RELIABILITY AND THE AEROPLANE

BY

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It is a truism that Britain has the finest aeronautical equipment in the modern world. A glance at the popular press is sufficient to show that in the quality of her aeronautical products Britain is second to none. It is interesting to consider how we measure this quality. Where aircraft are concerned one automatically thinks of performance, speed, carrying capacity and operating economy. On the other hand with more mundane mechanisms such as motor cars one is equally aware of the reliability of British products. One of the greatest selling points of British cars has always been their seeming ability to last for ever ; whether it be a 1929 Rolls-Royce or a 1934 Austin 7, both exhibit the same quality of trouble-free service under all conditions.

It is not usual to think about aircraft in the same terms ; gradually the aircraft has been accepted as a mechanism of considerable complication which must be maintained with a capital ' M '. Reliability has only been considered in terms of safety and operational necessity.

It is natural for most engineers to think of reliability as a quality which a mechanism acquires through experience. In other words a well tried mechanism is usually a reliable one.

In pre-war days the inherent lack of reliability in new aircraft was compensated for by rigid inspection and maintenance. This included not only the normal servicing such as greasing, refuelling, etc., but a deliberate policy of looking for sources of trouble at frequent intervals. This policy was a very sound one, but in its full sense it can only be applied to comparatively simple aircraft.

Most parts of pre-war aircraft were readily accessible ; the decision as to their serviceability could be made, more or less, on the spot. There were few ' sealed boxes ' bearing large ' Don't Touch ' notices. The evolutionary process of obtaining reliability through experience eventually bore fruit—for example, in aircraft like the Tiger Moth and the D.H. Rapide.

Today the picture has changed out of all recognition. Modern aircraft are becoming unbelievably complicated ; much of the new equipment is experimental and untried ; and such is the pace of aeronautical development, that most of it seems to remain permanently in this state. The cost of test equipment, the skill of the maintenance engineer, and the cost of defects and modification are all rising rapidly in order to maintain even the present level of reliability in military aircraft.

The aircraft themselves are more costly and therefore fewer in number ; the effect of unserviceability is therefore felt more acutely.

To the operational commander the situation is frightening. For the successful completion of a warlike operation today he is dependent more and more on electronics, on new materials stretched to their physical limits, and on complicated mechanisms to keep his pilots functioning efficiently ; each and all of these are vital to any warlike success. If he sends out 50 bombers, how many can he rely on mechanically to do the job ? How many ? That is the question which looms up in his mind. A small number of potentially superb weapons—will they stand up to the acid test of successful operation ?

For the engineer this question is hard to answer. The designer has done his best, the engineer maintains his charges to the best of his ability and reports what goes wrong. Is all this enough ? In his heart he knows it isn't. There is no time to gain that vital operating experience which alone ensures success.

If the present rate of progress is maintained, and the results are going to carry out their task efficiently, something more is required. This ' something ' requires some new thinking about old ideas.

To obtain a clear idea of this ' something ' it is perhaps best to think in terms of a simple and slightly ludicrous example. Imagine an old well-established manufacturer of alarm clocks. For years he has supplied his clocks to the home market with success ; his great-grandfather built the first one and the reliability of its mechanism is unquestioned. He has never specifically tested for this reliability ; it has simply grown with the mechanism. Quite suddenly he gets a large order from Alaska—it appears that alarm clocks are among the benefits which civilization has brought to the Eskimoes. The question is, will his clock perform satisfactorily in the Arctic ? From the point of view of British exports it is vital to answer this question.

He could of course just send the clocks and hope for the best ; but this is too risky. He could study the conditions on the spot and reproduce them in the workshop, and try out some clocks ; this would take some time. He could do the same thing, and accelerate the clock mechanism to shorten the tests. This last idea is the most attractive ; but would such an accelerated test, really show up the defects which would occur in practice ? Only a practical test can answer this. He decides to carry out the tests and thereafter he can proudly advertise his clocks as reliable in the United Kingdom and within the Arctic Circle.

This example illustrates, in an over simplified way, the idea of trying to establish the reliability of a mechanism before it goes into service. This idea is very attractive ; visions of well behaved components, each neatly labelled with its life-span drift before the eyes. Alas such dreams are far from the truth.

It has never been proved in practice, on any large scale, that simulated laboratory tests can reproduce a defect pattern which will show a good correlation with Service experience. An experiment is now in progress, aimed at solving this problem. It would seem that, provided the conditions of the tests are sufficiently realistic, a reasonable prediction could be made.

It would hardly be practicable to subject a complete aircraft to such a test, and consequently any large mechanism will have to be broken down into convenient units and systems. If this can be done, then there is a way of combining the individual test results to obtain an estimate for the whole.

It would be equally impracticable to test each and every unit. The same question would face our manufacturer of alarm clocks ; how many clocks should he test under arctic conditions ?

The answer to this question lies in statistics and involves such things as ' samples ' and ' populations '. It is sufficient to say that if the final reliability desired is stated, and a degree of confidence is attached to that figure, a statistician can give the answer to the question.

Provided the reliability of individual units could be established in this way, and that the failure of any one unit does not affect the probability of any other unit failure, then it may be said that the reliability of the whole mechanism is the simple multiple of the individual unit reliabilities.

The final answer would be in some form such as this—' if 100 aircraft of a certain type are sent on an operation, say, 70 per cent. of them will fulfil their task and return serviceable, nine times out of ten '. In addition, a wealth of information about component lives would be forthcoming.

There are many who contend that the difficulties and expense involved in these ideas put the whole project beyond sense and reason. It is readily admitted that the difficulties are very great, but it is necessary to weigh all this against the cost and difficulty of the present state of affairs. It is not known whether anyone has ever added up the cost in man/hours of rectification, inspection, and modification in the Royal Air Force and Fleet Air Arm ; it is certain that the total would be enormous. More serious than this however is the loss of potential striking power in a war.

Perhaps the fact which clinches the argument is the case of the guided missile. The days of piloted aircraft are most certainly numbered ; with the guided weapon there is no chance of gaining reliability through experience. Nothing could be more absurd or expensive than firing 100 rockets to see how many are likely to reach the target. In this case the chances of success must be determined before launching.

Without in any way trying to minimise the difficulties and expense of pre-testing, it is obvious that a start on this type of work will have to be undertaken on a large scale. It is perhaps, a salutary thought that for every beautiful sleek modern aircraft one sees making vapour trials in the sky there is one on the ground unable to join its kin in the air.

Power, speed and performance are not enough in themselves ; potential superiority is not enough ; what counts is the ability to hit at once, and to go on hitting.