FLIGHT TEST: SUPPORTING THE INVESTIGATION OF FACTORS AFFECTING LOSS OF CONTROL OF LIGHT AIRCRAFT

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ABSTRACT

A quarter of all fatal General Aviation accidents in the UK during the period 1980 to 2006 involved Loss of Control (LoC) in Visual Meteorological Conditions (VMC). LoC has consistently appeared in accident statistics over this period, but at apparently different rates for different aircraft types. This raises two important questions - why do these LoC events happen and why is there a difference between aircraft types?.

One case in point is that of the Cessna 150 /152 and over the 27-year period analysed, the Cessna 150 falls approximately on the average for fatal accidents in the UK GA fleet, whereas the Cessna 152 exhibits a lower accident rate. Brunel Flight Safety Laboratory, in conjunction with the UK General Aviation Safety Council, undertook to try and understand why this is so. The key design differences in relation to performance and handling qualities were researched using available published material and informal interviews with type-experienced students, pilots and flying instructors.

A flight test programme was conducted using examples of both aircraft types to gather additional research data, to assess and compare the apparent performance and handling qualities (both qualitatively and quantitatively). Flight tests were performed at three different CG conditions relevant to the key design differences, concentrating upon apparent longitudinal (static and dynamic) stability and control characteristics, stall and low-speed handling characteristics, and cockpit ergonomics / pilot workload. In all tests, normal (unmodified) flying club aircraft were used, in most cases with a 2-man (TP+FTE) crew. Data was recorded manually on test cards and automatically using a low-cost, commercially available, portable FDR.

Proven theory was used to estimate static margins and pilot stick forces and gradients in the region of the stall, the pre-cursor to an LoC event.

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The paper will cover the execution of these flight tests within a university environment (preparation, pre and post-test analysis, construction of Cooper-Harper tasks) and the use of low-cost, automated flight data recording. It will also discuss the team's lessons learned, initial findings and the ongoing research into aircraft, pilot and environmental causal factors involving LoC incidents within the light aircraft community. On completion, it is hoped that this research programme will contribute to improving operational safety and provide supporting ideas to make future light aircraft 'LoC-proof'.

NOTATION

Symbol	Meaning	Units of Measure
BFSL	Brunel Flight Safety Laboratory	
CAA	United Kingdom Civil Aviation Authority	
CAS	Calibrated Airspeed	knots
CG	Centre of Gravity	%MAC
CVR	Cockpit Voice Recorder	
CFIT	Controlled Flight into Terrain	
CRM	Crew Resource Management	
FDR	Flight Data Recorder	
FTE	Flight Test Engineer	
GASCo	General Aviation Safety Council	
HFACS	Human Factors Analysis & Classification System	
HQRs	Cooper-Harper Handling Quality Ratings	
IAS	Indicated Airspeed	knots
IMC	Instrument Meteorological Conditions	
LoC	Loss of Control	
LSS	Longitudinal Static Stability	
MAC	Mean Aerodynamic Chord	inches

MIAS	Indicated Airspeed in Miles per Hour	mph
MTOW	Maximum Take-Off Weight	pounds
PIC	Pilot in Command	
PiL	Pilot in the Loop	
TP	Test Pilot	
VMC	Visual Meteorological Conditions	
V_{S0}	Stall speed in the landing configuration	mph, IAS or knots CAS
V_{CAS}	Calibrated Airspeed	knots
V_{TAS}	True Airspeed	knots
V_{EAS}	Equivalent Airspeed	knots
V_{WIND}	Wind Speed	knots
V_{GND}	Ground Speed	knots
W&CG	Weight and Balance	
ϕ_{AC}	Aircraft Yaw Angle	degrees
ϕ_{WIND}	Wind Drift Angle	degrees
σ	Air Density Ratio	
θ	Temperature Ratio	
h	Altitude	km

INTRODUCTION

Each year in the UK, USA, Australia & Canada, over 300 people lose their lives in General Aviation (GA) accidents. Approximately one third of these involve *Loss of Control* (LoC), a situation that arises when the actual direction of the aircraft and the pilot's intended direction differ.

In association with the General Aviation Safety Council (GASCo), Brunel Flight Safety Laboratory has instigated a project to find out why these LoC events, many of which fall into the classic "stall-spin" pattern, happen and why certain aircraft types appear to be more susceptible than others. Having a better appreciation of the causal factors will hopefully contribute to improving operational safety and also have an input into helping to make future GA aircraft 'LoC-proof'.

A recent survey carried out by GASCo [**1**] for the period 1980 to 2006 (Figure 1), showed that for fixed wing aeroplanes (MTOW 994 - 12,569lb), LoC in VMC conditions was a factor in 25% of all fatal accidents with a further 8% involved LoC in IMC conditions. Low flying, aerobatics and Controlled Flight Into Terrain (CFIT) the next two highest causal categories of 16% and 12% respectively, also involve LoC to some degree. The net result is that LoC probably accounts for many more of these fatalities in any one year.

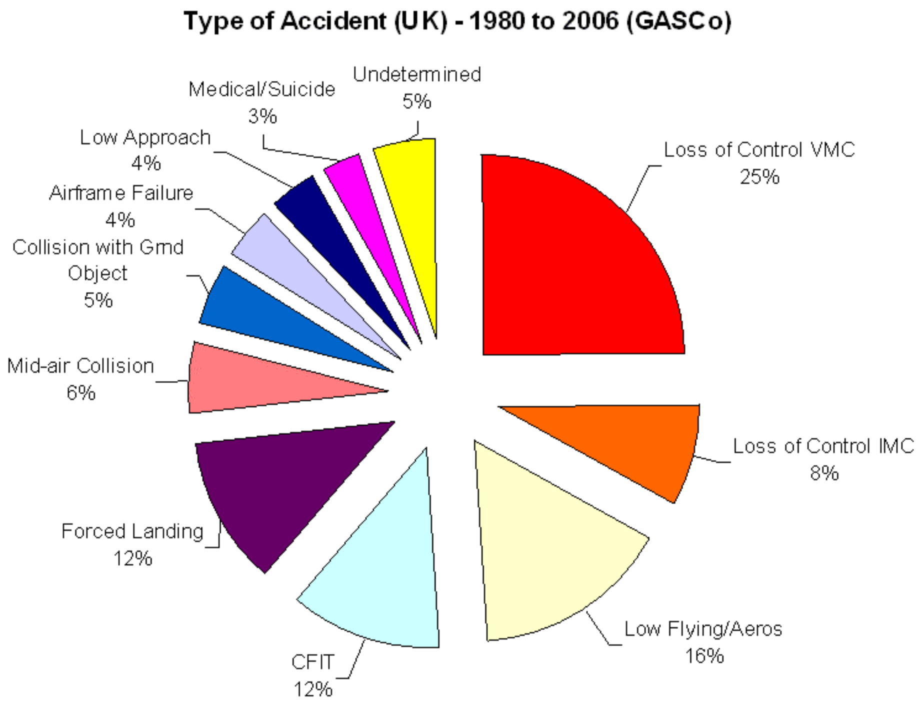

Figure 1, Type of Accident UK (GASCo)

This paper describes a programme of investigation into the reasons for stall related LoC incidents – this starts with a model combining aircraft and pilot characteristics that attempts to explain the causes of LoC, but then expands into description of the planning and results for a case study involving two similar aircraft - the Cessna C150 and C152, with markedly different safety records. Proposed follow on work from this study is then described, along with lessons learned – in particular concerning design and management of the test programme associated with the case study.

PILOT IN THE LOOP

To better understand the underlying causes for these fatal accidents, it is necessary to examine the total environment in which both a pilot and aircraft operate. The pilot has specific tasks to perform (which we will term "aviating") and is part of a complex closed-loop system. The pilot's control inputs are determined by the quality and quantity of cues received via all five physical senses: tactile, visual, aural, vestibular and smell. The pilot selects the appropriate cue, applies perception, decides on the action and then makes a responding control input. The control system and aircraft dynamics determine the response of the aircraft and the associated cues change within both the external and internal cockpit environment. External disturbances such as wind gusts or turbulence also affect the aircraft and again dynamics respond accordingly (Figure 2).

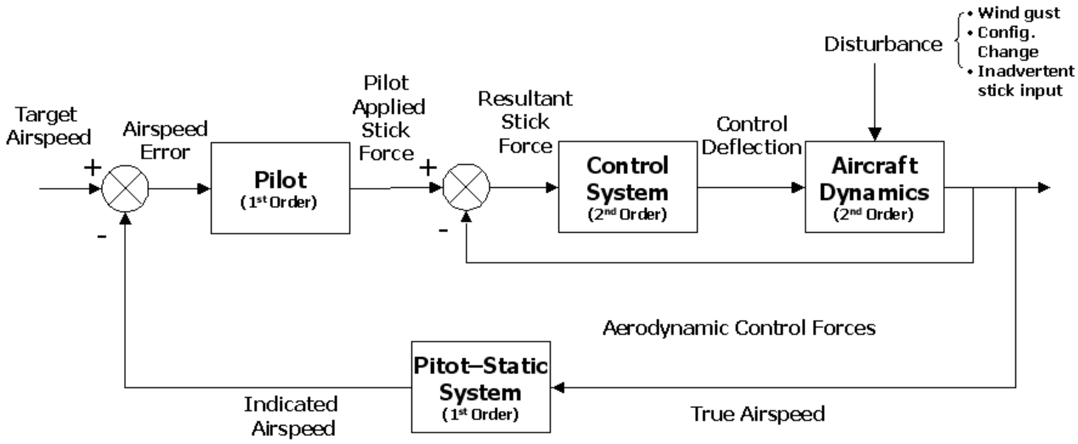

Figure 2, Pilot in the Loop Compensatory Tracking Model

So why does LoC happen?. For the purposes of this paper, all LoC related accidents involve a stall and usually occur when the aircraft is low (below circuit or pattern height), slow and with partial or full flap deployed. Using human factors analysis methods such as Wiegmann & Shappell [**2**], there are both active and latent errors present. Latent errors being errors laying dormant for some time and active errors being conscious decisions and/or actions on behalf of the pilot that have contributed to the accident. A simple pilot distraction or deliberate aerobatic manoeuvre can take the aircraft to the limits of its normal operating envelope and beyond.

To assist in understanding the factors affecting LoC, a case study was selected: Initial statistical analysis of fatal stall/spin accident rate by aircraft type conducted by GASCo, highlighted the case of the Cessna 150 and 152. These two aircraft, whilst apparently similar in design, have very different fatal stall/spin accident rates. The Cessna 150 lies approximately on the average of 0.65 fatals per 100,000 flying hours whereas the Cessna 152 has a rate of only 0.05 fatals per 100,000 flying hours. These statistics were independently verified by the authors after obtaining source data directly from the CAA.

DESIGN REVIEW

A detailed design analysis was conducted and key differences affecting performance and handling qualities were thoroughly researched using available published material and informal interviews with type-experienced students, pilots and flying instructors (Table 1).

Within the UK the Cessna 150 Models K, L & M account for approximately 70% of all flying hours in the generic Cessna 150 family. This study therefore concentrated upon these aircraft variants. Comparing the Cessna 150 (K, L & M's) to Cessna 152s, most Cessna 150s have airspeed indicators measured in mph (1975 and earlier models) not knots; the Cessna 150 has 10 degrees more flap and a more complex flap activation and indication system (except 1977 'M' model); the Cessna 150 has typically 50 lb less useful load, and cannot operate with 2 (adult) POB and full fuel without exceeding the MTOW. In addition, an aft CG loading inside the CG envelope for Cessna 152 could well be outside the envelope for a Cessna 150 under similar loading conditions. Prop wash effects due to different engine/propeller combinations in the Cessna 150 could result in more aggressive power on stall characteristics, combined with less down elevator authority for stall recovery, although our understanding of this is currently weak

The most noticeable difference is that of the CG location for similar loading conditions. Theory suggests that a more aft CG results in lower static stability, the natural nose down tendency of an aircraft.

	Cessna 150L ('74) Cessna 150 M ('75)	Cessna 152 ('80)
Powerplant	100 hp @ 2750 rpm Continental	110 hp @ 2550 rpm Lycoming
Propeller	McCauley Std	McAuley 'Gull Wing' type propeller
MTOW (lbs)	1600	1670
CG Range (in)	31.5~37.5 (19.9~30.1 %MAC)	31~36.5 (19.1~28.4 %MAC)
Flap Range (deg)	0~40, no detents	0~30, detents @ 0/10/20/30
Flap Activation / Monitoring	2-way switch, LH Door post Indicator	Gated 4 position switch, adj. indicator
V_{S0} (KCAS) Pwr Off / Aft CG / MTOW: L(30)	42	41

Table 1, Comparison of Design & Performance, Cessna 150L,150M & 152

THE FLIGHT TEST PROGRAMME

A flight test programme was devised utilising examples of the Cessna 150 L, M and Cessna 152 aircraft types to gather additional research data in order to assess and compare the apparent performance and handling qualities (both qualitatively and quantitatively. Prior to commencement of flight testing, an FDR calibration test flight was conducted with the support of the National Flying Laboratory at Cranfield University onboard their BAe Jetstream 31 aeroplane. This aircraft has onboard, calibrated systems for measuring all necessary in flight parameters and formed a useful baseline for comparison with the low-cost portable FDR unit (Appareo GAU 1000). A series of dynamic stability tests were conducted to evaluate data outputs of the Appareo FDR.

Following the calibration, flight tests were performed in the Cessna 150L, M and 152 for up to three different CG conditions relevant to the key design differences, focussing on apparent longitudinal (static and dynamic) stability and control characteristics, stalling and low-speed handling characteristics, as well as cockpit ergonomics / pilot workload (Table 2). All tests used normal (unmodified) flying club aircraft in most cases with a 2-man (Test Pilot + Flight Test Engineer) crew. Data was recorded manually on test cards and automatically using a low-cost, portable Flight Data Recorder (FDR). In addition, a portable cockpit voice recorder and headset mounted video camera were used for debriefing. Tests were commenced in the Cessna 152 with mid-CG position and phased towards the aft position to minimise risk.

	Phase 1		
Baseline	CG1 Mid	CG2 Mid-Aft	CG3 Aft
C152 - G-BOFL **% MAC:** **Flt Test/Sortie:**	Sortie #1 23.6% 2006-06-04 & 2006-08-01	Sortie #4 25.1% 2006-06-05	Sortie #6 XX% 2006-06-06 TBD
F150L - G-BGLR **% MAC:** **Flt Test/Sortie:**	2 25.2% 2006-06-02	N/A	N/A
F150M - G-BCRT **% MAC:** **Flt Test/Sortie:**	Sortie #3 25.5% 2006-06-03	Sortie #5 27.1% 2006-06-08	Sortie #7 27.8% 2006-06-07
Crew:	2	2	1

Table 2, Flight Test Programme, Cessna 150 & 152 at different CG Conditions

A case could be made that for an exercise of this nature, involving simple certified aeroplanes, test planning could be substantially simplified compared to that of evaluation tasks in true research or developmental aeroplanes. To some extent this is recognised within BFSL, but it is also recognised that as well as the development of new knowledge, BFSL's role includes the training of flight test professionals and development of best practice in test conduct. Procedures thus have been developed which are similar to those in use in most other flight test organisations. In particular, minimum planning requirements are separately laid down for use of certified aircraft (such as this case), experimental aircraft, or flight simulator work – these are shown in Table 3 below

	TYPE OF TESTING		
	Certified aircraft (current permit or CofA)	**Experimental or developmental aircraft**	**Flight simulator**
Test plan	*Y*	*Y*	*O*
Test cards	*Y*	*Y*	*Y*
Weight and balance statement	*Y*	*Y*	*Y*
Safety assessment and mitigation plan	*Y*	*Y*	*O*
Details to be lodged outside of aircraft	*Y*	*Y*	*N*
Crew competence statement	*Y*	*Y*	*O* *(Mandatory pilot competence statement for handling qualities assessments)*
Design statement and approval, including flight test instrumentation requirements	*O*	*Y*	*Y*
Maintenance approval	*N*	*Y*	*N*
Inspection approval	*N*	*Y*	*N*
Pilot acceptance of aircraft	*Y*	*Y*	*O*
Observers acceptance of briefing (if carried on-board aircraft)	*Y*	*Y*	*O*
Post flight report	*Y*	*Y*	*Y*

Y = Yes, required
N = No, not required
O = Optional, not mandatory but may be required for either best practice or educational purposes

Table 3, Brunel Flight Safety Laboratory minimum flight test planning requirements

Additionally, BFSL procedures allow for an escalating number and specific requirements for authorising signature for test plans. In this case: a certified aeroplane being paid for by an internal budget, and assessed as medium risk, but with cross-department interest (engineering and human factors) a minimum number of 3 signatories was required, although specifically encompassing the plan author, test pilot, budget holder, review signatory and head of laboratory. (A worst case of a high risk trial in an experimental aeroplane would require a minimum of 5 separate signatures encompassing 8 functions.)

RESULTS & ANALYSIS

For the specific aircraft tested, the results of the flight test programme, which are illustrated below in Figure 3 and Figure 4, showed that the Cessna 150 L & M have consistently lower apparent longitudinal static stability (LSS) than the Cessna 152 as measured by variation of stick forces versus airspeed in climb, cruise and approach configurations. Qualitative assessments by the same test pilot for all three aircraft were consistent with quantitative results. Whilst numerical minimum standards are not applied to part 23 aeroplanes, normal guidance[**3**] plus larger aeroplane regulations[**4**, **5**] are available as guidance and recommend a minimum stick force gradient of 1 lb/6kn.CAS; this recommendation is not met by any of the aeroplanes. Additionally, the F150M in particular failed in the judgement of the test team to consistently meet the part 23 [**6**, **7**] requirement that "The stick force must vary with speed so that any substantial speedchange results in a stick force clearly perceptible to the pilot." (FAR-23.175(c)). The deficiencies are most pronounced in the L30 and L40 configurations (L30, which exists for both the C150 and C152 aeroplanes is illustrated in Figure 4.)

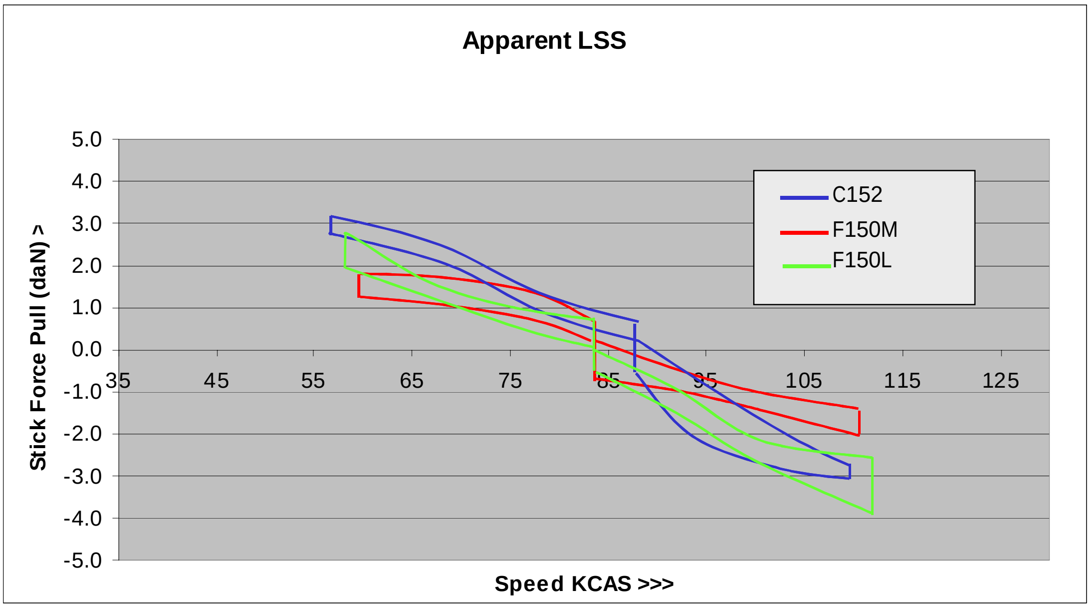

Figure 3, Comparison of Apparent LSS in the Cruise Configuration for the Cessna 150 L, 150M and Cessna 152 (mid-CG)

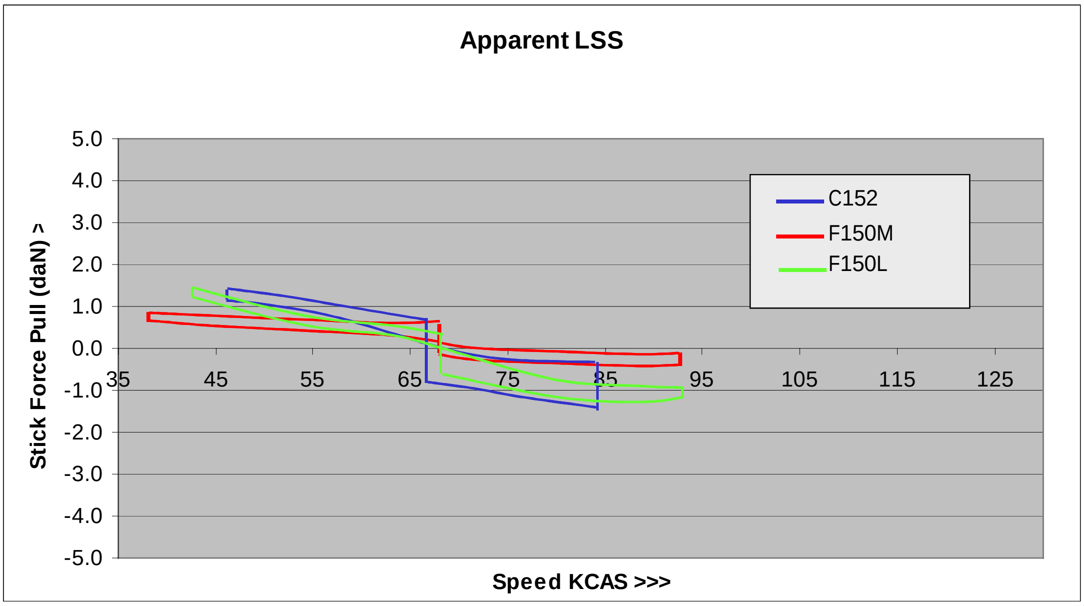

Figure 4, Comparison of Apparent LSS in the Landing Configuration (30 Flap) for the Cessna 150 L, 150M and Cessna 152 (mid-CG)

Using the portable flight data recorder, the pilots ability to track airspeed in the climb was also investigated. This was done by developing a “pseudo CAS” term, described in Appendix A and using this on a time-trace Y-axis (Figure 5 below) It was found that the deviations from target airspeed were more noticeable for aircraft and configurations with lower stick force gradients. As a result of poor stick force cues, the pilot was forced to make continuous corrections to airspeed, frequently referring to the airspeed and therefore increasing workload; in particular it was noticed that speed holding became poorer where aircraft management tasks were required: unsurprising in itself, but indicative of the marginal speed stability of the aeroplanes. The authors found this data plot against pseudo-CAS particularly useful in comparison with pilot-generated HQR scores because with well defined desirable and adequate airspeed tolerance limits, it was then possible to identify whether the aircraft remained within those limits, and thus whether HQR scores should have been within the 1-3, 4-6, 7-9 or 10 bands.

Figure 6 shows the corresponding Cooper-Harper HQRs recorded for the climb and point tracking task in the Cessna F150M with mid-aft CG. The pilot rated the task as HQR 7, reflecting the high workload experienced in maintaining the desired airspeed tolerance of +/2 MIAS. It can be seen that the airspeed tolerance deviates considerably at the commencement and completion of the task (in both cases > +5 MIAS) exceeding the adequate airspeed tolerance limits of +/- 5 MIAS. This contributed to the overall pilot HQR rating of 7.

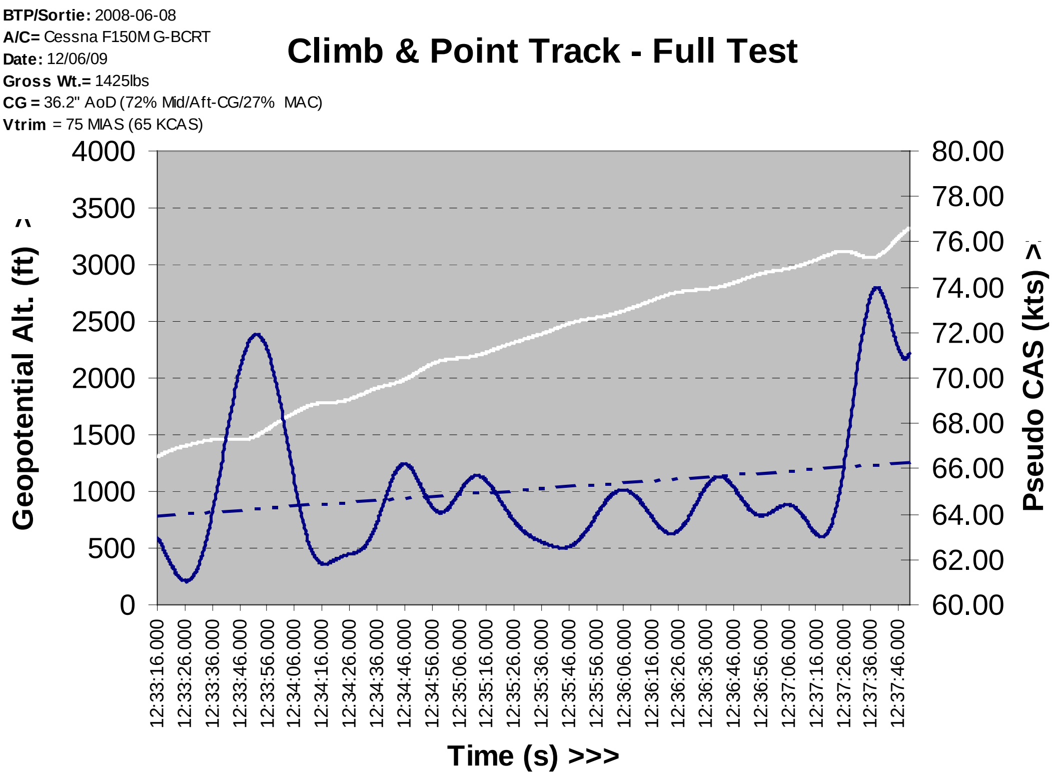

Figure 5, Time history for Climb & Point Tracking Task, Cessna F150M at Mid-aft CG.

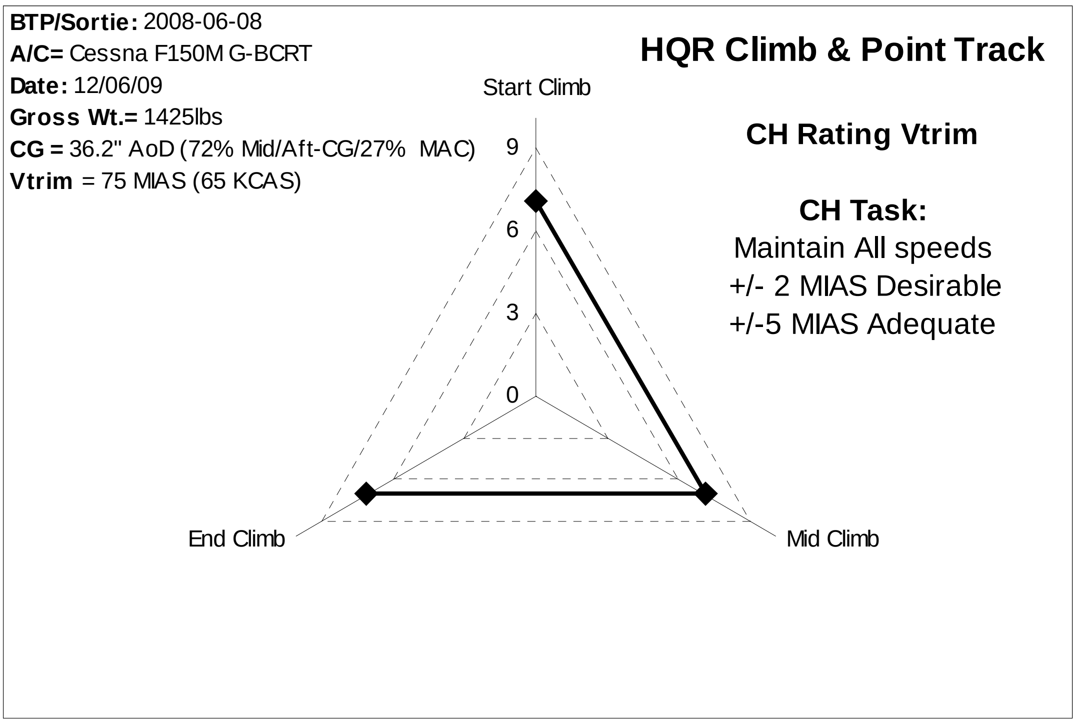

Figure 6, Cooper-Harper Handling Quality Ratings, Climb & Point Tracking, Cessna F150M – Full Test

During power on stall testing, both the Cessna 150 L & M exhibited more aggressive stall characteristics than the Cessna 152. In some cases, there was only limited advanced warning of the onset of stall and aircraft failed to meet CS23 [7] requirements in that, for example, a C150M in the landing configuration with greater than 65% power was capable of entering an incipient spin at the point of stall, as well as the previously mentioned failure to demonstrate a clearly discernible stick force gradient

LESSONS LEARNED

Lessons from the Flight Test Engineer

- Utilising standard (unmodified) flying club aircraft for flight testing requires fully portable flight test techniques and equipment.
- Simple issues such as the access to aircraft power for portable equipment vary from aircraft to aircraft.
- Working within an academic budget usually means working within strict limited a limited budget where flying time is money – so proper planning and the identification of required programme changes as early as possible is required.
- Quickly identifying the points of greatest interest for each aircraft tested can save valuable time & money further down the line in the programme.
- The importance of coinciding qualitative pilot assessment of aircraft handling qualities (HQRs), which can often appear subjective and erratic to an Engineer, as well as the better understood use of quantitative analysis has been proven. The pilot qualitative analysis adds a workload dimension to the task being performed not easily measured by an instrument.
- The use of a 'calibrated' TP is therefore essential for consistency in comparison of results. The data reduction process can be considerably shortened by using Test Cards designed with data reduction in mind – a 'key it once' philosophy pays dividends and can reduce data reduction time between sorties (all reports completed within 24 hrs).
- Expect technical problems with the technology and build in redundancy where possible. The CVR was invaluable in this respect, but there is never in this sort of testing a good reason not to take reasonably detailed notes in flight.
- For technical reporting, the conflict between academic rigour and brevity was also apparent; it is tempting to thoroughly analyse and report every test point in every flight – in reality this is completely impractical at any sensible sortie rate, and in addition attempting to do so means that reports seldom are written rapidly enough for any corrections to be made from crew memory: the old requirement for a 24 hour PFR is one which the authors found important to try and adhere to, with that timescale dictating reporting depth. Further analysis can be completed from data later as required, so long as it has been adequately recorded and indexed.

Lessons from the Test Pilot

- The largest lesson of this programme, learned during an unexpected and undesired incipient spin, was that even relatively docile (and certified!) GA aircraft can present the pilot handling with extreme attitudes and a need for emergency handling actions. To this end briefing for possible emergencies was always necessary before leaving the ground, and regularly in flight – for example briefing spin recoveries before a stall test.
- When using aircraft within a flying club environment, expect them to be sub-optimal; flying training is a low-margin industry and aeroplanes routinely carry multiple faults.
    - A thorough review of all documentation and pre-pre-flight is paramount.
    - In the aircraft tested, 1 in 3 W&CG schedules contained errors and serious consideration was given to re-weighing the aircraft as a result.
    - Hiring flying club aircraft means fitting within a schedule designed to maximise use of the aircraft. A test team who wish to postpone testing because of conditions which are suitable for normal club flying but unsuitable for the test in hand are costing the operator money and losing goodwill. This requires continuous communication and introduction of a certain level of programme flexibility which might not be what the test team really would prefer
    - No-go criteria must be established, agreed, and stuck to. Whilst this is of-course true for all flying, they are often more restrictive for test flying, and the aircraft operator must be given opportunities to understand, and hopefully accept, the test teams criteria.

Team lessons

- CRM is as important in this test environment as in any other. In particular, the team whilst formally divided into TP/FTE should understand and use each other's skills. In the authors' case this was well illustrated when the pilot's seat became unlocked during a performance climb – a known Cessna fault, but potentially serious if the level of collaboration between the crew had not ensured this was reduced to a non-event.
- Co-ordination of HQR[**8**] and quantitative assessment works extremely well, and in particular the use of FDR data to demark tasks into broad HQR brackets based upon demonstrated adherence within desirable and essential limits.
- Definition of the Cooper-Harper task is never trivial[**9**], and should be regarded as one of the major components of test planning. Criteria used for task construction can, and did, include PPL and CPL test requirements, margin above the stall, margin below the speed which gives a zero rate of climb, the speed range which gave close to scheduled climb performance, being able to compare similar results between different aeroplane types, and developing experience of operating the aeroplanes. Task definition, effectiveness in addressing

the research question, and potential for improvement, along with requirements for maintained standardisation with other results, should be a routine part of sortie debriefs.

CONCLUSIONS

For the specific aircraft tested and associated test configurations, the centre of gravity appears to minimally impact, and flap setting and power strongly impact the apparent longitudinal static stability. From the pilot's perspective, corresponding stick forces decrease, as would be expected, with aft movement of the CG and the associated stick force cues become weaker. This degrades the pilot's ability to track and maintain airspeed during critical phases of flight such as the climb, landing and go-around. For more experienced pilots, they have to work harder to track and maintain airspeed. An event trigger, leading to a significant deviation from the target airspeed, could result in a significant reduction in safety margin, with potential for LoC.

FURTHER WORK

This research is very much an ongoing programme, and the team's short to medium term objectives fall into four parts:

- Additional flight testing (phase 2) with other examples of the Cessna 150 L, M and Cessna 152 is necessary to establish whether the results so far demonstrate fleet-wide characteristics or are specific to each aircraft tested. The test will focus on critical test cases only.
- The research programme will also be extended to other aircraft types with marked differences in fatal accident rates for further insight into the LoC problem. In particular, the team hope to investigate the two groupings of straight wing Piper Cherokees (such as the PA28-140 and PA28-160) versus the newer tapered wing variants (such as the PA28-161 and PA28-180RT) which statistically exhibit similar patterns to the C150 versus C152 groupings (if anything more pronounced, with no tapered wing LoC related fatal accidents in 27 years of available UK records.)
- A series of simulation tests in the controlled environment of the university's Merlin MP521 flight simulator (Figure 7) is also planned. The tests will re-create potential LoC scenarios under different apparent longitudinal static stability conditions, using a group of approximately 50 volunteer pilots representative of the current UK GA community. Pilot workload will be investigated (particularly using measurement of heart rate and eye motion) in addition to the evaluation of handling quality rating group-crossovers as previously described for flight testing.
- Desktop modelling of the 'pilot in the loop' with Matlab / Simulink is also planned with varying stock force gradients and other aircraft control system characteristics to gather additional data for comparison. Initially it is hoped to generate a model which is representative of working PiL

models whilst giving similar results to those generated experimentally, particularly for the data-rich C150/C152 study. Subsequently, it is hoped that this model can be modified within limited parameters (for example stick force gradients or pilot reaction times) to allow tentative conclusions about the safety implications of a wider range of aircraft characteristics than those already tested.

Figure 7, Brunel University's Merlin MP521 Reconfigurable Flight Simulator

More tentative, longer term plans involve converging this research into LoC and in particular LoC avoidance with another BFSL programme investigating performance of light aeroplanes at low level (in response to a requirement from the air racing community) to investigate best actions following, and safety planning for, engine failures or glider cable-breaks at low level.

ACKNOWLEDGEMENTS

Thanks to Dr Mark Young for his support and encouragement during the course of the research to date. We also gratefully acknowledge the financial support of the Thomas Gerald Gray Charitable Trust Research Scholarship Scheme. The General Aviation Safety Council’s ‘Stall/Spin Working Group’ provided initial accident data. The Civil Aviation Authority (UK) who provided accidents reports, on which statistical analysis was based. Thanks also to Roger Bailey, Chief Test Pilot of the National Flying Laboratory at Cranfield University for his assistance in allowing the calibration of the Appareo FDR in Cranfield’s Jetstream flying classroom.

APPENDIX A – Pseudo CAS

During the flight test programme, quantitative data obtained from the portable flight data recorded was used to determine the airspeed point tracking qualities of the aircraft during the climb. The flight data recorder used for flight test, records all airspeeds as groundspeed in knots, including wind effects. It was necessary to convert this into a 'pseudos CAS' airspeed to correct for density altitude in the climb and wind effects. Ignoring compressibility effects and assuming wind is zero, then using McCormick [**10**] & Gratton [**11**]:-

$$V_{CAS} = V_{EAS}$$

Where:-

$$V_{EAS} = V_{TAS}\sqrt{\sigma}$$

And

$$V_{TAS} = V_{GND} + V_{WIND} COS(\phi_{AC} - \phi_{WIND})$$

Then substituting gives:-

$$V_{CAS} = V_{GND}\sqrt{\sigma} \qquad \textbf{(Equation 1)}$$

From McCormick again:-

$$\sigma = \theta^{4.2561}$$

$$\theta = 1 - 0.02256h$$

Where *h* is altitude in kilometres.

BIOGRAPHIES

Mike Bromfield (presenting author)

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Education:

- Bachelors degree in Aeronautical Engineering, University of Bath, UK 1984
- Master of Philosophy in Engineering Design & Simulation, University of Glamorgan, UK 1988
- Diploma in Management Studies, University of Glamorgan, UK 1988
- Currently in full-time study for a PhD in Aviation Safety, Brunel University, UK

Highlights of Flight Testing Experience:-

- In 1979 commenced a sponsored Engineering Technologist Apprenticeship with Westland Helicopters, Yeovil, UK. During that time was seconded to the Flight Test department to gain experience in flight test. Flew in rotary wing aircraft including Navy Lynx, Sea King, Commando, and WG30 as FTE recording flight test data. Seconded to the Aerodynamics department to conduct data reduction & data analysis of flight test data to 'close the loop'. After completing my apprenticeship and graduating, left Westland Helicopters to pursue interests in Information Technology & Management Consultancy.
- In 1997 gained my PPL whilst living and working in Australia, and re-kindled my interest in all things aeronautical. Since built up pilot in command time in 12 different GA aircraft types as well as developing interests in flight safety.
- In 2007 joined Brunel University as a Research Assistant to study (full-time) for a PhD in Aviation Safety. Conducting research with Brunel Flight Safety Laboratory into 'factors affecting loss of control of general aviation aircraft', the single largest category of fatal GA accidents in the UK. Also teaching Aviation Safety to final year undergraduates on Brunel's Aviation Engineering with Pilot Studies course.
- In 2008, attended the National Test Pilot School's short course 'Performance and Flying Qualities of Fixed-Wing Aircraft' to update skills and knowledge after considerable 'time out'.
- Currently acting as FTE on the BFSL GA research flight test programme and am responsible for the development of test plans, data reduction and data analysis. In addition to this, also responsible for the technical support of 'off-the-shelf', portable FDR equipment.

Dr Guy Gratton
Head of Brunel Flight Safety Laboratory (Brunel University) &
Head of Facility for Airborne Atmospheric Measurements (Cranfield University**)**

Education:

- Bachelors degree in Aeronautics and Astronautics, University of Southampton, 1992.
- PhD in Airworthiness evaluation techniques, University of Southampton, 2005

Highlights of Flight Testing Experience:-

- Flight test Engineer at Boscombe Down shortly after graduating from University, flew mostly in training and ground attack aeroplanes, including being "chief turn counter" for Tucano spinning trials, where we discovered the joys of going from -2½g in an inverted spin to a 4g pull out in 2 seconds, then regaining consciousness a few seconds later, as well as 19 turn erect spins which were supposed to be 6.
- Progressed to being head of Environmental Test from 1996-1997, managing facilities for environmental testing of the EH101 Merlin, Lynx AH8 and Saab JAS-39 Gripen..
- Chief Technical Officer at the British Microlight Aircraft Association from 1997-2005, also head of Flight Test and becoming approved by the CAA as a Test Pilot on Microlight Aeroplanes from 1999. Flew within numerous programmes with take-off weights from 350 to 1,000 lb, covering several control systems and 6 first flights of new-build aeroplanes, 3 of them new variants. During this period also did a part time PhD that concentrated upon departures from controlled flight and development of light aircraft flight test techniques.
- In 2005 joined Brunel University to teach various aircraft design and operational subjects, and also founded Brunel Flight Safety Laboratory – concentrating upon GA safety research.
- In 2008 became head of UK government funded Facility for Airborne Atmospheric Measurements, operating the BAe-146-301 large Atmospheric Research Aircraft (ARA) based at Cranfield.
- Currently head of both BFSL and FAAM, flying (not often enough) as back-end crew on the ARA, as a TP for light aviation research projects and for occasional BMAA testing. Currently have logged 100 types as operating crew, 50 of those as Pilot in Command, and about 2/3 of those types in some form of flight test.

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