further investigation. It was noticed that the cables themselves were of unusual construction. Most aeronautical wire cables are constructed of mild or stainless steel throughout: the failed cables clearly had the centre core strands made from a black, non-metallic material, probably polypropylene. Such cables are usually called 'fibre-cored' and do not appear to have found many applications in the aviation industry. In this case, the cables were of the specified 3 mm diameter, but the design assumes that 7 x 7 steel-cored cables will be used. This terminology indicates that the cable is made from seven groupings each containing seven strands, thus there are 49 metal strands in each cable. Fibre-cored cable of the same diameter would be termed '6 x 7', indicating that there are only 42 metal strands.

Consultation of the cable-makers' data for steel and fibre-cored cables of the same diameter indicated that there is not, surprisingly, much difference in the Ultimate Tensile Strength (UTS) of either variety; the fibre-cored type having about 7% less UTS. However, the manufacturer of the hand press tool, Nicopress, which was used to make the swages, confirmed that it was never intended for use on fibre-cored cable because the tool compresses the fitting down to a pre-determined dimension. The greater compressibility of the fibre core would mean that the copper fitting does not form itself around the outer strands as was intended. This was confirmed when several unbroken swages from G-MYVW were sectioned (see Figure 4).

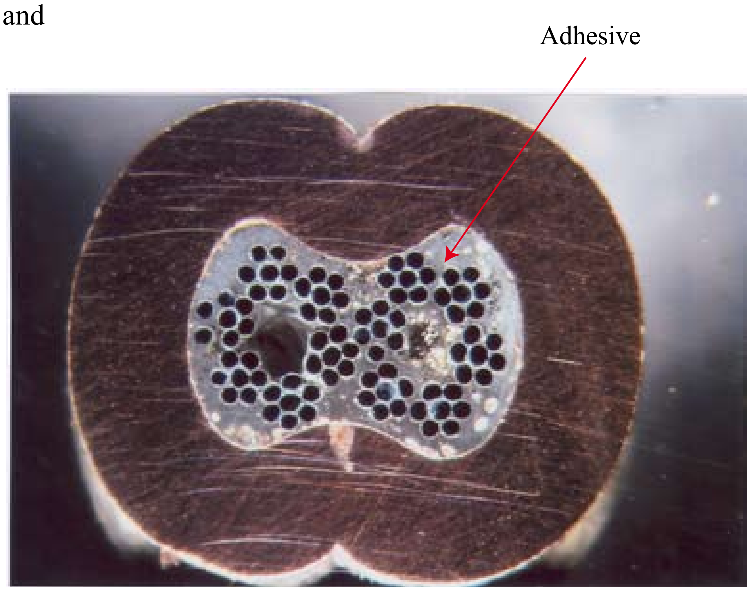

Figure 4

Section through an unfailed swage, showing poor grip of the cable strands by the ferrule. Note that the fibre core is not readily apparent (although present) and that the grey material filling the voids is cyanoacrylate adhesive, applied to stabilise the assembly during sectioning

All of the 3 mm cables on G-MYVW were fibre-cored, so it was decided that these cables, including the unbroken ends of the failed cables, would be subjected to a destructive 'pull' test to explore their UTS. Of the six swages subjected to the test, the highest value recorded was 5.5 kilonewtons (kN) and the lowest value was 3.67 kN before failure, all of which resulted in pulling of the cable through the swage. It was noted, however, that in all cases the cable was starting to pull through the swage at values considerably lower than the ultimate – one as low as 2.5 kN. The value at which correctly assembled steel cables failed was nominally in excess of 6 kN.

Detailed examination concluded that the swaged joints were of poor quality, probably as a result of the use of fibre-cored cable. In comparison, some original cables supplied by the manufacturer, and of about the same age as those fitted to G-MYVW, were significantly stronger and the swaged joints were satisfactory. Considerably greater strength would have been achieved if the correct cable had been used.

Tracing the origin of the errant cables proved inconclusive. The original manufacturer of G-MYVW produced documentation to show that he had purchased a bulk supply of the correct specification at the time the aircraft was made. The first owner of G-MYVW confirmed that he had not had to change any cables during his period of ownership (1995-2006) and there was no mention in the aircraft log book of any replacement of cables. All cables on the aircraft appeared to be of similar age, suggesting that the deceased owner-pilot had not changed any.

Analysis

Conclusions from on-site observations

Determining the precise attitude of the aircraft at impact was difficult because the nature of the ground meant that no clear ground marks had been left. However, the right wing was much more damaged than the left, with signs of ground contact along most of the span of the leading edge. It was therefore judged that this wing had struck the ground first. The 'snoot' at the extreme front of the trike had also made hard nose-first contact with the ground, causing failure of the keel further aft. It therefore appears that the aircraft's attitude at impact was about 30º nose-down but banked to the right.

The aircraft's speed must have been relatively low, since crashes at such extreme attitudes, whilst at normal flying speeds, would usually result in immediate fatality. Consideration was given to the possibility that the two battens found some distance away from the rest of the wreckage indicated that there had been a mid-air failure and loss of wing tension, allowing them to be released. However, they both showed damage consistent with the wing striking the ground (the inboard batten was bent when it should have been straight) and it was concluded that they were somehow ejected on impact and propelled through the air for a considerable distance. Failure of the cross-tube tension cables would be expected in this kind of impact and later examination confirmed that they had failed in overload.

The condition of the propeller blades was difficult to explain, since they both indicated a strike on the tips only, the leading edges otherwise being devoid of damage. If they had struck the ground during the impact sequence, then more leading edge damage (and possibly failures at the root as well) would be expected. A search was conducted for any evidence that the aircraft had first struck the ground or an object somewhere other than where it came to rest but no such evidence was found, although the nature of the terrain made this search extremely difficult. However, it is possible that the broken propeller pieces were thrown into the river estuary. There was no obvious explanation for the pilot's missing shoe.

Conclusions from examination of the cables

Despite the use of non-standard fibre-cored cable, several factors suggest that in-flight failure of the rear cables was not responsible for the accident:

- The nature of the impact and the momentum of the pilot's weight on the control bar could produce enough force to fail even cables made to the correct specification; in other words one would expect these particular cables to fail on impact.
- Although the strength of some of the cables was degraded, it appears that the lowest values measured were still higher than the calculated loads experienced by them, even in high 'g' manoeuvres.
- There was no sign of contact with the propeller which might be expected bearing in mind previous accidents where the rear cables had failed.
- Although it is possible that the cable may have been progressively pulling through the swages over a period of time without being noticed, this was not borne out by microscopic examination, which suggested that the pull-through occurred as a single event.

Nevertheless, the possibility of in-flight failure of the cables could not be completely eliminated and the fact remains that use of the type of tool employed to make the swages was inappropriate for fibre-cored cables and so the following Safety Recommendation is made:

Safety Recommendation 2006-126

The British Microlight Aircraft Association should promulgate the information that fibre-cored cables should not be used on aircraft, unless specified by the manufacturer, and that the Nicopress swaging tool was not designed for fibre-cored cables and will therefore not produce a correctly swaged joint.

Operational issues

The investigation into the cause of this accident was hampered by the lack of available evidence. Once the aircraft had departed from the airfield boundary there were no eyewitness accounts of its movements. This was not surprising, however, since the flight was probably over sparsely populated marshland. The pilot was not carrying Global Positioning (GPS) equipment so the only trace of the aircraft's routing came from the primary radar returns from radar heads located at Pease Pottage and Debden. Analysis of the recorded data did not reveal anything unusual; it was all within the pre-briefed manoeuvring area, all over land and consistent with the pre-briefed general handling exercises. The radar recording terminated 48 minutes after the aircraft took off from Rochester when it must be assumed that it descended below the height of radar coverage which is approximately 2,000 ft agl in this area. At this point, the aircraft was approximately 5 km east of the accident site and heading towards it. The actual time of the accident is not known but, based on the amount of fuel retrieved from the wreckage, it must have occurred within about 40 minutes of the last radar recording. In reality, it was probably much less than this since it is likely that there was leakage of fuel after the accident.

During this period the aircraft probably remained below 2,000 ft agl where it is possible that the pilot was carrying out simulated engine failures. It is also possible that he may have practised low flying along or close to the sea wall. This is a fairly common practice for microlights flying in this area and the student pilot had flown along the sea wall with his instructor on several occasions to practise low flying techniques. It is of note that he was heading towards the sea wall in the direction of the accident site when radar contact was lost. The broken propeller blade and pilot's missing shoe suggest that there may have been some ground contact prior to the final accident site but the initiating event for this accident cannot be determined.

The presence of cannabis in the pilot's body compounds the difficulty in understanding the circumstances regarding this accident. Although it is not possible to say whether Article 65 of the ANO was contravened, the possibility that cannabis may have impaired his judgement and/or handling of complex tasks cannot be excluded.

It is also evident from the pathologist's report that the accident was potentially survivable; indeed it appears the pilot attempted unsuccessfully to make a mobile telephone call after the accident. Thus it is worth considering why the pilot was not located earlier and ways in which survivability could have been improved.

If the crew of an aircraft are unable to provide any notification of an accident and there are no eyewitnesses (as in this accident), tracing action does not normally commence until the aircraft is identified as being overdue. Identifying an aircraft as overdue relies on a flight plan or knowledge of takeoff time and endurance. In this case the pilot was a student on a pre-briefed exercise for there was no flight plan and so only the flying school would have known when his endurance had been exceeded. In order that the FISO can fulfil the CAP 410B requirement to inform the area supervisor as soon as '*the aircraft's fuel is considered to be exhausted'*, the aircraft's endurance must be made available.

The microlight school instructors knew the area in which the student pilot had been briefed to fly and their reconnaissance of the area allowed the search to commence at the earliest opportunity. The FISO, when made aware that the aircraft's endurance was exceeded, began tracing action and then contacted D&D when the instructors' initial search proved fruitless. It would have been possible to save time by contacting D&D as soon as the fuel was known to have been exhausted because the first actions of D&D are also to begin tracing action and there is likely to have been duplication of effort at this point. There is a degree of reluctance for some airfields to involve D&D immediately after an aircraft has exceeded its endurance as aircraft, particularly those that have the ability to land on unlicensed fields, occasionally land elsewhere without informing ATC. However, informing D&D initiates a chain of events that, due to their resources and experience, are likely to resolve an overdue aircraft incident in the most expeditious manner.

It transpired that the microlight school's chief instructor had almost certainly flown over the accident site during his initial search but the black and yellow upper wing surface and pilot's dark green flying suit made the site relatively inconspicuous from the air (see Figure 5). Manufacturers now use white as the default colour for the upper wing surface but bright clothing and reflective strips would also improve visual conspicuity. Some microlight flying schools advocate the carrying of a switched-on mobile telephone in order to provide a signal for rescue services to use should incapacitation prevent a call being made. This accident demonstrated that a mobile telephone signal alone cannot be relied

Figure 5

upon to guide rescue services directly to the accident site. An alternative and more accurate method would be to use a personal locator beacon. However, their use does depend on positive initiation of the beacon which may not be possible if the occupant is incapacitated.

Follow-up action

As a result of this incident the Rochester Airport Airfield Director issued a memo on 22 August 2006 which requires the airport FISO's:

> *'to record the expected time of duration of the 'local' flights from Rochester. This information is to be recorded on all relevant flight strips enabling us to initiate prompt overdue action if required. Whenever possible a call should be made when a flight is longer than briefed in order to confirm everything is well. A revised ETA should be obtained'.*

Conclusion

The lack of available evidence and witness information meant that the cause of this accident could not be identified, although it did appear to be potentially survivable. Despite the use of non-standard fibre-cored cable, the evidence suggests that an in-flight failure of the rear cables was not responsible for the accident. Nevertheless, the possibility could not be completely eliminated. A number of factors delayed the discovery of the accident site and the airfield has put in place a procedure to reduce one of these. The lack of visual conspicuity and on-board location equipment also contributed to the difficulties of accident site detection. However, it is the Distress and Diversion cell in conjunction with the Aeronautical Rescue Co-Ordination Centre that have pre-eminence in search and rescue operations and their inclusion at the earliest stage gives the greatest likelihood of a successful outcome.