Aviation Safety Digest

ASD 138
SPRING 1988

Aviation Safety Digest is prepared by the Civil Aviation Authority and is published by the Australian Government Publishing Service. It is distributed to Australian licence holders (except student pilots), registered aircraft owners and certain other persons and organisations having an operational interest in safety within the Australian civil aviation environment.

Distributees who experience delivery problems or who wish to notify a change of address should contact:

The Publications Distribution Officer (EPSD)
Civil Aviation Authority
P.O. Box 1986, Carlton South, Vic. 3053, AUSTRALIA
Telephone (03) 667 2733

Aviation Safety Digest is also available on subscription from the Australian Government Publishing Service. There is a subscription form in this issue. Inquiries and notifications of change of address should be directed to:

Mail Order Sales
Australian Government Publishing Service
G.P.O. Box 84, Canberra, A.C.T. 2601, AUSTRALIA
Telephone (062) 95 4411. Telex AA62013

Subscriptions may also be lodged at Commonwealth Government Bookshops in the capital cities.

The views expressed in the Aviation Safety Digest are those of the editor or the individual contributor and are intended to stimulate discussion in the fields of aviation safety and related areas. They do not necessarily reflect the policy of the Authority. The articles are intended to serve as a basis for discussion and even argument in an effort to identify and resolve problem areas and potentially hazardous situations.

Unless otherwise noted, articles in this publication are based on Australian accidents, incidents or statistics.

Reader comments and contributions are welcome but the editor reserves the right to publish only those items which are assessed as being constructive towards flight safety.

Reader contributions and correspondence should be addressed to:

The Editor,
Aviation Safety Digest
Civil Aviation Authority
G.P.O. Box 367,
Canberra, A.C.T. 2601, AUSTRALIA

ISSN 0045-1207
R85/979(10) Cat. No. 87 1577 8

Printed by Ambassador Press Pty Ltd
51 Good Street, Granville, N.S.W. 2142, AUSTRALIA

Contents

Editor:	*David Robson*
Editorial Assistant:	*Karen Hutchison*
Graphic Design:	*Lesley Boulton*
	Peter Garfield
	Soussanith Nokham
Photographs:	*BASI*
	RAAF
	Colin Owers
	Neil Follett
	Keith Meggs
	S. J. Toomey
	G. Taberner
Art:	*David Robson*

Statement by Mr Collin Freeland, AO

Chief Executive, Civil Aviation Authority

Almost certainly all readers of the Digest are conscious of the major changes currently taking place in the industry and in the administration of aviation in Australia.

A new era is emerging with the forthcoming economic deregulation of the domestic industry and the advanced levels of technology now used in civil aviation in Australia with the introduction of state-of-the-art aircraft like A320, B747-400 and F50. Paradoxically, this is happening at a time when we are also facing problems with an aging fleet of GA aircraft. Another growing concern is the increasing evidence that Australia does not possess the pool of aviation skills and expertise to cope with all these changes. Shortages are evident in both the flight crew and aircraft maintenance areas. We are also facing the need for a major modernisation of our airways systems.

The Government has created the Civil Aviation Authority (CAA) in response to the emerging complexities and difficulties that were facing both the industry and the old Department. The new Authority became operational 1 July 1988 and has responsibility for safety and operational regulations as well as the business of providing air traffic services.

The Authority has been designed to provide a more responsive and flexible infrastructure to facilitate the provision of services and the regulatory framework for aviation. The main mechanism for achieving this will be the removal of the Authority from the constraints of the Government budget cycle by placing its operations under the control of a Board with membership from the business community and the requirement that it operate in a business like way in providing its various services.

The Government has also established the Air Safety Regulation Review for streamlining and modernising the operational and safety regulations and thus providing the environment wherein the Authority and the industry can work in closer co-operation to maintain Australia's outstanding safety record. The Government has made it clear that the Authority will be required to give primacy to safety considerations over commercial ones and that ample resources, including necessary legislative compliance tools, will be provided to ensure that safety regulation and surveillance are in no way diminished.

Both the Authority and the industry are facing challenges and opportunities which if met with determination, imagination and co-operation can enrich the aviation industry to the benefit of all Australians. For my part, I intend to see that the Authority performs and provides cost effective support to the travelling public and the industry. I believe that, in this endeavor, I will have your support and co-operation and that we can all lift our sights above our own or sectional interests — to view the interests of the community at large and that of the industry as a whole.

As far as safety promotion is concerned the CAA will maintain the initiatives sponsored by the Department. The Aviation Safety Digest will continue to perform its vital role and will continue to respond to the safety needs of the aviation community. It will also continue to be supplied free-of-charge to encourage and promote informed discussion on flight safety topics.

The Safety Promotion area will actively follow the already established program of videos, posters and brochures that has been so well received by the industry.

The program of co-operative seminars and workshops with AOPA and other organisations will continue and I believe may need to grow to meet the increasing demand. We will also be exploring ways for RPT operators to become actively involved in similar programs.

Aviation in Australia is entering an exciting phase — one where significant technological and economic development will bring new levels of operational efficiency — and one where co-operatively we can set new levels of aviation safety.

C. W. FREELAND

Editorial

The moving finger writes and, having writ, moves on . . .

As the first fleet sailed into Sydney 200 years ago, we had already experienced our first aviation fatality, two balloonists killed while attempting to cross the English Channel in 1785 — that's right, three years before white settlement in Australia.

It was over a hundred years later that gliders and then powered aircraft were developed. However, we soon learnt most of the ways to kill ourselves.

When we study modern day accidents there is little difference in the types of aviation accidents. The reason is fairly obvious — the same humans with the same limitations are piloting, maintaining and controlling them.

It is mainly since the last world war that we have really made great inroads into understanding the nature and weaknesses of the human machine. I believe we can now make significant progress towards safer flight — if each of us strives to admit and to compensate for our individual and collective characteristics. Time marches on but we don't have to accept the same accidents as inevitable. We can do something about it — individually.

Time marches on for editors too. This issue is my last as editor of the Digest. I would like to thank you all for your support, encouragement and constructive criticism over the past two and a half years. I wish you smooth air, clear skies, gentle breezes and safe arrivals for all your future flights.

DAVID ROBSON

Oh 'g' what can the matter be?

THE BUILDER/OWNER/PILOT was making his first visit to the Hunter Valley Gyro Club's strip at Bowmans Crossing but was well known to many of the members.

He had arrived at the strip at about lunchtime and assembled his gyroplane.

At about 1700 the pilot took off and carried out a demonstration of his machine's abilities, as he often did at this type of gathering. He then flew off to the south of the strip, out of sight of the camp area. It was reported that he usually disappeared after his displays, to fly by himself for half an hour or so.

One of the club members away from the camp area reported watching the aircraft leave the strip and head south towards the area where the accident ultimately occurred. He reported seeing it descend into wind (towards the west) very low, then climb steeply, make a steep left turn onto a reciprocal heading, descend out of sight behind terrain, reappear climbing and make another steep left turn back into wind. The aircraft again descended out of sight but this time failed to reappear.

The witness rushed to the club area and advised that he thought the aircraft had gone down. While vehicles proceeded towards the area, another club member took off and located the wreckage from the air.

The mature age pilot had previously enquired about 'blackouts' and had told his friends that he had occasionally felt 'woozy' during some manoeuvres. He had asked to fly in a Decathlon to see if the effect was the same as he had been experiencing.

After the official party had arrived and the opening ceremony had commenced, the pilot of the Mustang was cleared to position his aircraft to the north-east in preparation for a low run to the south-west over the field. As the airfield was about to be declared officially open, the Mustang was cleared to start its pass.

As he rolled into a turn the pilot of the Mustang lowered the nose and descended with increasing speed towards the strip.

The aircraft crossed the aerodrome boundary at a height of 2-300 feet and continued to descend to 150 feet. The speed was estimated at 250 knots during the pass and the pilot then pulled the nose up 30 degrees, climbed to 1500 feet and turned for a second run.

The aircraft then approached the strip at a lower height than the first run but after being warned about power lines, the pilot abruptly checked the descent. The aircraft was held down to cross the field at 270 knots and again climbed at 30 degrees. The pageant organiser then requested an additional run and the pilot acknowledged.

The aircraft continued its steep climb to about 1500 feet and rolled into an almost vertically banked turn to the right. Almost immediately the nose dropped and the Mustang flicked into a roll to the right for two and a half turns as the flight path changed to a descent angle of 30 degrees.

At a height of 800-1000 feet, the aircraft appeared to hesitate on its back with the nose down at 45 degrees, then fell in a tight descending spiral to the right making about four more turns before disappearing from view. A few seconds later black smoke rose from the direction of the lost aircraft.

Because the evidence of a number of witnesses clearly indicated the turn at the end of the second run was quite tight, consideration was given to the possibility of the pilot having lost control as a result of blacking-out under high flight loads or having become incapacitated in some way. However, as he appeared to lose control early in the 180 degree turn it was considered most unlikely that he would have been affected by 'g' force to any appreciable degree by that stage. *Furthermore, the onset of blackout is progressive and the condition can be relieved promptly by easing the back-pressure on the elevator controls, so reducing the load factor.*

This account is from a *Digest* of some years ago. It is interesting to note the apparent unawareness of the possibility of G-LOC without prior symptoms and the insidious effects of mental confusion and possible disorientation that may follow G-LOC.

As a result of all the above accidents which to some extent are 'unexplained', I have asked our Human Factors expert, Dr Harry Rance to explain a few aspects of 'g' to us.

G-LOC the twilight zone

by Dr Harry Rance

The Bureau of Air Safety Investigation (BASI) suspects that a number of otherwise unexplained accidents following aerobatic manoeuvres, may have 'g'- related disorientation, confusion or even loss of consciousness as their cause.

It is therefore opportune to discuss some of the effects of acceleration on the human body and to present some data on acceleration levels which can occur in ordinary, non-competitive, aerobatic flying.

What is 'g'?

Load factor, or 'g' is the ratio of the acceleration applied to the aircraft compared to the normal acceleration due to gravity. Hence it is a measure of the effective weight that is felt by the aircraft (and the pilot's body). Thus 4 'g' represents a force which is four times that of gravity.

Acceleration is of course, the rate of change of velocity (speed or direction). It is associated with changing speed or flight path and consequently, manoeuvring involves almost continuous changes in 'g'.

Accelerations may be of several types:

- linear — as in accelerating or braking
- radial — as in a turn (centrifugal force)
- angular — as in rotation about an axis (when the ice skater spins).

In an aircraft we feel:

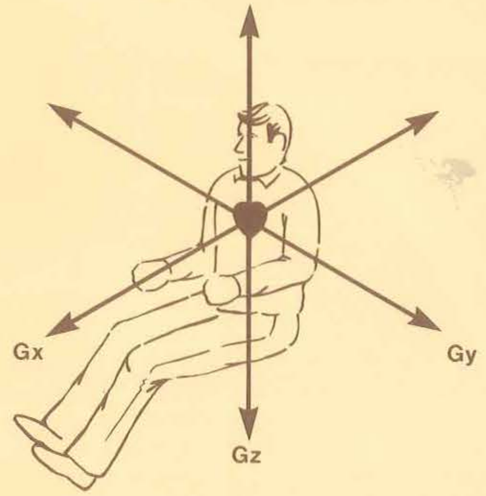
- linear accelerations when we take-off and land, slip or skid and pull up or pitch down
- radial accelerations when we turn the aircraft and in fact, we feel the resultant reaction to both centrifugal force and gravity
- angular accelerations when we displace the ailerons suddenly and cause the aircraft to accelerate to a rapid roll.

Linear accelerations are the most significant and of those, the accelerations through the vertical axis of the body have the most noticable effect.

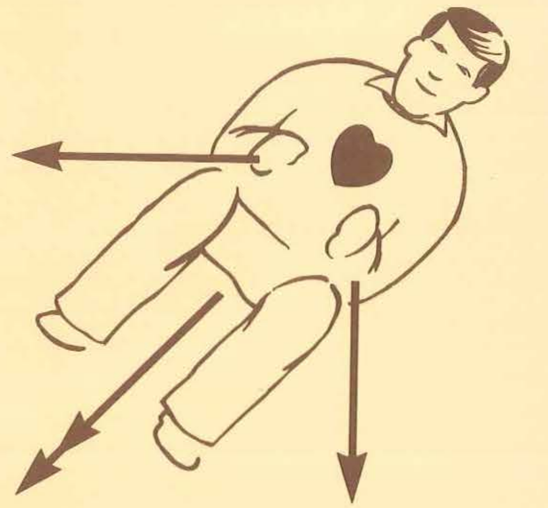
To change flight path the pilot alters the angle-of-attack of the wing which therefore generates an excess of lift. This excess lift accelerates the aircraft in that direction and causes a change in flight path. The aircraft structure responds and the seat (in the case of positive vertical acceleration) pushes the pilot's bottom in the new direction. The pilot's spine is then compressed as the lower body causes the upper body to change direction.

Finally the neck accelerates the head in the new direction. While all this is happening the pilot feels that his head and upper body are pushing down when in fact the lower body is pushing up against the inertia of the upper parts.

Acceleration may be applied in any direction. Linear accelerations are usually described in relation to the human body, by reference to three orthogonal (right angled) axes passing through the heart — lateral, longitudinal and vertical. Vertical acceleration is correctly abbreviated as Gz but more commonly, 'g' is used.



Vertical acceleration is what you feel when you go over a bump in the car. Lateral acceleration is felt when you go around a corner. Longitudinal 'g' is felt when you accelerate or brake. You rarely feel lateral 'g' in an aircraft because it is banked like a motor-cycle — so the resultant acceleration is felt as a vertical acceleration.



The vertical axis is the most significant in terms of physiological effects (except perhaps for the massive longitudinal deceleration experienced in a sudden stop!). With positive acceleration (+g) the inertial reaction (the tendency to 'slump') is away from the head and is often known as 'eyeballs-up' acceleration.

Negative acceleration is consequently called 'eyeballs-down'. The response of the body to 'g' depends on a number of factors including the magnitude, direction, duration and rate of application of 'g' (also called the rate of onset).

Differences between individuals are also important and may be critical. The important features of a body's reaction to 'g' revolve around the changes in effective weight of various parts of the body and the shift of body fluids — particularly the blood supply.

At +3g it is difficult to rise from the seat, at +5g you cannot raise your head and at +8g, the hands cannot be raised although you can still move your fingers.

Additionally, under these positive accelerations the internal organs of the body are pushed down.

Body fluids, especially the blood, will tend to shift down and pool in the lower parts with a consequent reduction in supply and pressure at the level of the brain.

Normally at +1g, as you sit reading this *Digest*, the blood pressure at the brain is 75-80% of the pressure at the level of the heart. If you are subjected to +4.5g (a typical value in a loop) the blood pressure at the brain will theoretically be reduced to 1% — not enough to support brain function.

Further, the heart will be forced down and further exacerbate the situation. In practice the body compensates to maintain blood flow to the brain — pressure sensors in the main arteries to the brain sense the reduced pressure and as a result the output of the heart is increased in an attempt to keep up the supply of blood.

If +Gz is sustained for a long period, then blood will begin to pool in the lower limits and lower trunk. The amount of available circulatory blood will be reduced and a consequent reduction in flow to the brain will occur and eventually lead to loss of consciousness.

This period of unconsciousness is followed by at least 12-15 seconds of extreme confusion and disorientation during which co-ordinated control of the aircraft becomes impossible.

The pilot will not remember the event — an effect similar to the amnesia associated with hypoxia or lack of oxygen. In addition you may lose consciousness you will be aware of changes to your vision. Initially there will be some loss of peripheral visual field (tunnel vision) and an overall 'greying' of the vision (loss of colour or grey-out) followed by a total loss of vision.

These are all good reasons to be careful before any flying but more importantly, before flights where you will be deliberately applying 'g'.

There is also a group of persons who are placed at risk by their activities. These people have a high level of aerobic fitness which leads to a low pulse-rate and blood pressure. These 'fit' people actually start at a disadvantage when exposed to 'g'.

What about negative 'g'?

Negative 'g' usually occurs with inverted or 'outside' manoeuvres and inverted spins. The body is less able to cope with negative 'g' and quite low values will produce severe decrements in performance. The disturbances to the body are mainly related to the cardiovascular system. Exposure to minus-one g produces a fullness and pressure in the head which is very disagreeable. Minus two may produce small haemorrhages in the skin of the face and neck. The blood pressure and flow of blood to the head rises and the body responds by slowing the heart in an effort to compensate.

Rate of onset of 'g'

I have been discussing the effects of 'g' but there is a further factor — the rate of onset. The prominence of the warning signs and the reaction time to compensate for the effects of 'g' reduce at high rates of onset of 'g'. In military aviation there have been instances of pilots losing consciousness without having any of the visual symptoms — and these pilots are current and wear anti-'g' suits.

The rapid onset of 'g' prevents the compensatory mechanisms from having any worthwhile effect. Loss of consciousness occurs when the oxygen reserves of the brain are used up — five seconds or less. This phenomenon has become known as g-induced loss-of-consciousness — or 'G-LOC'. In military experience, the levels have been as low as +2g and it is possible that many reports have been withheld because loss of memory has erased the incident.

It should be pointed out that you don't need to be in a high-performance jet aircraft to be susceptible to G-LOC. It can be experienced in most aerobatic aircraft if you use high values of 'g' or high rates of application — and it is accentuated if you pass from negative to positive 'g' in a short time.

G-LOC can result in loss of control and ground impact during the period of lost consciousness or subsequent disorientation and mental confusion.

How to avoid G-LOC

- Be aware of the problem, the dangers and the possible lack of symptoms.
- Avoid flying when other stresses exist.
- Practice the anti-'g' straining manoeuvre.
- Undergo a fitness program to build-up muscle strength (as distinct from an aerobics program).

G-LOC the BASI Casebook

This article is a summary of a BASI report, available to interested parties from government bookshops. BASI will be sensitive to possible cases of G-LOC in future and I would appreciate advice from pilots of any similar experiences.

Introduction

THE BUREAU of Air Safety Investigation recently conducted research into the rates of 'g' onset and 'g' levels experienced by a light aircraft pilot during normal aerobatics. The objective was to relate data obtained from the research to other data available from military authorities, in order to evaluate the possibility or otherwise of a light aircraft pilot sustaining 'g'-induced loss of consciousness (G-LOC) during aerobatics.

The research followed a fatal accident in Australia during 1987 involving a pilot who was practicing an aerobatic sequence in a Bellanca 8KCAB Decathlon aircraft.

The Bureau fitted a Decathlon aircraft with appropriate instrumentation to enable acceleration values in three axes to be recorded during a sequence of ten aerobatic manoeuvres.

Circumstances of the particular accident which initiated the research

The purpose of the flight was to practice an aerobatic sequence of ten manoeuvres in preparation for a competition. The pilot had arranged for an observer to assess his performance from the ground, and there were several other pilot witnesses to the sequence of events.

It was known that the pilot intended to practice the following sequence of manoeuvres:

. A one-turn spin
. Roll-off-the-top of a loop
. 270 degree horizontal turn using 60 degrees of bank
. 90 degree turn in the opposite direction using 60 degrees of bank
. Loop
. Reverse ½ Cuban 8
. ½ Cuban 8
. Aileron roll
. Stall turn
. Barrel roll

The pilot commenced aerobatics over the aerodrome, probably at 4000 feet, but apparently stalled while inverted at the end of the second manoeuvre the 180 degree roll-off-the-top of the loop. There was witness evidence that the pilot had heard on the preceding day that it was not possible to perform one and half rolls-off-the-top of a loop in a Decathlon and evidence that he was anxious to attempt such a maneouvre on the day of the accident.

After recovering from the inverted stall the pilot continued with aerobatic manoeuvres, but it was not possible to determine from the evidence whether he continued with the planned sequence, recommenced the sequence, or performed some other sequence of aerobatics.

Although it was considered impossible to perform one and a half rolls-off-the-top in a Decathlon, there was no means of determining whether the pilot was in fact attempting to fly such a maneouvre. Equally, an aerobatic pilot would be aware that to lengthen the manoeuvre from a half roll to one and a half rolls would require some combination of a higher airspeed and/or tighter loop prior to attempting the manoeuvre.

However, after completing a number of manoeuvres following the inverted stall, the aircraft was observed to enter a steep spiral dive which continued without any apparent control input until it struck powerlines, caught fire and fell to the ground, killing the pilot.

Investigation

An intensive examination of the wreckage did not reveal any pre-existing mechanical defect.

No evidence was found of any physical or psychological factors which might have impaired the pilot's flying ability.

Consideration was given to the possibility of temporary loss of consciousness of the pilot induced by the positive Gz forces associated with the aerobatic manoeuvres being flown. The question of G-LOC arose due to a number of witness comments which strongly suggested that the manoeuvres were flown with unusual tightness. Such comments, if correct, would not be inconsistent with an attempt, or attempts, by the pilot to complete a one and a half rolls-off-the-top maneouvre.

Although there was no evidence to show that the pilot in the Decathlon accident had suffered G-LOC, equally it was difficult to ignore the consistent witness evidence concerning the tightness with which the manoeuvres were apparently flown. For example, one pilot witness described some of the high-g manoeuvres prior to the descent to the ground as being the most excessive manoeuvres he had ever seen during ten years of observing aerobatics over the particular aerodrome.

Conclusions

The research undertaken by BASI was on a relatively small scale due to limitations of available resources. It would require a more comprehensive experimental design, duplication of measuring and recording devices and a much greater degree of repetition across a representative sample of pilots before fully validated conclusions could be drawn.

Nevertheless the project successfully explored in a broad-brush fashion the order of magnitude of Gz changes and their durations during aerobatics in a light aircraft. It provided information useful to the particular investigation and to the aviation community in general.

There can be little doubt that instantaneous G-LOC is a real possibility in such aircraft. International studies have revealed that the phenomenon is a possibility in medically normal individuals at levels as low as +2 to +3Gz. In recent surveys in the RAF, USN and RAAF numerous occurrences of G-LOC have been disclosed involving aircraft similar to the Decathlon in performance.

These latter surveys have shown that approximately 20% of military pilots have either suffered loss of consciousness themselves, knew someone who had, or had seen someone lose consciousness. The possibility that civilian pilots may have generally lower G-LOC thresholds than military pilots cannot be ignored, not only because of possibly different fitness levels but because of a number of other factors including a lower frequency of exposure to Gz amongst civilian pilots. The effect, if any, of aging on tolerance is largely unknown. Now that we know it's a possibility in civil aviation we must all be doubly cautious □

G-LOC summary

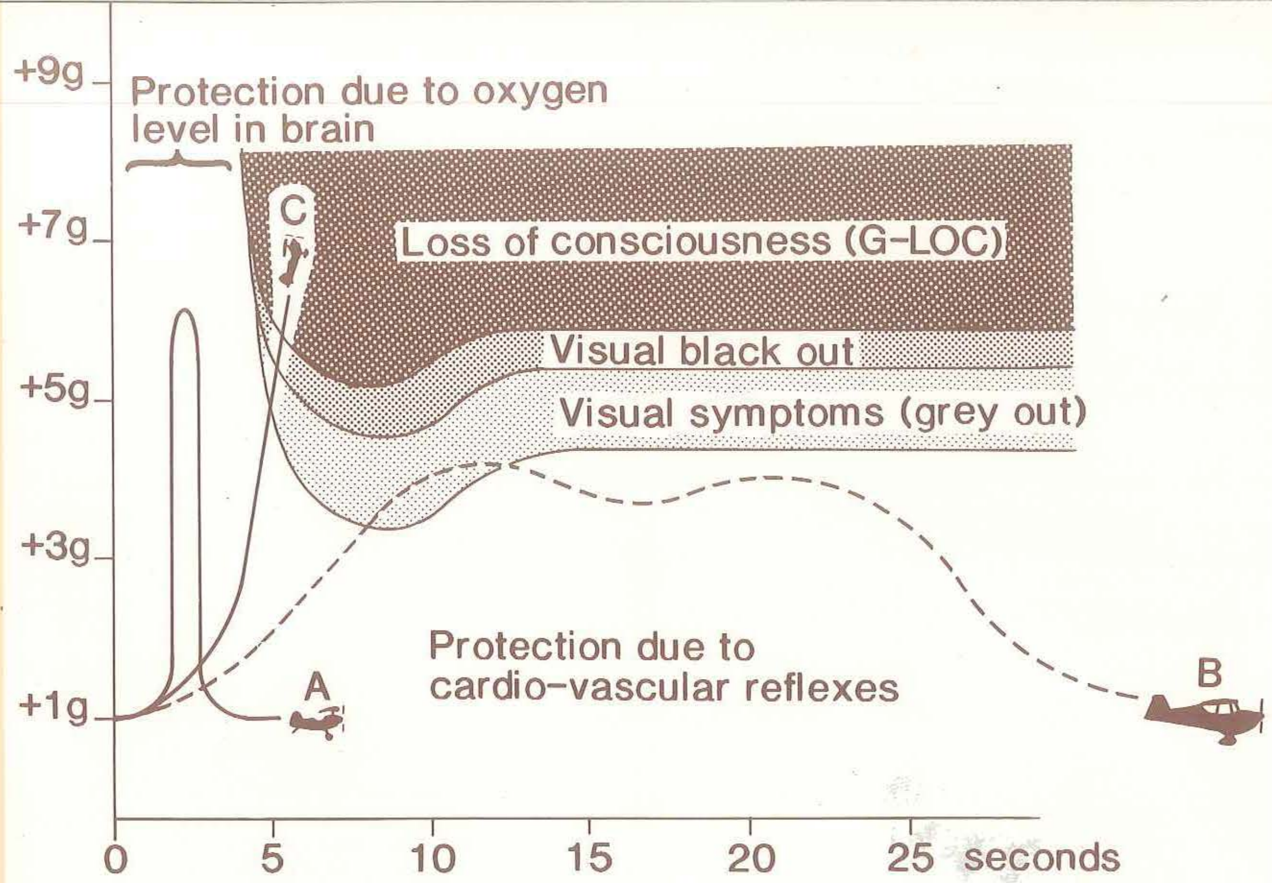
I was interested to read an account in the EAA magazine, 'Sport Aviation', of the flight characteristics of the BD-5. The pilot reported that the manoeuvring flight characteristics were excellent because of the quick response and low stick forces required. These manoeuvring characteristics were not completely without fault, however, as he noted in the following incident. During a photo flight, he was overtaking the photo aircraft (Cessna 175) at a high closure rate. He elected to reduce speed by executing a quick 360 degree turn. He banked sharply and abruptly applied back pressure. Instantly all reality with the outside world disappeared and he 'woke-up' in a slightly banked, nose-down attitude. The 'g' meter indicated slightly over +3g. He was confused and couldn't understand why he had blacked out at such a low value of 'g' and why there were no prior symptoms.

There was no narrowing of field of vision, no grey-out — just instant loss of consciousness. The next day an article in 'Aviation Week' discussed a new phenomenon known as GLC (loss of consciousness due to 'g') which had been experienced by fighter pilots in highly manoeuvrable aircraft such as the F15 and F16. The loss of consciousness without prior cues was attributed to rapid rates of onset of 'g'. The following week the same pilot flew the BD-5 in turning manoeuvres and noted that he could go to about +3.5g before some narrowing of vision occurred. In these turns he tightened his stomach muscles (a part of the anti-g straining manoeuvre) and applied the 'g' load gradually.

However, when 'g' was applied rapidly, GLC effects set in as previously noted. Apparently the BD-5 with its inherent quick pitch response and low stick force gradient (approximately 2 lb/g as compared with about 8lb/g for a typical GA aircraft) was capable of simulating a basic problem encountered with some digitally-controlled, fly-by-wire fighter aircraft.

This brings to light another aspect. If the stick force gradient is high then it is likely that the semi-conscious pilot would release the applied 'g' during the manoeuvre and therefore soon recover. However, with a low stick force gradient and especially if the aircraft was trimmed for a lower speed (higher angle-of-attack) then the 'g' would be sustained during the period the pilot was blacked-out and he may not regain consciousness at all before impact with the ground.

Further, the side-stick controller fitted to both the F16 and the BD-5 may have some influence in allowing the 'g' to be sustained.



A.rapid onset, brief period 'snatch-pull' such as corner or square loop.

B.smooth onset - sustained such as normal loop normal symptoms

C.rapid onset - sustained, such as high 'g' sequence of manoeuvres. Few or no symptoms before loss of consciousness.

CAUTION: The vertical scale is an "average". Some pilots on some days may find their band of symptoms is as low as +2g.

G-LOC is a known phenomenon but it's not as simple as we first thought. The guidance I can offer is:

- Be cautious about any aerobatic or high 'g' manoeuvring routine.
- Practice the same sequence and gradually work up to the full 'g' values.
- Fly one aircraft type for these sequences or start from scratch if you have to use some other aircraft.
- A normal aerobatic sequence can be flown without requiring more than +5g for more than five seconds. Be conservative about higher values or more sustained periods.
- Try to avoid going directly from a high value of negative 'g' to a high positive value. Use a wing-over or similar manoeuvre in between.
- Condition your body to high 'g' slowly and maintain a high level of medical and physical fitness.
- For a display routine I set maximum continuous power in level flight and trim the aircraft for a high cruise speed. I don't touch the trim during the display as this gives me a constant and continuous feel in terms of stick force and stick position of where I am in relation to applied 'g' and the stalling angle-of-attack.
- Try to plan the high 'g' manoeuvres so that they end in an upward flight path.
- Plan sequences to include low 'g' escape routes in case you become disoriented or 'lose-the-place'.
- Plan sequences for a smooth transition from one manoeuvre to the next and avoid high rates of onset or 'snatch' manoeuvres.

G-LOC is a loss-of-consciousness which can lead to loss-of-control due to the unconsciousness itself or to the subsequent confusion and disorientation.

Like any other form of loss-of-control it requires time and space from which to recover. That time and space has to be allowed for when you plan the routine — long before you take off □

It started with a hissssss . . .

From Rainhill to Bass Strait: Aviation accident investigation's railway heritage

James Walker is and has been the Historical Officer for the Department for over five years. This article arose because of James' academic interest in railway history and his professional interest in aviation history.

BEFORE THE coming of mechanical transport, loss of life while travelling was normally caused by shipwreck — which did not affect the majority of the population. While coach accidents were far from rare, the comparatively low speeds involved and lowness to the ground, meant that fatalities were unusual. The advent of the railway was to change that state of affairs. Reactions (and techniques) which were adequate for a coach lumbering along at four miles per hour were not so with trains running at forty miles per hour.

The problem was quickly made apparent on the opening of the Liverpool and Manchester Railway when the President of the Board of Trade, Huskinson, was run down by the 'Rocket' driven by Joseph Locke. The 'Rocket' had no brakes, and there was no time to pin down the brakes on the carriages. Another major cause was Huskinson's panic on meeting an unprecedented situation.

The problems which confronted the early railway men were without precedent. There was much to learn. The learning process was to be accelerated by the inspecting officers of the Railway Department of the Board of Trade. The Department, including the Railway Inspectorate, was set up under the Railway Regulation Act of 1840. The measure was received with a great deal of opposition. Many engineers resented what they regarded as interference. Brunel claimed that no one would co-operate with the inspectors. Daniel Gooch was later to refer to 'minute and irresponsible interference.' Their view was the common one. On the other hand, George Stephenson, in a letter to the President of the Board of Trade, dated 31 March 1841, supported the new regime. One of Stephenson's reasons was the inexperience of many of the engineers and contractors engaged in railway construction.

The inspectorate was set up to inspect and certify new lines before they opened. The Act had not given them any powers to investigate accidents. Indeed, statutory provisions on inquiries were not enacted until 1871, although the 1840 Act did require the railway companies to submit returns of all accidents involving personal injury. This, however, did not stop inspectors carrying out investigations. The first investigation of an accident involving passenger facilities was in December 1841. Eight third class passengers had lost their lives and seventeen had been injured, when a Great Railway goods train, with two passenger carriages attached, ran into a 'slip' in Sonning cutting. The inspector's report exonerated the Company from blame for the accident, but criticised the arrangements which had passengers travelling in open trucks in a goods train.

The lack of statutory powers for these investigations forced the inspectors to rely on the co-operation of the railway companies and their officers and employees. On the surface, it is surprising that such co-operation was so often forthcoming. Two factors appear to have been important in achieving this. One was the social activity of the inspectors. Pasley, the second Inspector-General, 'attended a party given by the Secretary of the London & Birmingham Railway, was the guest of the engineer whose line he was about to inspect and drank champagne with the Secretary of the Great Western Railway'. Other staff of the Department acted similarly. The policy was eminently successful. So successful, indeed, that some inspecting officers later joined the railway companies. Captain Coddington, with the inspectorate from 1844 to 1847, then became Secretary of the Caledonian Railway. Sir Henry Tyler became Deputy Chairman of the Great Eastern Railway. These officers were, in their turn, able to ease the acceptance of other inspectors.

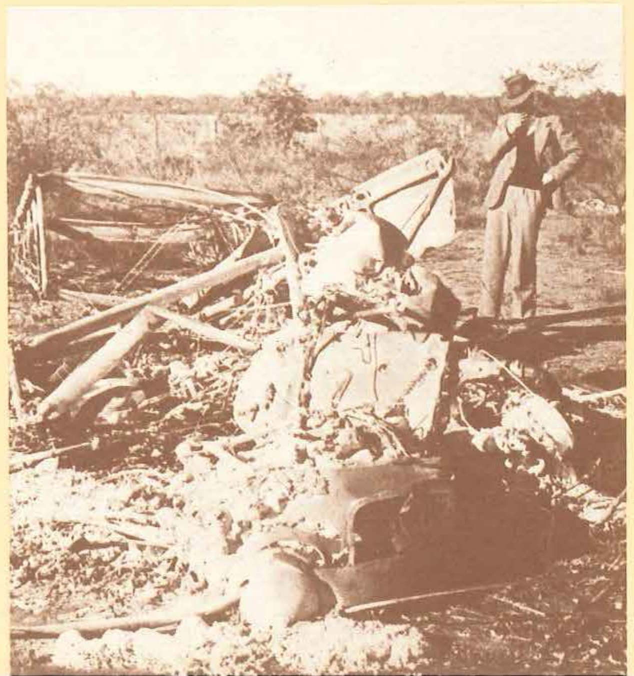
The other factor was the growing realisation that the activities of the Inspectorate had benefits for the companies. Boards of smaller companies, made up of men with little knowledge of

railway construction and operations, often welcomed a report which was independent of the companies' officials. Engineers and operating staff found the inspectors, because of the wide range of their activities, had much to contribute. Probably of more importance was that inquests into accidents, usually technically uninformed, could be highly embarrassing to the companies — as the juries preferred, when in doubt, to blame the companies. The report, issued with official sanction by a competent engineer, could, and often did, correct these tendencies. However, to gain the benefits, the companies had to exercise at least a minimum of co-operation with the inspector and to give at least lip service to the recommendations of his report. Even so, if the recommendations involved spending money, the companies would normally try to avoid it.

Many accidents in the early years were caused by boiler explosions. Two engine crews were killed at Bromsgrove on 10 November 1840 when the boiler of their engine exploded. Year after year there were further incidents. The year 1864 saw three particularly bad explosions. As corrective measures were applied, the number of incidents decreased but three men were killed, and another three injured by a boiler explosion as late as 1909. There were two major causes of the explosions. One was excessive wear of boiler plates, the other faulty safety valves. There were two needs. One was for regular boiler inspections by qualified staff. The other was for thorough pre-journey checks of valves and gauges by the engine crew. It was the investigation reports which first drew attention to these two needs.

Another major cause, breakage of tyres, springs and couplings, further emphasised the need for inspections. Many people can still recall the sound of the wheel tappers, checking the carriage tyres. What was being learnt was that nothing could be taken for granted.

Causes which were the most puzzling for investigators were those involving decisions, or lack of decisions, by operating staff, and especially by footplate crew. Unfortunately, those who



made the mistake were often amongst those killed. The accident causes could be divided roughly into excess speed, failure to obey signals and lack of caution in foggy conditions. A good example of the former was the accident at Grantham on 19 September 1906. In this incident the driver and fireman were killed instantly. It is still not known why the train approached Grantham station, where it was due to stop, at excessive speed. This was one of three such accidents within a period of two years.

The classic example of the misreading of signals was the Aisgill tragedy on 2 September 1913, when the driver of an express mistook the aspect of a distant signal, then ran through a stop signal into the back of the preceding train. November 1870 saw a good example of lack of caution during fog at Harrow, when seven people were killed, including the driver, who was criticised in the report for driving too fast in view of the poor visibility, and for over-riding the signals which had been set against him.

Doesn't it all sound familiar?

When, in 1919, the rising number of aircraft accidents caused extreme concern in the British public, it was natural for the Government to turn to precedents. Consequently, the Accidents Investigation Branch was organised in the Air Ministry under Colonel Clifton Brown of the Royal Flying Corps. The Branch investigated accidents to both civil and military aircraft. Its position was formalised under the Air Navigation Act of 1920, supplemented by the Civil Aviation (Investigation of Accidents) Regulations of 1922, 1925, 1930, and 1935.

In 1945, the Branch was transferred to the new Ministry of Aviation, which was in turn, absorbed in 1953 into the Ministry of Transport and Civil Aviation.

Throughout the period to World War I, the rail inspectorate had relied on persuasion, rather than on compulsion, even when the means of compulsion existed. The heads of the inspectorate resisted pressures for more direct government control. They largely saw it as a question of responsibility. Direct supervision or control by the government would divide, and so weaken, responsibility. The inspectors believed that final responsibility must remain with the railways themselves. All the government could do was to try to bring about reform by persuasion and pressure of public opinion.

Because of this, the Board of Trade commenced to publish the accident reports and the annual accident statistics. There were two reasons for this. One was to apply pressure on the culprit managements. The other was to spread the lessons learnt as widely and quickly as possible. (This of course is the same reason for publication of the *Aviation Safety Digest*.)

This approach proved itself on the railways of Britain. By the time many safety measures had been enacted by Parliament, they were already in widespread use, due to the urgings of the Railway Inspectorate. Similarly, new safety practices are generally introduced in civil aviation long before their legal enforcement.

In Australia, we followed the UK precedents. From the start, officers of the Civil Aviation Branch investigated aviation incidents in Australia. In 1927 the Air Accidents Investigation Committee was formed. In 1946 the Accident Investigation Branch was formed in the Directorate of Air Transport and External Relations. The same year also saw the creation of the Accident Studies Branch of the Directorate of Air Navigation and Safety.

But it took a little longer to learn from the Railway Inspectorate experience, which had shown the need for close co-ordination between those looking at general trends and those investigating particular incidents. This was corrected in the 1952 reorganisation when the two Branches were combined into a new Accident Investigation Branch, which reported to the Director General. Early in 1982 there were proposals to expand the Air Safety Investigation Branch into a multi-modal Investigation Branch, similar in operation to the National Transportation Safety Board in the United States, but this proposal was dropped when the Department of Transport split in May 1982. Under the new Department of Aviation, the Branch became the Bureau of Air Safety Investigation, with direct reportage to the Secretary of the Department, and some direct access to Minister. We have now reached the situation where an active Safety Promotion Section has been formed and will be part of the Civil Aviation Authority. BASI will retain its independent, purely investigative role.

Australia's first fatal aviation accident was on 28 March 1917 when a Sopwith biplane crashed into Port Phillip Bay.

The pilot, Basil Watson, was killed.

In the years 1931 and 1932, a total of 276 accidents, forced landings and mishaps occurred. Of these 13 accidents were fatal and 18 people were killed. There were 205 aircraft on the register, of which 173 had airworthiness certificates. There were 601 licensed pilots and 170 government aerodromes and emergency landing grounds.

Now, over fifty years later the aviation scene is far more complex. Nevertheless, Australia has achieved an enviable aviation safety record — one which will require continuing vigilance — [and a tapping of wheels] □

A backwards look at forecasts

Bureau of Meteorology

METEOROLOGICAL services to civil aviation commenced around 1920. The early services were very generalised, as can be seen by the forecast provided to the aircrew of the 'Southern Cloud' for its flight from Sydney to Melbourne on the morning of 21 March 1931:

'Cloudy and unsettled with rain and thunderstorms from the north at first, but with a cooler southerly change over the state from the west over the weekend'.

The forecast was in fact provided to the pilot at Mascot by phone from the Sydney Weather Bureau very early that morning and based on a weather chart of 9am the previous day. After the aircraft departed, the subsequent observations showed conditions were much worse than originally anticipated, but with no on-board radio there was no way of conveying this vital information to the crew. After passing Goulburn, the aircraft would have encountered severe frontal conditions causing massive drift, low cloud, squally winds, severe icing and turbulence; the aircraft crashed into the Snowy Mountains, the wreck not being discovered for another 27 years.

Following the crash of the 'Southern Cloud' more specialised services were provided to civil aviation. Individual forecasts were provided to each flight and these included information on wind and cloud along the route. Until 1948 most aircraft operated below 10 000 feet, but in the next 11 years, they flew at increasingly higher levels. Appropriate forecasts were required for these new type of operations and the emphasis changed. Until the advent of the turbo-jet era in 1959, aircraft were still frequently operating in cloud. Jet aircraft were above most of the weather when operating at their normal cruising level, but they frequently encountered jet-stream strength winds.

A remarkable growth has occurred in aviation in Australia in the last 30 years; there has been a four-fold increase in the number of aircraft on the Australian register. To cater for the rapid growth and diversification of aircraft types there has been a trend from individual forecasts to advices covering many flights. Area forecasts are provided for 35 areas for low level users; these provide forecast information on the temporal and spatial variations in all elements of concern.

The type of information contained in present day low level area forecasts would have been of inestimable value to the crew of the 'Southern Cloud' on that fateful day in 1931.

For higher level users pictorial significant weather prognoses are available.

In addition:

- In 1957 SIGMET advises were developed to provide warnings of hazardous meteorological conditions for all aircraft.
- In 1970 a VOLMET broadcast was developed to meet the ever-increasing demand of international jet aircraft for information on conditions at the terminal aerodrome.
- In 1970 a system of routine forecasts was designed for major air routes.

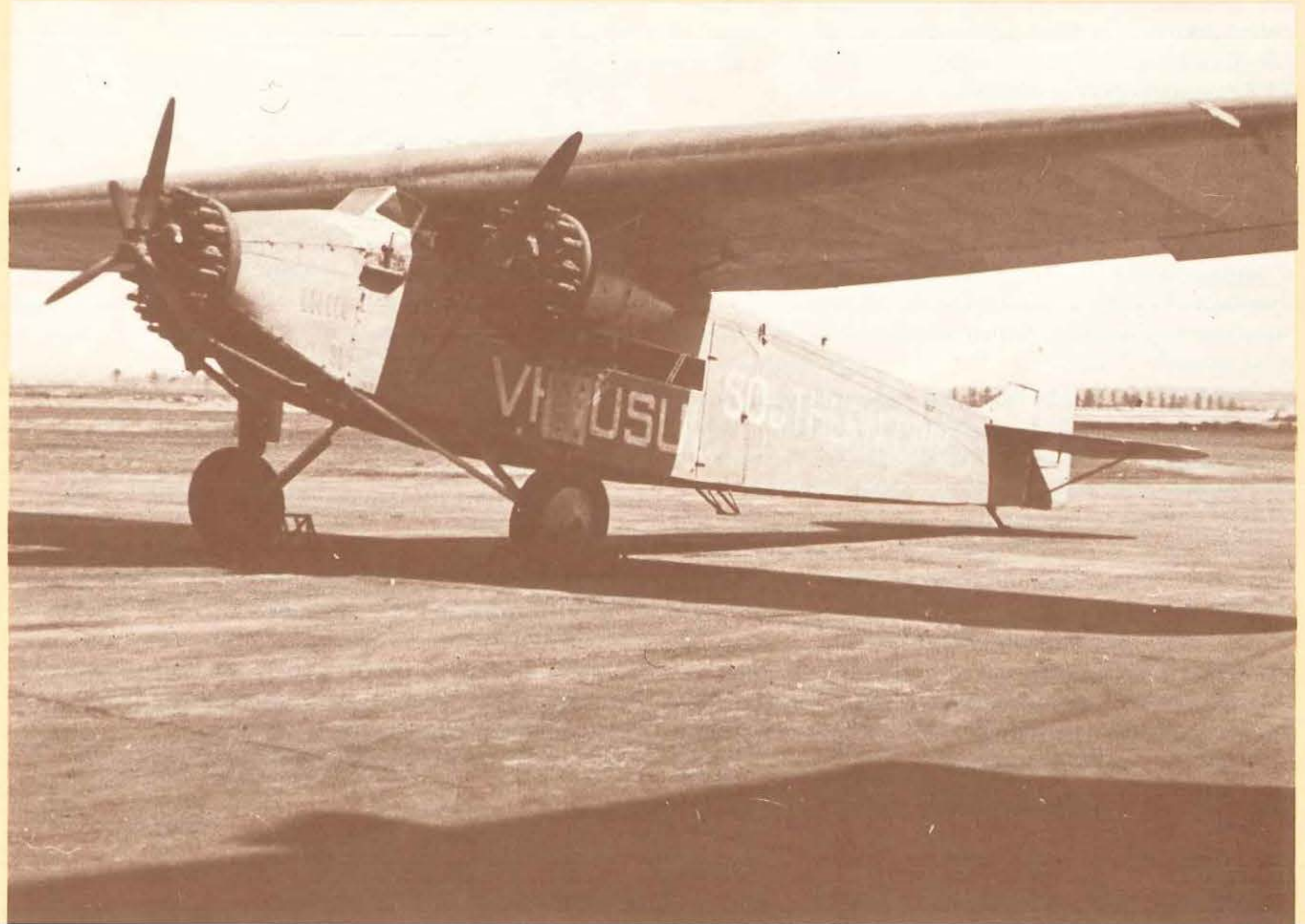
The safety record for RPT operations in Australia is very good. The loss of the Viscount aircraft VH-TVC in storm-associated turbulence close to Sydney airport in 1961 emphasised the importance of weather conditions in the terminal area. Justice Spicer in his Report to the Board of Inquiry on the accident recommended that 'when thunderstorm activity is present the approach controller should be provided with the best current weather information pertinent to the assessment of the changing weather pattern.'

This resulted in the use of ground based radar to provide information on the location of severe turbulence areas within 60 nautical miles of major airports.

In 1963 a Joint Approach Control Meteorology Advisory Service was established and as its name implied it was a cooperative advisory service provided by the mutual efforts of the Air Traffic Control Offers of the (then) Department of Civil Aviation and Meteorological Officers of the Bureau of Meteorology. The service evolved to the now-named Terminal Area Severe Turbulence (TAST) service. This service is currently being revised to provide an automated forecast of hazardous airspace.

The new service provides a colour display basically divided into two parts. The left part of the display shows the current weather radar return in six colour intensity. By continual updating, the changing pattern is displayed and the growth and decay of storms can be monitored.

The right part of the display contains the actual TAST advice. The details of the display have not been finalised yet but one possible form of display involves the core of the forecast severe turbulence area and a buffer being shown by two distinctive shades. This display will be updated at very frequent intervals and consequently will provide the best possible advice for departing and arriving aircraft □



It isn't easy being green

An experience of a lifetime, by Graham Gillies

THE SCENE OPENS . . . it was to be a four hour flight in two stages. The first was approximately 70 minutes. The tanks were filled and jerry cans containing eighty litres of fuel were put in the rear of the passenger section and strapped in securely. A preflight inspection was carried out.

The aircraft, a 1968 model Cherokee six, was in good shape.

My first worry occurred when the *young* pilot (19) started the engines with the aircraft still in the hangar — and simply 'drove' it out.

We weren't heavy and the long, grass runway presented no problems. The first stop, we had telephones and fuel available, plus there was a RPT 'Bandit' on the ground.

My pilot made a decision to top up the tanks, then changed his mind as, 'We've only used eighty litres'. I asked if that was ample and was assured it was. I asked the RPT pilot what the weather was like on our track and he asked if we were IFR. I asked my pilot. He said, 'limited'. The RPT pilot offered to transmit the weather to us as he would be on our track and well ahead. 'Thanks'.

We took off at four thirty into clear skies. On the horizon, I could see build-ups and they were pretty high so I made reference to them. Then the engine stopped (the right main was dry).

The build-ups were getting bigger and pinker as the sun went down. We were on track and *all* was apparently well. I made a subtle hint that we should 'maybe' track toward the coast — a bit north of our present track.

I don't think he liked hints from an old bloke like me, especially a helicopter pilot. 'What would he know?', he probably thought. We pressed on. Darkness arrived.

I had my own WAC so I grabbed a scale and made a couple of quick calculations. We still had two hours to go, at this ground speed.

'What's the endurance?' I asked again.

'Three hundred and fifteen litres at 1 litre per minute = 315 mins, 5 hours 15 minutes endurance.' This seemed enough, but the left main gauge was getting low. I pointed it out. No response from him.

We were now approaching the cloud. I couldn't see many instruments. 'Are you going to fly into that?' I asked, hoping he would say no. In we went — rain, turbulence, darkness, flashes, terror. At one stage I thought the aircraft was in a vertical dive. I had to force myself to look at the instruments on his side, for reassurance. We weren't vertical, thank heavens. I'm not religious but I was on the verge of conversion.

'Are you instrument-rated?' I mumbled — dreading the answer.

'Night VMC,' was the answer. Night VMC in a thunderstorm! I thought it was all over. I was surprised how calm I was.

'I think we'll do a '180',' he said. I nearly cheered.

We broke out to reasonable visibility and located ourselves over the ground. Relief abounded inside me.

I persisted about the fuel contents so I flew while he did his calculations. He said we were fine. I suggested an alternate. He said we were okay.

Ten minutes later he said we would land at an aerodrome enroute and put in the 80 litres contained in the jerry cans.

'No you won't' I said, 'No lights'.

'Oh,' he said, 'I think we'll divert to the coast'

'Good idea,' I said.

We didn't change track and when asked, he said he would prefer to track via his reporting point. I stressed our fuel contents. We turned.

Amending our planned route brought a bit of pressure to bear on my young friend. I think the controller had a sense of problems. 'Endurance?' he asked, 'POB?' 'Alternate for our new destination in case lights U/S?'

'Why were we NGTVMC in these conditions?!' — a very inquisitive person. My pilot lied about our endurance.

We would be lucky to make our new port, let alone an alternate. The controller was going home. We had no one to talk to in case of an emergency.

By now the tip tanks were both on 3-4 gals, the right main was empty, the left just below ten US gallons.

In the distance, I could see the flicker of a beacon rotating. 'There's our aerodrome,' I said, 'that beacon is on a tower there.'

'There's no tower there', he said.

'Not a control tower, a tower for a beacon that is activated by the P.A.L.' I replied.

'Never seen one of those' he said.

'Believe me. Track to it'.

Bright lights of a town appeared to our left.

'Thats it, over there' he proclaimed.

'Believe me. Track to that light over there.' I convince him to track my way but he doesn't really believe me.

We are at 4000 ft over sea-level terrain and he flies straight into a rain cloud! I'm counting the cc's of fuel and he flies into cloud! The needles are having a race to empty.

'Descend, Please.'

We descend and break out 30 degrees north of track, more cc's wasted and I'm starting to hate him and the 80 litres in the back of the cabin. The town comes into view and the runway lights appear, we are at 2000 ft, three miles out and intercepting for a straight-in from 20 degrees off the centreline. It's raining and the town lights keep disappearing behind low cloud

My ex-friend turns right.

'What are you doing?' I nearly scream.

'Turning downwind' he says.

'Go straight in, we don't have any fuel in the tanks.' For God's sake, we've made it this far and he's going to run out of fuel in the circuit area!

'I got into trouble once' he reckons, 'for not doing three legs.'

We're committed to a circuit, downwind in rain and base.

I said 'Turn on the fuel pump. If we run-out I'll select a tip tank. You just fly it'. Final, two lots of flap and all needles hit the stops. We are almost a glider. Over the threshold, on the ground, off the ground, floating, three legs of a circuit and we land with 20 knots of wind up the bum. We're on the ground and I'm not dead.

315 litres. 315 mins — but empty in four hours We put in the 80 litres in the drizzle and called a refueller. He puts in 200 litres.

The pilot couldn't believe it because, 'My dad's Cherokee gets five hours'. He'd never timed the fuel flow, he just *ASSUMED* that aircraft of the same name got the same endurance. He found it hard to believe that ALL aircraft are different, even the same type can have vastly different characteristics: flight, fuel and controls.

His assumptions on that night, had his passenger been ignorant of things, would probably have been fatal.

We landed one hour short of our destination with less than 20 litres spread through three tanks. I'll bet the consequences still haven't sunk in.

[I don't know the identity of our young P.I.C. However if you do, please take him to one side . . . and brief him thoroughly.] □

Still a pilot's greatest dread

THE STRUCTURE of an aircraft is continuously under stress and the stress is continuously changing — for example as a result of normal manoeuvres or turbulence. Some parts are more highly stressed than others and it is not always deliberately so — for example a small nick in an otherwise smooth component can lead to a concentration of stress and an accelerated reduction in strength.

The aircraft structure can accept an enormous number of changing loads and provided they remain within normal limits, the structure will not show any deleterious effects even though it may be suffering undetectable fatigue damage.

However, as the structure ages, the accumulated fatigue damage may then begin to show as visible or insidiously hidden cracks and depending on the criticality of the component, may eventually cause complete failure.

One preventative measure is for the life of the aircraft to be limited to a value safely below the life at which degradation of strength is estimated to occur.

These days aircraft structures are required to be 'fail-safe' or 'damage tolerant' and non-destructive techniques have been developed to detect the potential cracks before they reach the stage of critically affecting the strength of the structure — provided of course that you know where to look for them!

Further, a complex monitoring system has been developed between regulatory authorities, manufacturers and operators to exchange information on particular aircraft types in service so that catastrophic failures can be avoided.

But it wasn't always thus:

It was January, 1945 and the Stinson, one of two modified to a twin engined configuration, was taxying at Essendon for a flight to Kerang. It was early morning and the aircraft carried two crew and eight passengers.

The Captain and First Officer were experienced and the aircraft was fully serviceable and correctly loaded.

Departure was normal and about an hour later, at 0807 hours, the DCA Aeradio station at Essendon received a routine message from the aircraft that operations were normal — 'I have nothing to report', it said.

Residents of Spring Plains, about 54 miles north-west of Essendon, saw the aircraft about ten minutes later on track at an altitude of about 1000 feet, due to the cloud base. The visibility was good but conditions were gusty — and likely turbulent. The aircraft was flying normally, although the engine noise was loud.

The aircraft passed over a fairly steep-sided gully. Suddenly and without warning, the port outer wing came away. The aircraft immediately rolled over and hurtled to the ground about three quarters of a mile further on. In the dive, various other portions of the aircraft separated. Just before impact, the tailplane was seen to be thrashing about — there was nothing to suggest that this had started before the wing separated.

The aircraft burned on impact and all were lost.

The investigation by DCA experts and the Council for Scientific and Industrial Research concluded that the failure had begun as a fatigue crack which propagated from a cavity in a weld which attached the lower main spar to a support lug.

The cavity was under the surface of the weld metal and could not have been seen by eye. The cavity set up a stress concentration which started a fatigue crack in the weld metal and under the resulting further stress concentrations, the crack progressed in the parent structure. Eventually the residual strength of the component deteriorated to the extent that it could no longer support normal flight loads and this resulted in the catastrophic failure of the spar.

[Incidentally, wood does not fatigue like metal and hence the whole concept of fatigue was a revelation.]

The Stinson was the first fully recorded civil aircraft crash in the world, known to have been caused by primary structural failure as a result of fatigue. Canada had imposed a life of 14 years on metal aircraft as an arbitrary limit and was the only regulatory body at that time to have any limit.

The recommendations of the investigation panel were significant:

- all welded steel, highly stressed members were to be Magnaflux tested — for detection of invisible cracks
- the accident was to be reported to the Australian Council for Aeronautics with a request that they undertake a study into fatigue of airframe structures
- the remaining Stinson be grounded
- that the outer wing panels from the grounded aircraft be examined by CSIR and DCA to further knowledge of fatigue damage
- that DCA obtain recorders to survey conditions of turbulence on the Australian air routes — a knowledge of such loads would then allow comparison of predicted fatigue lives with the environmental conditions of other countries.

Thus the world was introduced to the concept of metal fatigue — in this case welded steel fittings. The problem though was to predict the safe life of other metal structures — most aircraft were now made of stressed skin aluminium construction.

Aircraft designers generally adopted a 'safe life' philosophy. That is to say that the life of airframes were very conservatively estimated by applying a safety factor to the predicted failure areas. For example the wing root fittings were generally considered to be the highest load-bearing members. If these fittings were tested in a rig which could represent the in-flight loads and if they showed signs of deterioration or failure after the equivalent of say 30 000 hours, then the structure would be approved for a safe life of 6000 hours (a safety factor of 5) after which time the fittings had to be retired from service or had to undergo periodic inspection to ensure there were no cracks developing.

The validity of this safe-life theory depended on two factors:

- that the selected item was the critical item
- that the loads used to simulate the in-flight conditions were in fact representative of the in-service life of the aircraft in all parts of the world.

Thus the safe-life design philosophy was backed up by other inspections for signs of fatigue in other areas and data was gathered on in-flight loads.

Research was also undertaken with full size, complete airframes in hydraulically operated test rigs to verify critical load paths and likely failure items.

However, the system was not foolproof:

In October 1951, near Kalgoorlie, a Dove aircraft experienced a catastrophic failure of the centre-section spar boom. This accident caused a world-wide re-appraisal of aircraft design standards and led to a comprehensive fatigue research program by DCA and ARL.

But fatigue prediction was still an art rather than a science:

On the thirty-first of December 1968, a Viscount airliner taxied at Perth airport, bound for Port Hedland on the north-west coast.

The flight was planned to cruise at FL 170 and the EET was 189 minutes. The aircraft carried a crew of four and twenty two passengers.

Takeoff and departure were normal and the Captain advised that they were climbing at an IAS of 155 knots instead of the planned 175 knots, due to turbulence. Cruising level was amended to FL 190. The flight and all communications were normal and at 1120 hours they advised their intention to commence the descent into Port Hedland in three minutes time. At 1134 hours they reported passing 30 miles DME and had left 7000 feet on descent. This was the last transmission received from the aircraft.

Two witnesses saw the aircraft descending rapidly and steeply but did not see any impact. At 1223 hours a searching Cessna 337 located the burning wreckage of the Viscount, close to planned track and 28 miles south of Port Hedland.

There were no survivors.

The aircraft had a total of nearly 32000 hours and 25000 landings. It had been Correctly maintained and was loaded within AUW and CG limits.

There was no evidence of any dangerous cargo being carried on this flight.

The Viscount had an aluminium, stressed skin structure. The wing carried a single main spar, with leading and trailing edge members and a stressed skin.

The spar alone was designed to carry 90% of the overall wing bending moment and shear force.

Weather conditions were generally good with moderate turbulence forecast and experienced between 5000 and 7000 feet, during the climb.

There was no other significant turbulence experienced and there was no cloud en-route, nor significant winds.

As a result of earlier accidents there was by now a requirement for all RPT aircraft to be fitted with a flight data recorder. The recorder had been damaged on impact but was found to offer a usable record of the flight. The flight apparently proceeded completely normally to the point where it passed an altitude of 7000 feet in the descent into Port Hedland. After this, there were gross variations in vertical acceleration, heading and indicated airspeed while the rate of descent increased to an average of 14000 fpm until ground level.

The trace of normal acceleration ('g' forces) showed the turbulence experienced during the climb, where deviations of approximately plus and minus 0.5g were recorded — relative to the normal level of plus 1g in level flight. After the 7000 foot descent point, it showed accelerations from nearly plus 3g to minus 3g.

The most significant observation made from examination of the wreckage was that the whole of the starboard wing, outboard of the inner engine but including the outer engine, propeller and supporting structure, was found some three thousand feet away from the main point of impact. The tail section and rear fuselage was found some 1600 feet from the main point. This evidence suggested that there had been a failure of the aircraft structure before ground impact.

The components were then removed for closer examination in the laboratory. It was evident that failure of the tail section and rear fuselage were caused by an overload and there was no evidence of any prior defect. The starboard tailplane and elevator had also failed in flight as a result of being struck by sections of the separating wing structure.

An intensive search was then carried out for missing pieces of the wing structure. All of the fracture surfaces evident on the sections of the main spar boom visible above the ground, displayed overload failures consistent with ground impact but, immediately adjacent to the wreckage of the number 4 engine, there was a large ground indentation from which three sections of the main spar boom protruded. [The spar booms, upper and lower are the main load-bearing sections of the spar as distinct from the spar web which keeps the booms apart, i.e. if the spar was an 'I' section then the upper and lower horizontals would be the booms and the vertical line would be the web.]

After a digging operation lasting two days, three sections of the boom were recovered from very hard rocky ground and one section which had been driven about three feet into the ground was identified as being the most inboard section of the lower spar boom in this group of wreckage.

Despite considerable damage as a result of being driven into the hard ground, there were unmistakable signs of fatigue on the fracture surface. The face of the structure which mated with this area was subsequently located and showed even more distinct signs of fatigue. It was determined that the failure had occurred at a point coinciding with the outer edge of the number three engine nacelle. The fatigue cracking and subsequent failure had occurred through a bushed hole — one of a group of five which passed through the spar boom at this point to carry the engine nacelle support tube. This particular bush had been distorted on insertion and had scored the hole. This created a nucleus from which a premature fatigue crack subsequently grew.

Tests by the Aeronautical Research Laboratories in Melbourne showed that the fatigue crack extended over some 85% of the cross-section of the boom, at the time of the ultimate failure.

It was originally estimated that the safe life of the boom using a safety factor of 5 for airborne loads was 11 400 flights — and yet this boom failed after only 8000 flights. A very detailed examination into the cause of the failure was undertaken and suffice to say that the life of the spar was critically dependent on the way in which the hole was bored and the way the bush was inserted. Although this item triggered the fatigue crack, it was also found that other Viscounts suffered similar fatigue damage.

As a consequence of this accident and the subsequent investigation, all Viscount spars were inspected. Several Viscounts overseas were found to have fatigue cracks and required spar boom changes. The safe life was reduced to 7000 flights.

By the way, the flight load spectrum for Australian conditions had been measured and used to calculate the safe life of the Viscount spar and a safety factor of 5 had been used for calculating airborne 'damage'.

The Viscount was lost as a result of fatigue cracking which started around a tiny hole but more importantly many lives were saved as a result of the international cooperation which had developed in the study and protection against fatigue failures. But for this exchange of information several other Viscounts would almost certainly have suffered similar catastrophic failures.

Later developments have led to the concept of 'damage-tolerant' design which is a totally different way of predicting the life of airframes — but that's another story in the continuing development and maintenance of safe aircraft operation □

For over thirty years, the *Aviation Safety Digest* has been an integral part of Australian aviation.

In July 1986, responsibility for the *Digest* was transferred from the Bureau of Air Safety Investigation to the Flight Standards Division of the Australian Department of Transport and Communications. This move reflected the perception that civil aviation may have reached the limit of accident prevention through regulation and that the way forward is through increased emphasis on safety education in general, and the 'human factor' in particular. Rather than just draw lessons from accident investigations, the *Digest* will increasingly seek to influence pilot behaviour by positive reinforcement of sound techniques. It will examine all aspects of piloting and publish formal results as well as 'the tricks of the trade'. The 'crash comic' will become a 'how not to crash' comic.

Anyone with an interest in aviation will benefit from tapping into this unique source of the accumulated wisdom of the profession and the latest research into aviation safety in Australia. Indeed, anyone with an interest in high technology and the roles and limitations of the human operator will find this publication enlightening.

AIRFLOW

Feeling a little query?

The AIRFLOW column is intended to promote discussion on topics relating to aviation safety. Input from student pilots and flying instructors is particularly welcome.

Anonymity will be respected if requested. 'Immunity' applies with respect to any self-confessed infringements that are highlighted for the benefit of others.

Write to: AIRFLOW
Aviation Safety Digest
P.O. Box 367
CANBERRA A.C.T. 2601
Australia

ENTRY FORM FOR THE DIGEST PHOTOGRAPHIC COMPETITION

TO: Photographic Competition
Aviation Safety Digest
Civil Aviation Authority
GPO Box 367
Canberra, ACT 2601

ENTRIES CLOSE: Last Mail,
Friday,
14 April 1989
Results will be published in the Spring edition of the Digest

Dear Sir,
Enclosed is an entry for the Aviation Safety Digest Photographic Competition. Details are as follows:

Category of Entry: .... Film Size and Type: ....

Camera Type: .... Caption or Title: ....

Description of the Photograph and Theme: ....

....

Name of Entrant: ....

Address: ....

....

I do/do not wish the photograph to be returned (return postage enclosed?)

I agree to be bound by the conditions of entry as described in the advertisement

.... *(Signature)* .... *(Date)*

ENTRY FORM FOR THE DIGEST PHOTOGRAPHIC COMPETITION

TO: Photographic Competition
Aviation Safety Digest
Civil Aviation Authority
GPO Box 367
Canberra, ACT 2601

ENTRIES CLOSE: Last Mail,
Friday,
14 April 1989
Results will be published in the Spring edition of the Digest

Dear Sir,
Enclosed is an entry for the Aviation Safety Digest Photographic Competition. Details are as follows:

Category of Entry: .... Film Size and Type: ....

Camera Type: .... Caption or Title: ....

Description of the Photograph and Theme: ....

....

Name of Entrant: ....

Address: ....

....

I do/do not wish the photograph to be returned (return postage enclosed?)

I agree to be bound by the conditions of entry as described in the advertisement

.... *(Signature)* .... *(Date)*

A time to remember

Official Secrets?

THE DH-9 was approaching to land at Pratts aerodrome near Geelong. When the aircraft was at a height of about two feet, the cadet pilot noticed a cow, which had been running away with about twenty others, turn around and come back towards the landing area.

The pilot immediately opened the throttle but failed to clear the cow. The impact broke the port undercarriage strut. Because he was unsure of the extent of the damage, the pilot elected to land ahead and 'pancaked' from a height of six feet.

After exiting the damaged aircraft, the pilot made contact with the officer of the watch to report the accident and then returned to his machine.

The local senior constable subsequently arrived and asked for the pilot's name and a statement of what had happened. The pilot refused to give him either but requested that the cow which had internal injuries, be attended to.

The pilot was then approached by a local reporter who tried five or six times to get the pilot to discuss the accident. He again rigidly refused to provide any information.

(The cow was later valued at between seven and eight pounds.)

Pomp and Ceremony

In April 1927, a RAAF formation was providing top cover for HRH The Duke of York. The leader of the formation was briefed to lead a vic of seven DH-9 aeroplanes from Point Cook. His instructions were to escort the Royal party from the time of their leaving HMS Renown until arrival at Federal Government House.

The aircraft were to remain in close formation for the whole time and were not to come within 2000 feet of the Royal party — in case the noise of the engines interfered with the ceremonies.

These instructions were observed and when the Royal party arrived at the gates of Government House, the leader of the formation decided to return to Point Cook.

At this time the formation was flying at a height of about 1000 feet. The leader of the formation then dived as he passed over St Kilda Road — with the intention of giving a final salute. The lowest point of the dive was about five or six hundred feet.

The leader then pulled up into a steep climb and as he passed nine hundred feet, he looked back to see if the following aircraft were still in position. He saw that the two rear machines on his starboard quarter were falling apart, evidently after a collision.

One of these almost immediately went into a vertical dive and disappeared through the roof of a building about three hundred yards West of the gates to Government House. Immediately after this machine disappeared, a sheet of flame shot through the roof of the building.

The other machine, which appeared to have a badly damaged port wing, commenced a flat spin and it appeared that the pilot was struggling to regain control.

Finally it crashed into a street about fifty yards east of where the other machine had hit.

It appeared to other members of the formation that both aircraft had been lagging and that one of them tried to regain position and pull up into the climb at the same time. It was possible that the other aircraft was then obscured by the upper wing.

All crews were killed.

Up to a point . . .

Having received its flight clearance the DC-3 taxied out to the holding point.

It was four minutes past two in the morning. It had been raining heavily but had now eased to a light shower. The lights on a nearby mast, nearly three miles away were visible as were lights on another hill six miles away. Main cloudbase was 8000 feet.

The aircraft appeared to take off normally and became airborne after about 1750 feet. By the time it reached the end of the 4000 feet runway, it had climbed to a height of about 50 feet.

From this point, it was seen to climb steeply until its attitude was almost vertical — with its back towards the way it had come. It reached a height of 500 to 600 feet when it suddenly nosed down, the port wing dipped and the machine plummeted to earth. It was unclear whether the aircraft did a 'back-flip' or pitched nose-down at the peak of its flight path.

One of the remarkable features of the crash was the very confined area of the wreckage.

All crew and passengers were killed.

The court of inquiry found that the evidence was inconclusive in determining the cause of the crash but it found that the aircraft was loaded beyond the allowable aft CG limit for this aircraft. The court also made the observation that improper distribution of the load may render the aircraft at best more difficult to handle and at worst highly dangerous.

. . . and beyond

The fully-loaded Lockheed Lodestar taxied for takeoff.

There was apparently no prior run-up and the aircraft accelerated for takeoff.

The ground run was quite short — indicating that the engines were delivering full power.

After leaving the ground, the aircraft was observed flying level, close to the ground during which time the wheels retracted. It was just as the retraction was completed that the aircraft started to climb — but this climb soon became abnormal in its steepness.

Some eyewitnesses gained the impression that the aircraft would go over the vertical and they estimated that it ultimately reached an attitude of 80 to 85 degrees. A pilot who observed the flight, estimated a more conservative 40 to 45 degrees.

The aircraft reached a height of 200 to 300 feet.

One wing dropped, was raised and then the other dropped until the aircraft was almost on its side. One witness believed that the engine noise died away at this point and the comparatively undamaged state of the airscrews suggests that the engines were delivering little power on impact.

When it was still some appreciable height above the ground, the aircraft assumed a flat attitude and eyewitnesses emphasised how it appeared to then drop most steeply and on an even keel until it hit the ground. Examination of the wreckage and surroundings revealed that the aircraft had struck in a most unusual manner in that there was practically no indication of forward movement.

The aircraft was found to be loaded beyond the permissible aft CG limit. Also the trim tab was in a setting of three degrees nose-up whereas a setting of ten degrees nose-down was appropriate to aft CG positions.

The CG in this aircraft would also move further aft with undercarriage retraction. There would be a further nose-up trim change due to the change in the drag vector associated with the gear retraction.

The three crew, sixteen adult passengers and two children all perished and the aircraft was destroyed by impact and fire.

Other company pilots had reported difficulty in controlling this aircraft during takeoff when the CG was known to be in the vicinity of, if not beyond, the aft limit, but on no known occasion did the CG approach its position on this flight.

It was also observed that when the aircraft began to climb steeply, the fuel and baggage would move as far rearward as they could thereby further moving the CG aft.

Why did I choose these particular accidents? For interest? Certainly. In one case perhaps for a touch of humour. The important thing though is the 'message', the moral of the story. I don't need to remind pilots of the frequency of accidents involving a collision of some kind, either with an animate object — as experienced by our cadet friend — or an inanimate object.

Of these, the mid-air collision is especially frightening. You will recall the recent 'Skydancers' accident and the RAAF's 'Roulettes'. There have also been mid-airs in the circuit area. Even one is too many.

The aft CG accidents are topical because of the hidden danger of aircraft loading — a danger not realised until it's too late. A recent accident in the United States brings this horrifyingly to mind:

A Lockheed Lodestar was being used to carry skydivers. The big lumbering transport was the ideal platform for mass jumps where dozens of jumpers could exit close together and link up.

The aircraft was designed to carry a nominal 10 to 14 passengers but with the seats removed and with low fuel, it could carry 24 jumpers and still stay within the all-up-weight limit. However, the CG was another matter.

It was theoretically possible to carry a load of 24 parachutists and stay within the CG envelope. However, in practice the jumpers with their bulky parachutes could not be arranged in this way.

Nevertheless, the Lodestar regularly carried this load — and it remained controllable.

To minimise the separation between jumpers, it was usual to have a few hanging around the outside of the door — indeed a special ledge had been constructed for this purpose. The remainder bunched inside. The pilot would slow the aircraft to within 10 knots of the stall with gear and flaps down and then throttle back the left engine to minimise prop blast on the exiting jumpers.

As the aircraft slowed down for the drop, the parachutists moved back towards the door. The pilot applied full nose-down trim and held the yoke hard forward — to hold the tail up against the effect of the extreme aft CG position.

(The CG was estimated to be some 16 inches beyond the aft limit for the aircraft.)

The jumpers began to exit as the aircraft ran out of elevator power. It pitched up, stalled, rolled inverted and entered a near vertical, spiral dive. Three jumpers got out after the spiral began. Two dragged themselves out against heavy centrifugal forces and were struck by the tailplane. A third was killed by this impact. The remaining eight jumpers and two pilots died in the aircraft.

It was later discovered that four other instances had occurred, of spins or spirals in these circumstances. In these cases the pilots had been able to recover. (perhaps the jumpers managed to exit and the aircraft again became controllable.)

So that's a slice of history, both humorous and tragic. All accidents have a message. Individually we must be receptive to these messages. Above all others, the message from our forebears is:

'Don't you make the same mistakes that killed us.'

Look out

by Roger Marchant

ON November 10 1985, in the vicinity of Teterboro airport, New York, a PA28-181 Archer impacted the leading edge of the port wing of a Falcon DA50 jet. The Archer was transitting the airport traffic zone. The Falcon was manoeuvering for a standard instrument approach. Both aircraft were operating in VMC at night, were at 1500 ft above the field and were under the control of Teterboro tower. There were six other aircraft on frequency, and the Falcon had been ordered to 'plan number three following traffic turning downwind abeam the tower'. The Falcon acknowledged this call and thirty seconds later, advised the tower; 'traffic in sight'. In fact, he had acquired the PA28, which, far from maneouvering for an approach, was merely crossing west to east. The Falcon subsequently made a left turn outside the Archer in order to remain in the pattern, lost sight of the light aircraft, which was maintaining its heading across the zone, until eight seconds before impact, when the captain shouted 'Hey watch out, this guy's coming right at us!'

Subsequent calculations established that a minimum of 12½ seconds would have been required under the prevailing circumstances for the Falcon crew to make a substantial change to aircraft heading/altitude. The weather conditions were good, but it was 10 minutes past evening civil twilight and the accident took place above a heavily populated, well lit area.

The National Transportation Safety Board determined the cause of the accident to be a combination of breakdown in ATC coordination, whereby an overloaded tower controller passed inaccurate advice, resulting in an air traffic conflict, and the inability of the Faclon crew to 'see and avoid' the other aircraft due to the erroneous traffic advisory combined with physiological limitations of human vision and reaction time at night.

One aspect, though, predominates. The Falcon and all other aircraft were circuit traffic. Only the PA28 was in overflight. But they were all at 1500 ft agl! The Archer pilot knew there were other aircraft; he knew they were in the circuit. Could it be he assumed all circuit traffic flew at 1000 ft. Did he really think he had a certain 500 ft separation?

It is interesting to consider the situation in Australia. The IFR jet would be given positive separation by ATC, not merely 'traffic' on other aircraft operating VMC. And, of course, everyone knows that circuit height is 1000 ft for pistons, 1500 ft for jets. Or do they? Or, more to the point, is it? Well, let's assume most pilots are of the opinion that those heights prevail for the differing aircraft types. Nowhere in the Air Navigation Act or the Regulations is it legislated that there is a particular height above the ground for 'circuit' flying. The only stipulations are that the traffic pattern must be joined up, cross or downwind and all turns be to the left (even this is capable of variation by the Secretary). There are, however, many subsidiary documents and publications — none of which has legal status — to persuade you that 1000 ft is correct. For example, the VFG at 61-2, 4.3.1 suggests that any other circuit altitude than 1000 ft above the ground requires an individual clearance, and at 61-5 it quotes 'normal circuit pattern' as being 1000 ft above aerodome elevation.

More recently, in this very magazine, the beautiful diagram titled 'How are your circuit entries?' (ASD Summer 1985) specifies the same 1000 ft. In truth, there is nothing legally to prevent you doing a circuit at 1200 ft, or even down to 500 ft (where ANR 133(2) (b) steps in to prevent low-flying). It is as well to know, then, that should you be overflying an airfield at 1500 ft agl, you may well be confronted with somebody who is legitimately 'downwind'. This goes double for jets, for 1500 ft is a more comfortable altitude for bigger/faster aircraft and it normally coincides with final approach fix altitude for practice instrument approaches. Therefore operators, in their operations manuals, stipulate 1500 ft for circuit flying. But be warned! These are not legal requirements. 1000 ft for pistons, 1500 ft for jets, like Topsy, have 'just growed up' as convenient circuit heights in Australia. So don't get caught. Be aware of the possibilities of other aircraft operating at your altitude. Give your eyes a chance and make sure your undoubtedly excellent scan is backed up by an awareness of the law and a knowledge of the consequent possibilities of confliction.

Above all, do not plan to operate in a circuit where jet operations take place, at 1500 feet agl ☐

'I believed I could climb above it'

From an earlier Digest

THE SINGULARITY of this latest addition to the 'Below VMC' accident list, lies in the fact that it didn't happen — at least not in the way we normally expect. The traditional type of ending was however, avoided only by what must have been the narrowest of markings and certainly not by any good management on the part of the pilot! Thus, as well as providing another most valuable object lesson on the dangers of unauthorised 'Below VMC' operations, the happy ending to this near-disaster exemplifies the value of requesting assistance when in difficulties, and gives some idea of the help that is readily and freely offered to pilots who are known to be in trouble.

At the time control was lost, the light aircraft involved was in the vicinity of Kilmore, en route from Moorabbin to Canberra. Kilmore is situated in a gap in the Great Dividing Range, 35 miles north-east of the city of Melbourne. The story has been taken almost verbatim from the actual record of communications between the aircraft and Melbourne ATC, and the pilot's description of the flight which he gave after landing at Melbourne Airport.

1125	AIRCRAFT	*Melbourne, this is Juliett Victor Mike on 118.9.*
	ATC	This is Melbourne Departures. You're not yet identified. Report present altitude.
1126	AIRCRAFT	*Present altitude 3000.*
	ATC	Climb to 7000 VFR. Area QNH 1005. Report at 7000. Your route clearance is Kilmore, direct Mangalore.
1129	ATC	Confirm you're just passing Kilmore now.
	AIRCRAFT	*Cannot see Kilmore. We're not in VFR conditions. I'm climbing to 4000 now and going to 7000.*
	ATC	Confirm you're not in VFR conditions or you just don't have sight of the ground?
	AIRCRAFT	*I don't have sight of the ground.*
	ATC	Roger, but confirm you can continue climb in VMC?
	AIRCRAFT	*Well I'm going to keep going for a little longer to see how I go.*
	ATC	Roger, advise if you can't maintain VMC.
1133	ATC	Present altitude?
	AIRCRAFT	*Just going through 6000.*
	ATC	Are you equipped with 130.4?
	AIRCRAFT	*Standby.*
1135	ATC	Still this frequency?
1136	(Aircraft calls on 124.7)	
	ATC	This is Melbourne Approach, maintain VFR and report if in VFR conditions
	AIRCRAFT	*We are not VFR!*
	ATC	Roger, report your altitude.
	AIRCRAFT	*Four and a half thousand.*
1147	AIRCRAFT	*Juliett Victor Mike. We're having terrible difficulties at the moment. We're not VFR and we're about four and a half thousand. I'm trying hard to control the aircraft!*
	ATC	Roger, report when you are clear of cloud. Are you able to maintain a level attitude?
1138	ATC	Reply when ready. Are you able to maintain a level attitude?
1139	AIRCRAFT	*Just managed to regain level attitude. I'm having a hell of a job. But I'm at 5000 feet and I am in a level attitude at the moment and I'm following the ADF to Mangalore.*
	ATC	Roger you're cleared at 5000. Maintain a level attitude and report when you are visual, clear of cloud.
1140	ATC	Reply when convenient with your fuel endurance.
	AIRCRAFT	*We departed Moorabbin with 310 minutes endurance.*
1142	ATC	Your flight conditions at the moment?
	AIRCRAFT	*I still cannot see the ground and I'm flying straight and level. I've got the ADF needle heading for Mangalore and I can see the sun above me but that's all.*

ATC Roger. If you can climb safely, suggest you initiate a climb to get on top of cloud and this will also improve our radar response on your aircraft.

1143 AIRCRAFT *Am climbing now from 6000 through 7000...my present heading is 360 with the ADF needle pointing to 0. I might help you to pinpoint my position.*

ATC We have you identified at 10 miles SSE of Mangalore. Report your flight conditions now.

AIRCRAFT *I'm climbing through seven and a half and I can't see the ground. I'm still not above cloud...do you suggest I continue to climb?*

1147 ATC We've been advised the cloud tops are at 10 000 feet so if you'd like to level out we'll initiate a turn right, on to a heading of 210. Make a very gradual turn and report when established on 210.

ATC Your position is 35 miles NNE of Melbourne. You can either maintain 7000 or you can continue to climb to try to get on top of this cloud. Advise.

1149 AIRCRAFT *I'm even on 7000. My present heading is 175 and I'm endeavoring to steer to 210.*

ATC I'll continue to plot you on radar. The main thing is to maintain a level attitude.

AIRCRAFT *Am continuing to climb. Am now at 7200. It's just starting to clear a little in front of us...we've broken through the cloud and we can see holes in it down below us!*

1150 ATC Roger. Do you think you can maintain a clearance from cloud in your present position or will you be going back into cloud?

AIRCRAFT *I'm going back into cloud. I can just see the ground. There's a little farmhouse below us.*

ATC Suggest you continue to maintain a level attitude and if you're able, position yourself clear of all cloud.

AIRCRAFT *Could you suggest at the moment a heading to try and keep on track?*

1151 ATC Your heading is good to Essendon or Melbourne. If you like you could turn right on to a heading of 210.

AIRCRAFT *Is the weather in Melbourne visual?*

ATC Affirmative. There are reported gaps in the cloud between you and Melbourne.

AIRCRAFT *I'd like to turn back to Melbourne if you'd give me the guidance.*

ATC Roger, I'll continue to plot you on radar. You can expect guidance to Melbourne but the main thing is to maintain a level attitude at this time.

AIRCRAFT *Am heading now 215.*

1153 ATC Your heading is good for Melbourne.

1154 AIRCRAFT *I have located Essendon NDB on 356 and am now following the needle.*

ATC Roger. Maintain a level attitude.

1155 AIRCRAFT *Melbourne, I've now broken through and can see blue sky in front and a break in different cloud formations.*

ATC Roger. Advise when you are fully VFR on top of this cloud.

1156 AIRCRAFT *Melbourne, this is Juliett Victor Mike,. Now that I'm out of the cloud, I've just noticed that the aeroplane has suffered structural damage on the wings due to the forces encountered whilst we were out of control.*

ATC Roger. Maintain VFR on top and advise the extent of this structural damage also your indicated airspeed.

AIRCRAFT *I'm now in the open away from cloud and can see the ground clearly. The structural damage is that the wings have bent just outward of the tanks on both sides where the wing joins. It's approximately five feet from the wing roots on both sides.*

ATC Could I have your indicated airspeed?

AIRCRAFT *Indicated airspeed is 96 knots.*

1157 ATC Roger. Are you able to descend from your present position to 4000 feet maintaining VFR?

AIRCRAFT *It is possible. It's quite clear beneath me now. Descending from 7000 through to 4000.*

ATC Report approaching 4000.

1159 ATC Could you advise if your wings are bent up or down?

AIRCRAFT *Both wings are bent upwards.*

At this stage, the flight was vectored west of Melbourne Airport while the air traffic controller working the aircraft telephoned Moorabbin Airport to confer with a highly experienced flying instructor who was thoroughly familiar with the aircraft type. They discussed the possible effect of the wing damage on the handling of the aircraft during the approach to land, particularly in relation to the strong crosswind components which prevailed on both runways at Melbourne Airport. As it seemed desirable that, in its damaged condition, the aircraft should be landed into wind, the question of it returning to Moorabbin was considered.

Before any decision was made however, the pilot was requested to check the aircraft's handling characteristics at a safe height by slowing to about 10 knots above stalling speed. He was warned while doing so to leave the flaps up and to restrict the angles of bank to no more than 20 degrees. A few minutes later the pilot reported that the aircraft's characteristics seemed normal but he had not wished to 'push' the tests too far as the wings had begun to 'flap a bit' as the aircraft approached the stall.

The pilot was then advised that his approach speed should be maintained at 80 knots, 10 knots above normal, to make allowance for this fact. It also was decided that it would be unwise to take the aircraft back over the suburban built-up areas to Moorabbin Airport in its damaged condition. Instead, a grassed area between the runways at Melbourne Airport, where the aircraft would be able to make a landing into wind if the pilot so desired, was prepared. Fire tenders were brought into position and after the aircraft had been vectored over the airport and detailed instructions had been passed to the pilot, he was told that the airspace was 'all his' and that he was cleared to land anytime he wished. The aircraft subsequently made a safe crosswind landing on the runway.

Describing his experiences afterwards, the somewhat shaken private pilot said:

We departed Moorabbin at 1051 and I tracked to Yan Yean via Nunawading at 2000 feet without any problems although I was not familiar with the area. From Yan Yean we tracked to Kilmore and visibility to Kilmore was quite good. We could see the ground at Kilmore although there were patches of cloud in the area. I gave a position report at Kilmore at 1122 at 3000 and I was going to commence my climb from there. From there on I did not keep a log but at about 1135 I was aware that it had become misty and I asked for a clearance to 7000 feet because I could see the sun above us and believed that we could get above the cloud and into the sunlight.

The clearance came back to climb to 7000 feet and I immediately initiated the climb to seven thousand. It was during this climb that Melbourne asked if I had 130.4. Not having used this frequency before I was not sure that I had it or not. I tried to select this frequency and this is where the trouble started. I took my eyes from flying the aircraft and it was then that I lost my flying attitude. When I had finished fiddling with the radio selector I noticed that the flight attitude indicator had toppled. Then I tried to get back to the original frequency but I could not remember what it was. Eventually I managed to contact Essendon, who advised me the correct frequency. This is where I lost control of the aircraft completely and my wife had the presence of mind to select the Melbourne Approach frequency and I asked her to advise them that we were in difficulties.

From then on we were going up and down, in a spiral dive and I think that the aircraft descended from 6000 feet to about 2000 feet because I saw the ground at one stage — very close. But I managed to get in to a climb and the altimeter indicated the climbs and descents. The airspeed indicator was fluctuating from 0 to 140 and 160 knots. Eventually I got the aircraft approximately stabilised and managed to keep it on an even keel. From there on Melbourne asked me to let them know when I was straight and level, which I did. They then advised that they had me on radar and vectored me to Tullamarine. When we broke clear of cloud, I could see that the wings had suffered structural damage and during the descent we picked up some rime ice. We were given different headings to fly and when we could see the ground we were asked to descend. We eventually landed at Tullamarine.

The pilot, who needless to say, had no instrument flying experience, added that when he commenced his climb to 7000 feet at Kilmore, he believed he could climb above the cloud ahead. The cloud increased as the aircraft climbed but the pilot thought this would be temporary only. He had considered turning back but, because he could still see the sunlight, he continued . . . □

Trial and error

From Lilienthal to Ligeti

IN THE course of aeronautical progress many sacrifices have been made. The early pioneers certainly had to learn the hard way but today with such a wealth of aeronautical knowledge, is this loss of life inevitable?

I don't believe so. There are experts in most fields and flight testing is no exception. A flight test program is carefully planned and conducted to minimise risk and to maximise data gathering. No-one wants to lose the valuable aircraft or the expensive-to-train, test pilot. It is doubly important where the pilot is also the designer of the aircraft.

A flight test program is exploratory by nature and the golden rule is to always start from a known safe point and explore the envelope carefully from that point. There are many ways to identify that point using computer prediction, models, wind tunnel tests and modification to proven configurations.

To go straight to the first flight without such prediction is increasing the risk significantly. There is enough risk and loss of aircraft in professionally conducted programs — the risk in non-professional programs is potentially much greater.

Also tests are planned with a way out — an escape route for the pilot — perhaps a parachute, ejection seat, anti-spin chute and above all tests are conducted at a safe altitude — an altitude such that if things turn to worms the pilot has time and space to attempt some novel recovery methods and still have time to get out.

In recent years the design of ultralight aircraft has emulated those early pioneering days — the new dawn of aviation. But why do we not learn from the past? There is a wealth of data available. It seems crazy to make all the same mistakes and accept further unnecessary loss of life.

Historically there are many incidents. Overseas, famous pioneers such as Lilienthal, Wright, de Havilland were lost in exploratory or demonstration flights. There were several in Australia. Here are a couple from the archives:

Oct 1921 Rainbow VIC Experimental machine

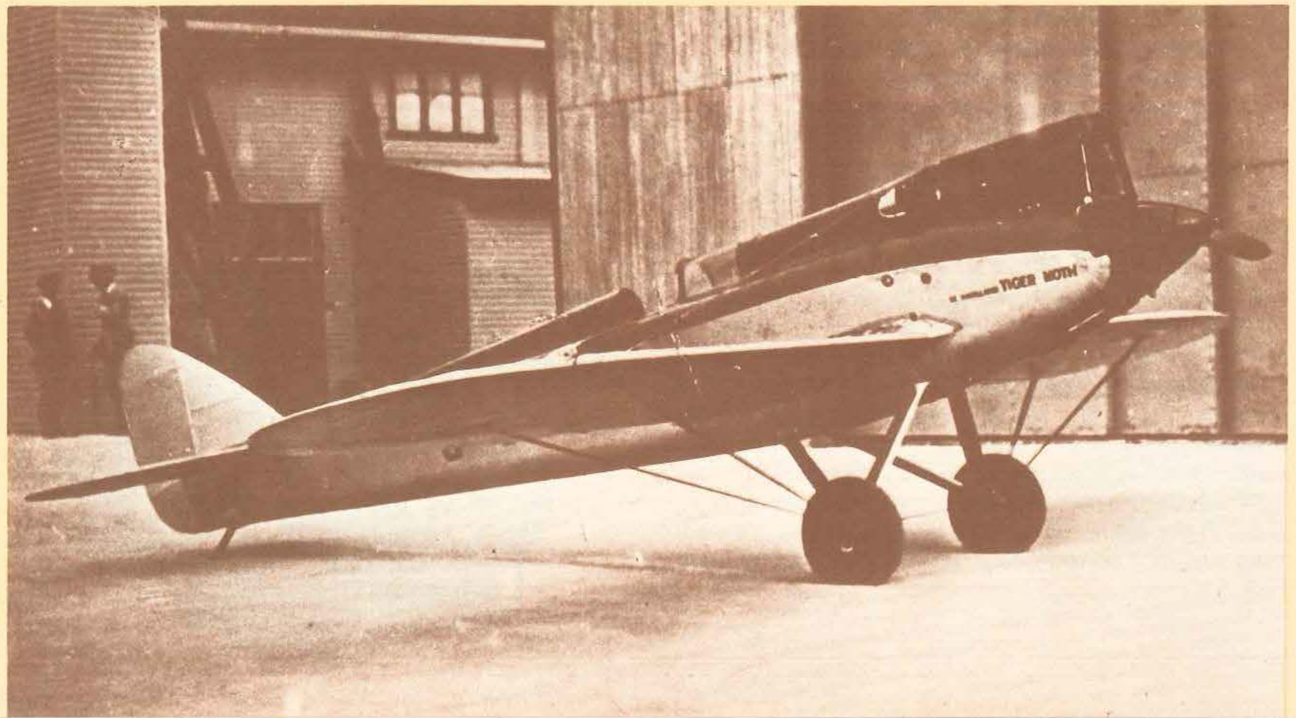
Struck tree in taking-off on trial flight. Pilot not licensed.

Sep 1930 Mascot NSW DH-71 Tiger Moth

Test flight in experimental machine. First flight by pilot. Take off normal. When travelling at high speed at 1000 feet, the machine dived, then rose and the pilot fell from the machine. Pilot had not affixed safety belt before leaving ground. Pilot used controls coarsely through inexperience causing machine to hunt during which he was thrown from his seat. Fatal.

Aug 1937 Fishermen's Bend VIC Experimental Monoplane

Starboard wing crumpled and broke off at end of power dive and although the pilot straightened the machine out and attempted a pancake landing, it became uncontrollable and crashed. Fatal.



Similarly, more recent flight test accidents have aspects that are cause for concern:

March 1984 Kingaroy Qld Bryan HP18

The glider was undergoing its second test flight since construction had been completed. After the test sequence had been completed satisfactorily, the pilot positioned the aircraft for landing. When the aircraft was about 150 feet agl the pilot reported by radio 'something broke'. It was observed to enter a steep spiral descent which continued until ground impact.

The glider had been built by the owner from a kit of parts which had included the fuselage for one glider type and the wings of a different type. This anomaly was not detected until the wings were being fitted to the fuselage. The aircraft kit manufacturer then advised the builder on ways to overcome the problem. The builder had carried out the modifications but found that the flap drivers did not fit correctly into the flap ends. Plates were then added to the flap drivers to provide more engagement with the flap ends.

Following the first test flight, the pilot, an approved sailplane engineer, undertook to carry out work on the aircraft to correct various faults discovered during the flight. These faults included problems with the flap actuating mechanism. The alterations were carried out with the wings removed from the aircraft.

When the aircraft was assembled prior to the second test flight, the pilot apparently failed to notice during his inspection, that the flap drivers were not adequately engaged in the flap ends. During the approach to land, the left hand flap driver had become disengaged and the flap retracted. The resulting asymmetric flap condition led to loss of control of the aircraft.

March 1985 Nagambie Vic. Veenstra Rustler

The owner/pilot had been designing and building ultralight aircraft for a number of years. This particular aircraft had been designed for a nosewheel landing gear system. However, after flying the aircraft, the pilot decided that he did not like this particular configuration. He had decided to modify the aircraft to a tailwheel design and had spent a considerable time over the preceding weeks on the rebuilding program. After completing the work, the pilot was forced to wait for several days for suitable weather conditions in which to carry out the first flight.

On the morning of the accident, the pilot carried out a pre- flight inspection before taxying to the end of the strip. He was observed to exercise the controls prior to commencing the take-off. The aircraft became airborne after a ground run of about 125 metres, and the angle of climb was seen to progressively increase. At a height of about 80 feet above the ground the left wing dropped and the aircraft dived steeply to the ground.

An inspection of the wreckage revealed that the ailerons had been incorrectly rigged and were operating in the reverse sense. It was considered possible that the pilot may have been momentarily confused when the aileron response was not as expected, and may not have noticed the steepening nose attitude in time to take corrective measures. In this design, he pilot sat in a totally exposed position at the front of the aircraft, and had only limited pitch attitude references. The pilot had not flown a totally open cockpit aircraft for some considerable time and was not wearing goggles. Apart from the aileron problem, no other faults were found during the investigation.

October 1985 Bankstown NSW Quickie Q200

The aircraft was being flown for the first time. The pilot stated that after take-off, the aircraft felt very nose heavy and that he had difficulty in maintaining a nose-up attitude. When he attempted to reset the elevator trim, the friction nut broke. The back pressure that he was required to hold, reduced as the airspeed increased. During the subsequent approach, the pilot found he had insufficient elevator control to flare the aircraft. On touchdown, the aircraft bounced and a go-around was carried out. The pilot made several other landing attempts but on each occasion, the aircraft bounced. On the final attempt, the aircraft bounced a number of times before the right canard collapsed and the aircraft ran off the runway.

The aircraft had been correctly loaded, with the centre of gravity 14% aft of the forward limit. However, the rigger's angles of incidence on the wing and the canard were found to be 0.3 degrees outside the design specifications. It was apparent that there was a critical relationship between these angles, the centre of gravity position and the amount of pitch control available.

July 1986 Toogoolawah Qld Unnamed Prototype

Initial test flying of the aircraft had been commenced the previous day. The pilot, who was a friend of the owner, had carried out a number of short hops along the 1000 metre strip. The following morning, a further six hops were carried out, after which the pilot announced his intention to conduct a right hand circuit and landing. He made one further short flight along the strip, before taking off for the circuit. The aircraft passed over observers on the ground at a height of about 300 feet, before passing out of sight. Shortly afterwards the noise level of the engine changed several times before ceasing altogether. A nearby farmer saw the aircraft in a left turn when the engine stopped. The turn tightened and the aircraft disappeared behind a hill. Sounds of impact were then heard.

Investigation revealed that the aircraft had struck the ground while in a left spiral and travelling at relatively high speed. The engine was not rotating at the time of impact but no evidence could be found to suggest that it was not capable of operation. The fabric on the left wing showed signs that it had separated along the entire trailing edge in flight.

September 1987 Deeral Qld Wheeler Scout

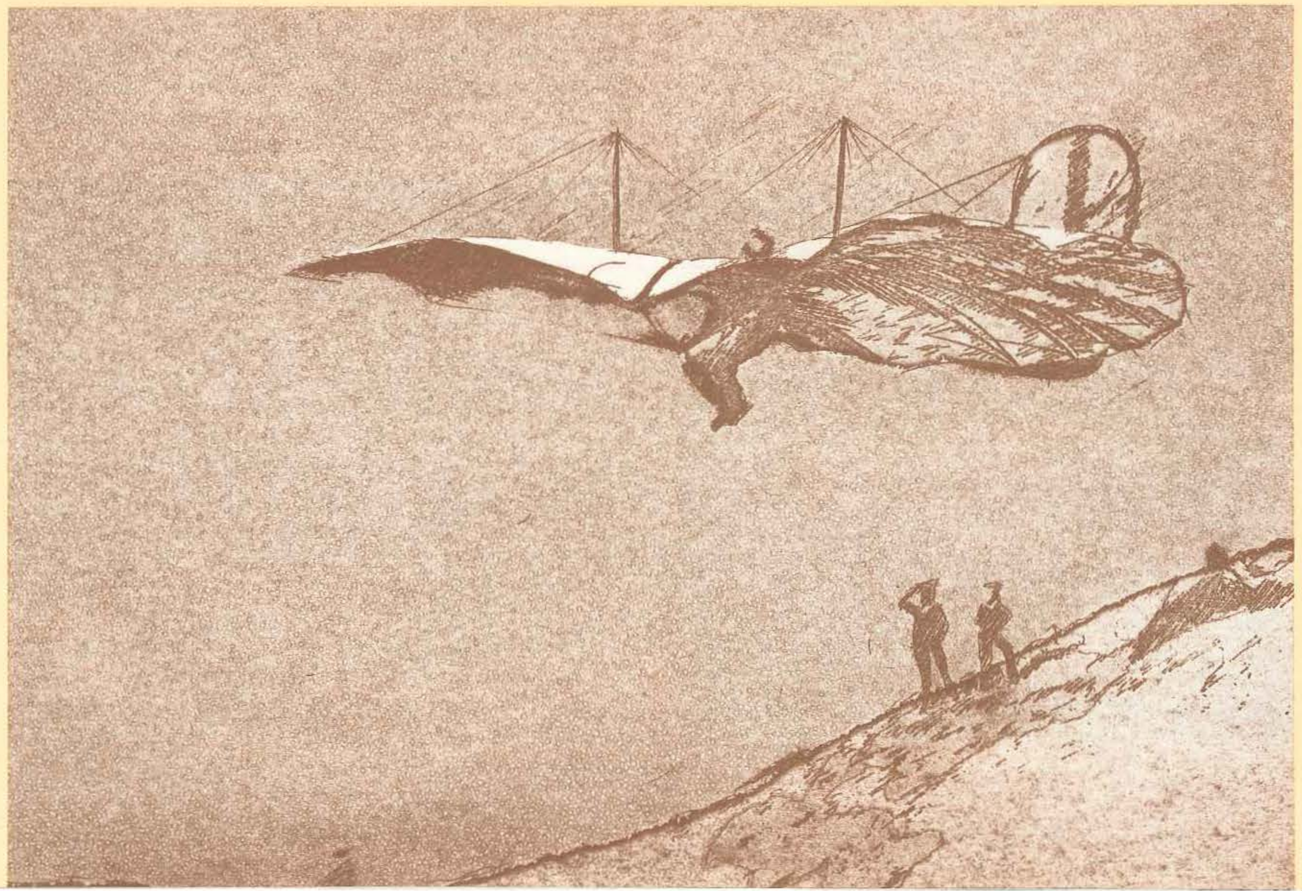
Previously the aircraft had to be flown with the control stick displaced to the right of centre in order to maintain a wings-level attitude. The aircraft owner advised a visiting ultralight pilot of the problem, who offered to attempt rectification. After conducting a flight to experience the problem first hand, this pilot adjusted the right wing warping wire and conducted another test flight.

The adjustment had improved the trim problem but had still not completely provided a fix. The pilot then readjusted the right wing warping wire to its original condition and added a D-shackle to the left wing warping wire, to increase its length. Another test flight was carried out and it was found that the aircraft could only be maintained in level flight with full right rudder and full right control stick applied. Unfortunately the aircraft was then struck by a wind gust and the left wing dropped. As no further control was available to correct this situation, the pilot grabbed a wing warping wire. As luck would have it he pulled the right wire instead of the left wire and was unable to correct his error before the aircraft struck the ground.

A subsequent inspection of the wreckage found that the right wing warping wire was 19 millimetres longer than the left. Also, all the dimensions of the right wing were slightly larger than that of the left wing, resulting in the right wing area being about 80 square centimetres greater.

September 1987 Penfield Vic. Ligeti Stratos

This aircraft was intended to be the production version of the 'Stratos' aircraft. The prototype version had successfully flown some 340 hours. The production model incorporated significant changes made by the designer/pilot. These changes included the removal of the dihedral from the main wing, the use of full span elevators on the canard wing and full span ailerons on the main wing. The engine mounting was lowered such that the ducted propeller was totally below the main wing and the lower part of the propeller duct was extended well forward to form a 'channel wing' or strake.



The main purpose of the channel wing was an attempt by the designer to lower the stall speed of the aircraft and to consequently reduce both landing and takeoff speeds and distances. As far as the investigation could determine, the effect of these modifications had not been checked by wind tunnel or other methods prior to this flight.

On the day of the accident, the pilot and his assistants had worked at the factory preparing the aircraft for testing. The preparation included a determination of the CG position, although no record was kept of these calculations. The aircraft was taxied up and down the runway five times and during these taxy tests, the control column position was adjusted. On the next run, the aircraft became airborne and flight was continued in the local area for about 17 minutes before the aircraft carried out a 'very slow' run over the airfield at an altitude of between 400 and 500 feet agl. The aircraft then flew for about a kilometre before turning and heading towards the airfield. Several witnesses reported that, shortly after the turn, the aircraft went out of control. The description of the type of manoeuvre performed by the aircraft at this time, varied from the nose of the aircraft going up and over the tail, to the nose abruptly falling through the vertical. All the witnesses agreed that the aircraft then fell vertically while the nose swung in a pendulous motion. The aircraft impacted rocky ground in an inverted attitude with little or no horizontal speed.

An inspection of the aircraft found that all airframe components were essentially intact and there was no indication of any airframe or control failure prior to ground impact . The engine was test run and strip inspected and no fault could be found.

No aerodynamic testing was carried out on the airframe to determine the likely effect on performance of the various modifications made to this aircraft. However, given that the prototype appeared to suffer no adverse flying characteristics, it is possible that the modifications incorporated in the new aircraft had an adverse effect on the stall characteristics.

The names of today's pioneers may one day become household words just as the early pioneers were household names in their day — the Veenstra's and Ligeti's of today are no different from the Lilienthal's and Wright's of yesteryear. But let's learn from the past and keep future pioneers alive a little longer. Please use professionals for flight test programs. Little aeroplanes can push the frontiers of technology just as much as the multi-million dollar jets — and they can kill you just as dead □

The times they are a'changing — or are they?

WHEN YOU look back over the years it seems at first sight that we are making the same mistakes and having the same accidents as our forebears. It is so consistent that it is predictable.

In the coming years there will probably be some of each of the following:

- stall/spin, loss of control
- takeoff, unable to climb
- engine failure, turn-back
- landing accidents
- loss of control in cloud
- wire strike
- maintenance fault
- collisions with various objects — animate and inanimate, and
- perhaps a mid-air collision or two.

But for a moment, let's turn back the clock:

Mar 1921 — Pithara WA — Avro
Doubt as to cause but suspicion of interference by passengers with pilot. Fatal.

Apr 1921 — Maryborough — Avro
Water in petrol caused forced landing. Machine struck rough ground.

May 1921 — Port Melbourne — Avro
Passenger's heel jammed controls. Fatal.

Nov 1921 — Sale — Boulton Paul
Passenger interfered with joystick. Write-off.

Dec 1921 — Canterbury — DH-6
Flying dangerously. Licence suspended for 6 months.

Dec 1921 — Geraldton — Bristol
Error of judgement. Banked too steeply when landing in rough country. Fatal.

Feb 1922 — Boulder — FE-2B
Engine trouble. Struck post while trying to land.

Nov 1922 — Serviceton — Boulton Paul
Struck car when taking off. Ground used was too small.

Dec 1922 — Sydney Harbour — Short
Machine canted to one side after rising from water, fell back and sank.

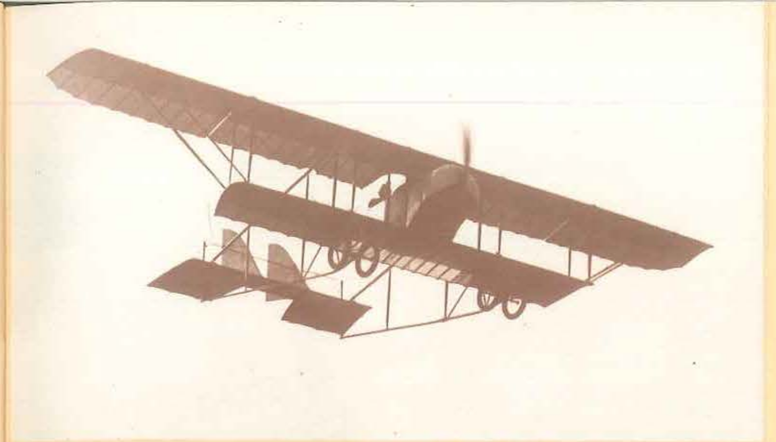
Dec 1922 — Cronulla — DH-6
Faulty ignition. Sparking plug failed. Gross negligence on part of engineers. Machine's licence cancelled. Pilot injured.

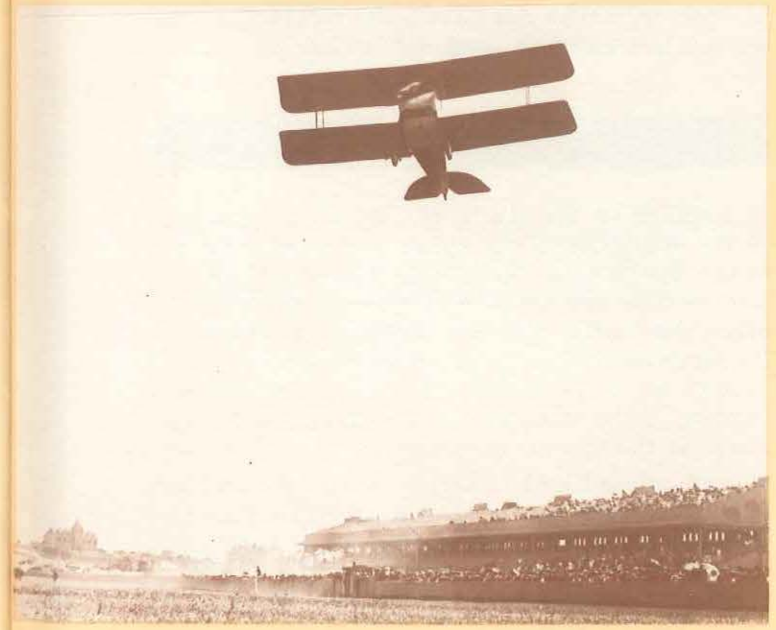
Jan 1923 — Hedland — Bristol Tourer
Error of judgement of pilot. Hit fence while taking off. Passenger killed.

Jun 1923 — Gilford Park — DH-4
Struck unforeseen telegraph wire when landing. Badly damaged.

Dec 1923 — Longreach — Bristol
Loss of height quicker than expected. Pilot hit ground with nose of machine in endeavour to clear a fence.

Jul 1924 — Hedland — Bristol
When turning at height of about 400 feet, machine suddenly nose-dived into sea. Cause not determined. Passenger apparently drowned.





Oct 1924 — Cunningham — DH-9
Encountered thunderstorm. Aircraft damaged during precautionary landing.

Apr 1925 — Orange — DH-6
Pilot suffered from weak heart. Pilot unlicensed and medically unfit. Machine without C of A. Fatal.

Sep 1925 — Caloundra — Avro
Machine damaged on landing. Encountered loose sand.

Oct 1925 — Moss Vale — DH-6
Engine giving insufficient revs for takeoff possibly due to inferior benzine.

Jan 1927 — Wallacedale — Avro
Struck stump when taking off. Then struck fence and overturned. Machine badly damaged.

Jan 1927 — Longreach — DH Moth
Flying school pupil doing first solo. Report indicates that pupil got air bump, lost his nerve and control over machine which crashed with engine on.

Feb 1927 — Ripley — Avro
Engine stopped at comparatively low altitude when petrol from one of the two gravity tanks was exhausted. Petrol from the other tank took some time to reach carburettor and before doing so, the pilot turned off the cock, possibly to avoid risk of fire.

Jul 1924 — Cloncurry — DH-9C
When taking off pilot experienced engine trouble. Blockage in petrol system. Forced landing.

Feb 1927 — Mackinlay — DH-50A
Attempting to take off on very soft ground after heavy rain. Collided with fence. Badly damaged.

Mar 1927 — Essendon — DH Moth
Pupil made bad landing, switched engine on again but couldn't pick up quickly. Struck Anec aircraft which was on the 'drome.

Mar 1927 — Mascot — DH-9C
Result of bad approach which was followed by stalling of the machine. Fatal.

Jun 1927 — Brisbane — DH Moth
Pupil made 'pancake' landing.

Jul 1927 — Perth — DH Moth
Pupil doing fourth solo flight. Machine 30 feet from ground came in contact with tramway cables and ignited. Fatal.

Aug 1927 — Essendon — DH Moth
Rudder control jammed following steep right hand turn when about to land. Jamming probably caused by passenger's feet.

Aug 1927 — Mascot — DH-50
Struck by propeller. Failed to get out of the way of the machine which was taxying after landing. Fatal.

Mar 1928 — Parafield — DH Moth
Carrying out aerobatics at too low an altitude. Fatal.

Sep 1928 — Mount Lofty — DH-50
Owing to compass being located in Ranges unsuitable position, pilot experienced difficulty in maintaining straight course while flying in thick clouds. Machine got out of control. Mechanic killed, pilot injured.

Sep 1928 — Coonabarabran — DH Moth
While taking off the machine suddenly lost height and the undercarriage failed to clear trees. Subsequently destroyed by fire caused by cigarette.

Aug 1928 — St Peters — Curtis
Tail spin — machine got out of control at 2000 feet — pilot did not regain control. Pilot not seriously injured.

Nov 1928 — Essendon — DH Moth
Error of judgement. Pilot believed passenger pilot had taken over and relinquished control. Machine flew uncontrolled for some time and struck fence at 85 mph.

Dec 1928 — Wagga — Widgeon
Restricted takeoff (buildings opposite runway) caused pilot to stall when climbing — and spin developed. First time pilot had tried to manoeuvre machine out of this park.

Feb 1929 — Mascot — DH Moth
Pilot put machine into controlled stall at about 1500 feet and when at an altitude of about 200 feet, lost control, the stall developing into a right hand spin from which he did not recover. Weather conditions bad owing to low lying clouds — visibility very bad.

Jul 1929 — Blue Mountains — DH Moth
Lost in fog. Struck tree when attempting to land. Fatal.

Oct 1929 — Baandoe — DH Moth
When flying at low altitude in the East-West air race, struck a tree which pilot did not see, in a fallowed field.

Oct 1929 — Ardrossan — DH Moth
Engine stalled at 800 feet. Due to a spin following an aerobatic manoeuvre. Fatal.

Nov 1929 — Grenfell — Widgeon
Destroyed following structural failure of the wing in flight. Fatal.

Mar 1930 — Inverell — DH Moth
When taking off machine struck a cow hidden in long thistles.

Jun 1930 — Smeaton — Avro
In endeavour to gain sufficient height to clear trees in line of flight, pilot stalled the machine at low altitude and had insufficient height to recover from resulting nose-dive before striking ground. Fatal.

Aug 1930 — Brighton-le-Sands — DH Moth
Failure to recover from inverted spin due to either stalling on the top of a loop or from a steep turn at a height of approximately 2500 feet, the pilot being thrown clear of the machine at 1000 feet. Fatal.

Aug 1930 — Brisbane — DH Moth
Pilot flying at a dangerously low altitude. In flying low and doing a left hand turn around the bows of HMAS Albatross, the aircraft touched the water causing it to crash.

We could go on for years. The significant points are the similarity of the types of accidents to today's operations. Technology has provided more reliable machines. Airfields are generally better. Air traffic services, communications and Met services are better. Instruments and avionics are much improved — as is our understanding of the strengths and weaknesses of the human in the scheme of things.

And yet, when I look through the list of accidents, I can find recent cases of almost exact circumstances. Does that mean that we haven't learnt from the past? I hope not. It would be a pity for all of those aviation pioneers to have died in vain. It is an essential requirement for progress, that we learn from our cumulative experiences and adapt our behaviour accordingly. Most pilots are doing just that. Some choose to go their own way. Some of the less experienced pilots may not have had the exposure to information that is available to help them survive in the unforgiving aviation environment.

It's up to each and every one of us to communicate and contribute to the bank of aviation knowledge.

Our future depends on our learning from the past □

AIRFLOW

Dear Sir,

As I am sure you know by experience, readers are ever ready to write in and blast the editor for some small conceived error, yet give no praise for anything learnt from the articles in the magazine. In this letter I am one of these narks.

On page 21 of ASD134 under heading 'The in-flight cure' there is a statement: 'It is difficult if not impossible to close a door in flight'.

During the mid-1970's I took out a P28 140 Cherokee on a weekday for a solo stooge from Bankstown over Katoomba and return. This was an RAC aircraft just out from a 100-hourly. At about 500 ft after takeoff, the top catch of door sprung open and door warped enough to let in a lot of fresh air and noise. I informed the Tower, completed the circuit and landed, thinking I had not properly closed and latched the door.

During checks prior to takeoff, I thumped the door to see if it was properly locked and it certainly was firmly shut. About Springwood, I dropped a wing to have a look at some traffic on the highway. Again the door came open at the top with all the accompanying noise and concern as to whether the centre latch would hold. On reaching Katoomba, I headed over to the strip at Blackheath and at about 1500 ft agl, pulled off the power, set the aircraft into a slow glide, reached over and fully opened the door and slammed it shut, locking it in place. It remained closed for about ten minutes until hitting turbulence, when the top again opened.

No difficulty was experienced on landing.

Therefore, I disagree — having had practical experience, with the statement quoted above.

(Name and address supplied).

Thanks for your comments. Despite your experience I would be reluctant to play around with the door in flight. A recent accident well illustrates my concerns:

The pilot was carrying out a cattle-spotting flight before his colleague started the muster. After initially setting-up a circuit pattern at 650 feet agl — due to turbulence at lower levels — he lowered 20 degrees of flap and maintained 65 knots.

When the mustering aircraft arrived, he tightened the pattern to stay on his side of the road and after the other aircraft moved off, he retracted the flaps and descended to 500 feet agl to see if any animals had been missed. As the aircraft was levelled, it encountered a severe updraught followed by severe downdraught and turbulence. The aircraft was still descending when the pilot's door became unlatched.

The pilot applied full power and lowered 10 degrees of flap as the airspeed was fluctuating between 55 and 65 knots. While he was attempting to close the door, he noticed that the airspeed was reducing and the aircraft was continuing to sink. He abandoned the attempts to latch the door when the buffeting and the sink rate increased. Height was now down to 250 feet and the airspeed was fluctuating between 40 and 50 knots.

The pilot realised the seriousness of the situation and lowered the nose and lowered another 10 degrees of flap. He decided to turn to avoid the turbulence and to head into wind to regain lost airspeed. As he entered the turn and started to lower more flap, heavier buffet was experienced and the right wing dropped. The aircraft stalled and started to spin.

He tried to recover from the spin by applying full left rudder and centralising the controls — followed by slight forward pressure. There was no immediate response and because of the limited altitude, the pilot tried to 'rock' the aircraft out of the spin by shoving the controls forward and back and by applying and reducing power accordingly.

AIRFLOW

He then returned to normal anti-spin control with forward pressure on the controls and the aircraft began to respond and the right wing started to come up.

However, by this stage the pilot felt that impact was inevitable and to avoid the risk of fire, he pulled the power off, cut the master switch and pulled the mixture control. He was in the process of turning off the fuel cock when the aircraft struck the ground right wing first. The pilot recalls his face impacting the instrument panel and some time later realising he was still in the aircraft with severe facial cuts and bruises and a broken collar bone. He managed to scramble clear of the wreckage which did not catch fire.

The pilot assessed the conditions as far more severe than anything he had previously experienced in that region — this was in the Pilbara region during the hot summer months and willy-willys were common.

I have described this accident in some detail because the pilot was able to provide us with a fairly good record of the events leading up to what could well have been a fatal accident — in which case we wouldn't even have detected or considered the popped-door. It may not have been significant but similarly, it's just the sort of minor distraction that can mean the difference between a safe arrival and an accident.

Dear Sir,

In ASD 136 there is a very readable and informative article by John Edwards — 'A measure of success' on 'happy and accurate landings'.

At the top right of page 18 there is a table of VSIs for a 3 degrees glideslope and the figures given are OK. Next comes a formula for use for any slope which translates as:

'Sink rate (ft/min) = glideslope degrees × GSkts × 100.'

Let's take for example the Bandierante with an ILS speed of 120 kts:

Sink rate = 3 degrees × 120 kts × 100
= 36 000 ft/min (!!!)

Whew! This looks more like the terminal velocity of an ICBM than a sedate approach to the touchdown zone.

I think that if you check with John, he will agree that there is a bit missing out of the formula, namely the radian measure of 1 degree which is 0.0175 because:

-36 000 × 0.0175 = -630 ft/min.

This is close enough to the accurate result from a complete trig. calculation which gives -636 fpm.

The '100' in the formula is a substitute for 101.27 ft/min, which is 1 kt (based on 1852 m = 6076 ft per nm) which must be good enough for practical purposes in the cockpit.

As they are constants in the formula the 100 and 0.0175 can be combined multiplied to give a factor of 1.75.

So now our example becomes:

VS = 3 degrees × 120 kt × 1.75 = -630 ft/min.

This agrees with the result obtained from the second formula using the slope percentage.

Because of the use of 100 instead of 101.27 in both these formula, the results are under-stated by a shade over 1% and keen types can mentally add 1%, in the example above it would be 630 + 6 = 636. Alternatively they may choose to use 1.77 as the factor and get a similar result.

I can think of a number of people down here (and up there) who would regard this as pedantic quibbling, and I'll agree with anybody who says that it is easier when flying with one hand, and thumbing around a circular slide-rule (or the 'prayer wheel' on the back of Dalton) to find the bigger graduation for 1.75 with the other.

As soon as I discovered this 'gremlin' my first response was to ring my 8000 hr, 4 ring Check Captain friend and ask him:

'Greg, do I or don't I write to David Robson, he may have already received a couple of dozen letters about this?'

'There may have been a number of people who have found the problem but haven't bothered to write, and very few will have taken the time and effort to find out what went wrong. It's your duty to write.'

So, David, here it is.

Captain L Buckworth

Dear Len,

Thank you for your comment. If you look closely at John's formula you will see that it includes ground speed — not in knots but in miles per minute. Hence for your 3 degree/120 knot approach, the approximate rate of descent would be:

3 degrees × 2 (miles per minute) × 100
= 600 feet per minute.

Obviously this method is not as accurate as your use of radian measure but as a guide, it serves the purpose fairly well and is easier to 'compute'.

And to all of you experienced Captains out there, please take the advice of the 'four-ringer' and write. As he said, 'It's your duty!'

AIRFLOW

Dear Mr Robson,
ASD 136 — A Measure of Success

Judging a three degree glideslope or setting up the correct rate of descent on a localiser or locator approach with a groundspeed which may reduce from 200 to 120 knots can require some mental gymnastics if the 5 × G/S rule is used.

We on the B767 at Ansett simply divide the ground speed by two, add a zero and call it rate of descent.

180 kt G/S = $\frac{180}{2}$ = 90 plus a zero = 900 fpm rate of descent

Yours sincerely,
Graham Thomas (Captain)

Thanks Graham. Dividing by 2 and adding a zero is of course mathematically the same as multiplying by five — but I agree that it is an easier way of doing it.

There are several such 'rules-of-thumb' in aviation and if readers have any similar mental tricks, I would be keen to see them shared via the Digest.

Dear Sir,

In your article 'Gone with the wind', you omitted one significant point regarding selection of a strip in crosswind conditions. The torque and gyroscopic effects all operate in the same direction. It's a sensible precaution in a situation where the wind is directly across the strip, to choose a takeoff direction where the crosswind counters the other effects, rather than adds to the problem.

If the aircraft normally swings left on takeoff then a crosswind from the right can actually be favorable.

Regards,

Doug Ryan

Good thinking Doug — and good planning.