A dispersed airworthiness management system — The model of the British Microlight Aircraft Association

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Abstract The British Microlight Aircraft Association is presented with an unusual problem of managing the continued airworthiness of a fleet of about 3,100 aircraft, of about 150 types, dispersed across several countries. This paper describes the problems faced in managing this task, while maintaining both low operating costs and an acceptable safety record.

THE TASK IN HAND

The problem presented to the British Microlight Aircraft Association (BMAA) is a daunting one, but not unique. It is responsible, by delegation from the UK Civil Aviation Authority (CAA), for the initial and continued airworthiness of the British fleet of microlight aircraft. This fleet, some 3,100 strong, comprises about 19 per cent of the UK civil register. The range of the fleet covers about 150 individual types, using three distinct control systems. While the fleet is primarily located in the UK, aircraft also operate routinely in Eire, France, the Gambia, Portugal, the Channel Islands and the Isle of Mann, and may be expected to fly through the national airspace of any country (as evidenced by two recent round-the-world flights, most recently a successful solo bid by Colin Bodill).

The operators of these aircraft are generally individual owners or small flying clubs and schools, whose technical facilities are usually limited. The objective within the UK is for the fatal accident rate to be no worse than General Aviation as a whole (currently about one fatality per 70,000 flying hours[1]). It is also an underlying objective (although to a large extent one which is subservient to the accident rate) that the operating costs of these aircraft are maintained well below those of equivalent light aircraft.

The task of the BMAA in managing the airworthiness of this fleet became enshrined in the 1980s, when microlight aircraft started to become widespread in the search for low-cost private aviation. The UK CAA, like most national aviation authorities (NAAs) became concerned at the high fatal accident rate and perceived level of public nuisance. The CAA (again similarly to counterparts in other countries), however, found that it lacked the expertise or resources to investigate and manage the safety of these aircraft and therefore opted for the solution of delegating airworthiness responsibility for this fleet to a national association. In the

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UK, this association was the BMAA, which at that time existed only as a sporting body. The CAA delegated powers to it, subject to its being re-established as an 'approved organisation', and maintaining a core of professional staff to administer this. From this inception, the BMAA has built up the current system, which is now maintaining a fatal accident rate of one per 50,000 hours, an acceptable value, although still short of the intended target.

The author presents this paper, not only as an explanation of how this particular system works, but also as an example to other operators (for example, other airsports organisations, or operators with multiple aircraft spread over large and sparsely populated areas) of how the problem of maintaining acceptable standards across such a fleet may be solved.

The BMAA's system is unique neither in the UK nor internationally. Similar organisations such as the British Gliding Association (BGA) or the German Ultralight Aircraft Association (Deutscher Ultraleightflieger Verband/DULV) do exist. The BMAA believes, however, that it possesses one of the most mature and efficient systems worldwide, and so far as information is available, this system maintains the lowest rate of fatal accidents worldwide in airsports aircraft.

IN-SERVICE AIRWORTHINESS

The key to in-service airworthiness is inevitably maintenance and inspection. When operating a large and mainly co-located fleet such as a military squadron or an air transport operator, this task may be rigidly controlled while maintaining good efficiency. When operating a geographically scattered fleet, on some hundreds of sites, it may not. It is therefore necessary to devolve day-to-day responsibility for the maintenance and inspection of aircraft to individual operators.[2] Because of the large number of these, it is also inevitable that the minimum qualification level of the persons maintaining the aircraft is comparatively low.

The solution used within the BMAA fleet is maintenance and inspection schedules that are technically undemanding, but which compensate for the simplicity of the inspection regime by very low intervals between inspections. Depending upon aircraft type, intervals of 12–50 hours are normal. This is sustainable in the short term, but is not sustainable in the long term, since mediocre inspection and maintenance standards will eventually accumulate to create safety problems. In order to ensure that this does not occur, an additional and independent inspection is also required. This inspection, which must be carried out annually, is by an independent BMAA Inspector, who is an individual holding qualifications equivalent to those of a self-supervisory maintenance technician. This annual inspection is specifically not equivalent to the strip-down inspection that is carried out under LAMS[3] for conventional operators (and which usually requires considerable downtime of a valuable asset); instead, the annual Permit to Fly Renewal is conducted as a detailed audit of the owner-operator's good care and maintenance of the aircraft. Each aspect of the aircraft's operating record is examined, and a duplicate inspection is made of all repairs, parts replacements or previously approved modifications.[4] Additionally, the aircraft itself is inspected to a standard roughly equivalent to a 50-hour inspection.

This method has proven itself highly effective in the prevention of developing problems, and the correction of slipping maintenance standards. It is also supplemented by a mandatory check-flight (air-test), however, carried out by a suitably qualified pilot, who is again independent of the owner-operator (but

inevitably current on type, the present requirement being 10 hours on type within the previous year), within one month of the inspection.[5] This provides both a second (albeit more cursory) check on the condition of the aircraft, but primarily ensures that any loss of engine performance, or marginal problems with flying controls or missed airframe deformation are identified. The check-pilot qualification is separate from the inspector's qualification, but inevitably complementary, for which reason many professionals within the microlight operating community will hold both qualifications. Where an aircraft is found essentially satisfactory, the total downtime of an aircraft for its annual renewal is likely to be between half a day and two days, depending upon the age and complexity of the aircraft. The most common reasons for greater downtime are either failure at inspection of temporarily unavailable components (a problem which is far from unique to microlight aircraft!), or the lack of suitable weather in which to carry out the check-flight.

A further restriction that has been found necessary for the safe operation of aircraft within this environment has been the regular (approximately five-yearly) preparation of a weight and balance (W&CG) report.[6,7] Owing to the relatively unsupervised operation and maintenance environment, cumulative modifications or minor repairs can accumulate to place an aircraft overweight or out of CG limits — an obviously unacceptable event. This five-yearly weighing (not simply the preparation of a new report from existing data) is somewhat onerous and was introduced following a series of accidents, one fatal, due to W&CG 'creep'. Since the introduction of this practice, no further such accidents have been reported and the UK CAA is currently proposing to incorporate the practice into law at the 2001 or 2002 routine amendment of the Air Navigation Order.

MODIFICATION AND REPAIR APPROVALS

As with the maintenance issue, the level of engineering talent capable of correctly assessing any aircraft modification is limited. Because of this, early in the creation of the BMAA system, it was identified that modification approvals had to be centralised. Therefore a system was devised[8] whereby applications may be made by any aircraft owner, via their local inspector, to the BMAA technical office, which maintains the capability to handle a large number of such applications. A simplified approach is encouraged by the publication of recommended 'standard methods' for certain modifications — encouraging applicants down relatively narrow but straightforward routes.[9,10,11] This has twin benefits of largely reducing the manpower and other resources required to complete approval of an aircraft modification, and that of standardisation — pilots and inspectors may reasonably expect certain items to be configured only in certain ways.

The approach used is for an application to be made to the central technical office,[12] which in the first instance will be classified Major or Minor, using the definition contained in the Joint Aviation Requirements, at JAR-21. The applications are then streamed to staff who are variously specialised in the approval of one of the three categories of 'Major', 'Minor' and 'Major Series' modification. Any further information required for approval of a modification is then obtained by direct contact between the employed technical staff and the applicant. Because of their degree of specialism, technical staff have become extremely accomplished at obtaining the required information (or reliable assurances that the correct design practices have been applied), with

minimum communication difficulty, from applicants who often have no formal technical knowledge.

One difficulty that has been experienced is that of protests as to the relative classification of modifications. This is a significant issue among aircraft operators dealing directly with the CAA, since there is an order of magnitude difference in the cost to an applicant between major and minor modifications. In order to avoid this, and prevent pressure being applied to down-classify modifications inappropriately on cost grounds, a single flat fee is charged for all such applications. This fee is set sufficiently high to dissuade frivolous applications, but nonetheless is sufficiently low that (a) few operators consider it worth the legal risk of operating with unapproved modifications, and (b) virtually all modifications are processed at a financial loss to the BMAA. It is accepted that this operating loss on the specific activity is a normal part of working principles; the cost being recovered by a small loading to the annual fee charged to each operator for validation of an aircraft's permit to fly. In effect, the system works as an insurance policy — against a requirement to modify each aircraft. While apparently unfair, this financial approach has operated for some 15 years, and is universally accepted as a reasonable and working system by aircraft operators.

Similarly, approval of repair schemes following damage to an aircraft is handled through the central technical office. In this case, in order to dissuade operators from making unapproved repairs, no charge is made for the technical work involved in repairs. This again is paid for by a small loading to the annual permit renewal fee — in effect providing a form of insurance. Apart from the difference in payment, repair schemes are treated as if they were modifications, and are subjected to the same technical approval process.

TEST FLYING

Inevitably, aircraft require test flying — this may be as part of the approval process of a modification, following a repair, or simply for the purposes of annually renewing a permit to fly. All test flying within the BMAA system is authorised through CAA F1 B-conditions (for the benefit of non-UK readers, this is a form of company approval which permits aircraft to be flown, subject to an agreed series of procedures, without the need to hold a valid Certificate of Airworthiness or Permit to Fly;[13] it is most commonly used for test flying purposes). In obtaining B-conditions, it was necessary to formalise the training and approval of test aircrew — particularly since the BMAA operates within financial constraints that make the recruitment of already experienced test pilots largely unfeasible.[14]

The system developed depends almost entirely upon semi-independent assessing pilots (dedicated flight test engineers being a luxury largely unaffordable in this environment). It was never considered sensible to have a single category of assessing pilot (such as is the case in a military flight test environment) or to consider each individual pilot's experience and qualifications for each task (as is practised by the UK's Popular Flying Association). Instead, three separate categories of pilot were defined as shown below.

— *Test Pilot Class 1 or TP1*: Qualified to carry out first flights of new aircraft types as well as lesser tests. This will be a highly experienced microlight pilot able to recognise flight test characteristics and able to produce clear and concise flight test reports. Normally such a person should have at least 500 flying hours as captain of aircraft in the same or similar classes as those that he or she is to be qualified to test.
— *Test Pilot Class 2 or TP2*: Qualified to carry out first flights of production aircraft and tests where flying qualities may have

been modified as well as lesser tests. This should be an experienced microlight pilot, able to recognise flight test characteristics and able to produce clear and concise flight test reports. Normally such a person should have at least 300 flying hours as captain of aircraft in the same or similar classes as those that he or she is to be qualified to test.

— *Check Pilot*: Qualified to fly aircraft on which they have sufficient experience for validation of a permit to fly, or for assessment of low-risk modifications (such as new propeller configurations); a competent microlight pilot, with at least 150 hours as captain of microlight aircraft and no recent record of dangerous or illegal flying.

A further subdivision is made by aircraft class, so that, for example, an individual may have a TP1 3-axis and a TP2 weightshift qualification, reflecting the relative proportions of their expertise (3-axis and weightshift are the two most common microlight control systems, the former is identical to that of a conventional fixed wing aeroplane, the latter is the classical microlight configuration, derived from a powered hang-glider).

The hours requirements are obviously low by the standards of commercial aviation, but are appropriate for microlight aircraft, where the hours required to obtain a private pilot's licence can be as low as 25 hours, and no commercial licence exists beyond instructors' qualifications (which can potentially be gained with under 200 hours). No doubt in an environment operating more complex aircraft these hours would be multiplied several times; however, the author would caution anybody considering mimicking this system that, in the BMAA's experience, the quality of an individual when assessed for test flying duties has little relation to their recorded flying hours. What has proven vitally important is a rigorous system for the assessment of test pilots, without which the quality of individuals to work this system could not be assured.

Depending upon the nature of the task, test flying is commonly carried out to standard schedules, which are usually excessive for a specific task, but in practice it is more economic for all concerned if testing is carried out to a familiar schedule,[15,16,17] and completed rapidly, than for shorter and more specific schedules to be developed and approved for each task.

CERTIFICATION OF NEW AIRCRAFT TYPES

While most of the activities described above will be familiar to any aircraft operating organisation, the certification of new aircraft types[18,19] may not. The BMAA routinely carries out type certification by delegation from the UK CAA. At present, this is confined to two spheres of activity: first, the investigation of old pre-regulation types on the basis of service experience and partial compliance with current safety standards[20] (termed Type Acceptance) and, secondly, the investigation of new types to the UK (whether imported or UK developed) for amateur construction (termed homebuilt approval).

In essence, this activity (which runs to perhaps six types and ten variants per year) is dealt with in a similar manner to the approval of modifications. Inevitably, the technical task required is considerably greater, and it is more likely that applicants will require professional technical assistance than a modification, but the overall process is essentially the same. In all such cases, independent test flying (that is by test aircrew approved by the BMAA but independent of the applicant) is considered essential. This is partly due to the legal requirement for independent assessment and partly because,

in a small company, personnel who have been actively involved in the airworthiness investigation and reporting of a project will almost inevitably tend to become considerably less current as aircrew than is desirable for such a task. The BMAA does find itself coming under pressure to waive these requirements owing to commercial pressures, which it resists; the encouraged option is to foster links between organisations, not in direct commercial competition, which may then provide the independent assessment function for each other on a *quid pro quo* basis.

TRAINING AND AUDIT OF KEY PERSONNEL

Although there is a limited interchange of skilled personnel between the microlight aviation community and other sectors of professional aviation, this is insufficient to disregard the requirements of training key technical personnel (which largely means inspectors and test pilots). Additionally, as with any large organisation, the BMAA has many peculiarities which are not necessarily obvious to an incomer to the community, regardless of their previous level of achievement or seniority. Therefore, it is essential that the BMAA maintains a system of training.

Inspectors

Continuous Professional Development (CPD) training of existing inspectors is primarily managed by arrangements with aircraft manufacturers or importers, who will usually be prepared to arrange short courses for inspectors for reasonably minimal costs. The motivation of companies in readily providing training is that they wish their products to be well supported, something facilitated by ensuring that inspectors, as the local source of expertise, are fully familiar with their products.

Initial training is also partly provided, where opportunities arise, through these courses. The main core of initial training, however, is by apprenticing a new inspector (who will already have been subject to a vetting process, including examination of their professional and educational qualifications) to an existing experienced individual, whom they will assist for as long as it is necessary for both persons to be fully satisfied with the new applicant's competence. Following this period, an audit will be carried out by the 'senior' inspector of the newcomer's competence — subject to this audit being satisfactory, the qualification will be awarded, with sub-qualifications covering each individual area of competence (eg wooden structures, fabric covering and 3-axis controlled aircraft). This process of audit is then repeated on a three-year rolling cycle throughout the inspector's career, with failing inspectors temporarily suspended until any necessary further training has been arranged and a successful audit carried out. Not being responsible for their remuneration, the BMAA is in the happy position of being able to qualify as many inspectors as are suitable — the removal of qualifications is usually only carried out on disciplinary grounds.

Test pilots

Test pilot training is initially offered through a self-paced syllabus[21] and opportunities to work under the supervision of experienced test aircrew. Following this, the qualification is non-expiring, subject to the individual continuing to practice as a check pilot or test pilot (defined as at least five test or check flights being carried out each year). CPD is not specifically arranged beyond an annual one-day seminar designed to permit cross-exchange of experiences between practitioners.

In practice, however, the team of test pilots are monitored in their activities and quality of reports by the technical office, which endeavours to ensure that pilots are

given opportunities, where they have weaknesses, to work on a large programme alongside pilots more experienced or current in that area (spinning evaluation or performance testing being the most often identified). Similarly, where overall working standards become weak, critical tasks will be actively steered away from the weak individual, while their working deficiencies will be discussed with them and means of rectification identified.

It will be evident that the management of test pilots is considerably more targeted than that of inspectors. This is partly due to the more specialised nature of the task, but mostly because it is possible — with about eight test pilots compared with 160 inspectors and 220 check pilots. At present, no routine training and auditing of check pilots takes place; this is perceived as a weakness of the BMAA system, which it is intended to address in the near future as resources permit.

SUMMARY

This paper has presented the approach used by the BMAA in maintaining the airworthiness of a large, disparate and geographically spread fleet of aircraft. This system is not perfect, but nonetheless maintains a good standard of airworthiness, while maintaining running costs and bureaucracy at what is considered to be acceptable minima. While the system is unique to the BMAA and could probably not be directly transplanted to anything other than another large airsports organisation, it contains elements, which in the author's opinion, would bear examination by other aircraft operators with problems of disparity or scatter.

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