Protecting the flight test programme

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Abstract

Considerable effort is put into the safety risk assessment of any flight test programme - and rightly so, since failures to apply best practice in this area may cause significant expense, and *in extremis* loss of life.

However, it must also be remembered that the flight test programme itself is an essential component in the development of the aircraft or system, and that even if safety is never compromised, the failure of a test programme to deliver the required results on time and budget can cause failure of the entire aircraft programme.

This paper considers the areas in which planning and conduct of a flight test programme should be protected. In particular it considers the conduct of flight test personnel in ways which go beyond *only* safety training, the important of documenting all flight test planning and conduct and the continuous justification of flight test conclusions, planning project manning to ensure that the loss (for whatever reason) of key personnel or equipment does not cause complete failure of the flight test programme, how to recover from significant programme disruptions, and most importantly whilst protecting or recovering the flight test programme – how to ensure that safety is not compromised in the process.

The relationship between safety and programme objectives

It is pertinent before commencing upon any flight test programme to question why it is to be flown. Generally the reasons will fall into one or more of three categories, which are (a) to learn something new about either the aircraft or some aspect of science, (b) to demonstrate either that the aircraft itself can be operated safely, or if not why not, and (c) to determine some aspect of safe operating limitations.

In this context, safety becomes a means to an end, not an end in itself. If safety is compromised, then this will at the very least cause cost. Damage to an aircraft or to equipment under test will require costly repairs, and in all likelihood compromise flight test data. A particularly public accident can additionally dent the credibility of whatever item is under test, which it is likely the flight tester's employer hopes to sell. An additional risk of-course is that of injury which apart from the obvious human tragedy, is likely to remove key personnel from the programme.

So, any accident, unserviceability, or injury is likely to cause cost and delay. This can dent sales, or even have such an impact upon the programme as to prevent the product ever becoming viable for the end user at-all. The end result of this is likely to be unemployment for many within an organisation, including those within the flight test department.

The conclusion then is clear, the flight test programme itself must be protected, this is additional to, but not separate from, all obvious and necessary requirements to protect flight test safety itself.

Continuity and programme protection issues at the BMAA

The British Microlight Aircraft Association (BMAA) is responsible for the oversight of a fleet of approximately 3,500 aeroplanes, predominantly in the United Kingdom. This oversight includes the approval of new amateur built aeroplane types at a rate of about 2 types (plus numerous variants) per year, as well as annually the flight testing of around 60 new amateur built aeroplanes, each of which must, even if apparently a "series aircraft", be assumed to have some variation from a known good standard. Further flight testing may include safety investigations or major modifications such as flying control or powerplant changes. This is managed centrally from the association's technical office in Deddington, Oxfordshire using a pool of 13 variously qualified Test Pilots who all have other professional activities and are spread across the country. Flight Test Engineers are not normally used in microlight flight testing, although senior airworthiness engineers may sometimes take this role.

A typical prototype test programme (for example, to obtain approval data for an aeroplane type which is either new, or new to the UK) is likely to only own one aeroplane with limited instrumentation, and primarily managed by a small team at a location remote from the Deddington technical office. Budgets are likely to be small, and predicated upon an early ability to release the aircraft onto the market. It is also likely to be the case that the team managing the project "in the field" have no prior experience of such a project, and so need to bring in external test flying expertise, as well as learn about issues such as design control and reporting for which they have limited preparation or sympathy.

A typical recent example of this was that of the clearance programme for the Savannah VG (Figure 1 below) which is a derivative of the better known MXP740 Savannah (Reference **[1]** and Figure 2 below). The Savannah VG shared a fuselage with the earlier MXP740, but boasted an uprated powerplant, removal of leading edge slats, and fitment of leading edge vortex generators intended to keep upper surface flow attached at high angles of attack. In simplistic terms, the aeroplane had a new wing and new engine, thus requiring a substantial re-assessment of take-off and landing performance, longitudinal static and dynamic stability, stalling and spinning characteristics, as well as a less substantial requirement to re-evaluate lateral and directional stability and control, powerplant behaviour, and conduct some CG range expansion. This was projected to a flight test programme of around 20 hours, which would be conducted from the company's base at Sandtoft airfield, some 220 miles from Deddington, and 150 miles from the nearest test pilot's usual base.

Figure 1, Savannah VG UK prototype

Figure 2, MXP740 Savannah

Figure 3, Savannah VG leading edge vortex generators

A single test pilot was allocated to the programme, with remote management of his flying of the programme being agreed by the Chief Test Pilot and Chief Technical Officer combined with local design control and maintenance management. Initial progress was steady but erratic – the requirement to coincide availability of the test pilot, small support team, aircraft, and weather, usually with some notice required to all parties, means that microlight flight testing often progresses as pauses then leaps forward. The programme had however progressed about 15 hours when due to a serious accident whilst flying an unrelated test programme, he became suddenly unavailable. It was rapidly realised that there was no available test pilot current on type, putting progress of an important programme in significant jeopardy. So, the BMAA and company management teams were faced with the problem that only having had a single pilot fly the aeroplane, but also with the realisation that any opinions about the aircraft had come from a single test pilot, who was not now readily available to discuss them. Inevitably, the last part of the programme was also the higher risk part.

In this case, there was approximately a 1 month delay in the programme, before another test pilot became available – this was fortunately a pilot who had 4 years previously participated in clearance of the MXP740 variant, so was familiar but not current with the type. Bringing that pilot into the process so late meant initially a substantial documentation review, since he had to both re-familiarise himself with previously tested aircraft characteristics, and become fully familiar with a substantial amount of flight testing progress, conduct his own review of this and understanding all of the conclusions and recommendations (some of which were disagreed with, also requiring additional senior management involvement). One product of this review was the conclusion that the spinning evaluation required some re-visiting; this created an additional time-consuming difficulty, which was the need for this test pilot, who had not flown a spinning programme for several years, to obtain re-currency training. Further complications were introduced by the operating company using this opportunity of delay to implement a planned design change, without communicating this to the BMAA. Overall it can be seen that the lack of a second test pilot in the programme caused both substantial delays when a key individual became unavailable, but substantial extra time and cost once a suitable replacement was found.

An alternative example at BMAA shows how sensible programme protection can ensure continuity. During the flight test programme of the British variant of the French X’Air ‘F’ (Reference **[2]** and Figure 4 below) , which was scheduled to be an approximately 40 hour programme (in practice somewhat longer, as is often the case) two test pilots were allocated to the programme, who shared the flying. Only one of these was current on spinning, and so he was scheduled to fly the spinning programme in the aircraft. When it came to the programme however, it was found that his relatively large frame rendered him unable to fly the aircraft whilst wearing the personal parachute and helmet considered necessary. The problem however was reasonably readily solved by flying the spinning programme with a 2 test-pilot crew of the second (type but not spin current) test pilot, and a third test pilot who was both spinning current and had maintained a watching brief on the programme. Thus any time and cost penalties were minimal.

Figure 4, X'Air 'F' (also known as the X'Air Falcon)

Appropriate programme protection

The section above might well give the impression that the authors would advocate a strenuous programme protection plan for every flight test programme. This is not the case; it must be considered that just as programme delays cost money, so to do the measures required to protect the programme. However, the subject should always be considered, in two important contexts:

(a) How important is programme protection?
Before undertaking a protection plan, consider the alternative methods – from full duplication of the programme resources (somewhat extreme and expensive) to simply ensuring that all plans and reports are copied to a competent flight test professional (reasonably low cost). There is no absolutely correct answer to this problem, but it is always preferable to consider the issues and to deliberately decide upon the approach that fits a particular programme, rather than either ignore the issues (probably ensuring that protection is inadequate) or automatically applying stringent protection measures which may be over-complex and over-expensive for the task.

(b) Physical safety and programme protection must be related.
Throughout any consideration of programme protection, it must never be forgotten than physical safety is inextricably linked to programme protection. If the safety case is taken to the extreme that all flying ceases for a period, whilst all involved are extremely safe, the programme itself comes under serious jeopardy. Conversely, whilst measures may be taken to protect or to recover a programme – this should never be allowed to remove focus from the requirement for operational safety, since a subsequent accident whilst maintaining or restoring an important programme is unacceptable both in terms of human and financial cost, and in terms of the effect that this is likely to have upon the programme itself.

An example of a successful minimally protected programme

Approval was being sought for approval of the Verner 133M Engine (Reference **[3]**, Figure 5) in the United Kingdom for use on microlight aeroplanes. This was not a major project at that time, being considered by the importer of the X'Air series of aircraft as a potential alternative to the more commonly used Rotax 582 and 912 **[4]** and Jabiru 2200 **[5]** engines. An X'Air 'F' aircraft was available as a test bed which could be made available, but release of the aircraft was not urgent, whilst failure of the programme carried limited commercial risk.

Figure 5, Verner 133M Engine fitted to X'Air 'F' Aircraft

In this case, the approach taken was deliberately minimalist; a single aeroplane and test pilot were allocated, with testing conducted as the pilot and aircraft were available. All tests were documented promptly, but little else was put in place in terms of specific programme protection. Confidence in this approach was borne out by the results, which were a successful programme (in that it was conducted within the long time and small financial budgets set) and sufficient data being obtained to allow approval of the engine – despite several occasions where mechanical failures or unavailability of the test pilot needed to be accommodated.

Consideration of programme recovery

Consider the case that a programme protection plan is in place, and something goes wrong – varying from the less extreme case of the project test pilot being rendered unfit to fly by a prolonged cold, to the more extreme case of severe damage to an aircraft and an injured test crew. Regardless of the circumstances, the programme must be got back on track – to protect the programme, and ultimately the organisation. Change in the way the programme is managed is inevitable – particularly where key personnel are changed, since no two flight testers will have an identical approach to management, safety assessment, or the development of flight test conclusions. Whilst recovering the programme, this is the time when physical safety of aircraft, crews and other parties must now be considered with great care. The following questions should be asked:

- Are the replacement test crew current on type and variant?

- Are the replacement test crew current in the flight test techniques in use?
- With any changes in personnel and approach, are the ongoing conclusions and recommendations still fully supportable and self consistent?
- Do any changes in any management approach cause either unnecessary and expensive duplication of previous testing effort (some is almost certainly essential of-course to bring new crews up to speed) or, far more seriously, the inadvertent omission of important aspects of testing?
- Is any revised physical safety plan proportional to the actual flight test risks involved?

It is essential that neither programme protection, nor physical safety measures are allowed to take sufficient precedence that the other suffers badly.

Conclusions

Golden rules for programme protection:

(1) Always have a second flight tester in the aircraft early in the programme, and keep them current on both the programme and the aircraft.

(2) Always keep all planning and test reports in circulation to all players in the programme.

(3) Always have a second specialist in the decision loop where recommendations are made.

(4) Document everything that goes on during a programme.

(5) Use some form of visible completion matrix to document test programme progress.

But also always consider:

(1) How important is programme protection for a particular activity?

(2) The relationship between programme protection, and physical safety.

And finally

Never take approach or training for either programme safety or physical safety for granted – there is no standard answer for either.

Authors' Biographical Information

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began flying in 1954, graduating in 1959 as an RAF pilot. After a tour on Hunters, he became an instructor on Chipmunks and Piston Provosts. He later commanded a flight of Wessex helicopters, seeing action in Northern Ireland. After the RAF he flew and test flew S61 helicopters with BAHL over the North Sea. Next, Tom set up an aviation consultancy from which he joined British Gas, becoming Aviation Manager. In 1999 he set up Wyvern (UK), auditing business aviation concerns. Tom is now CTP for BMAA and Thruster Air Services, and project test pilot for Reality Aircraft, also recently certifying the WT9 Dynamic.

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started at RAE in 1988, then Southampton University. After graduation he worked as a fixed wing FTE, then Environmental Test manager at Boscombe Down. Leaving there in 1997 as BMAA's Chief Technical Officer, Guy became approved by the CAA as a TP in 1999 and gained a PhD in aerospace engineering in 2004. Since 2005 Guy has been at Brunel University, but still test flies for BMAA and for aeronautical research purposes - he has flown 97 types as either pilot or FTE and won the safety in mechanical engineering award, Astridge aerospace safety medal, and SETP's Salmon award.

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