THE AEROPLANE IS TALKING TO YOU

What you should do to listen to it

Let us start with the basics about aircraft and airworthiness. Aircraft are designed by humans, maintained by humans and flown by humans. But, are we all the same? Do we all interpret things the same way? Of course not, put 20 people in a room and give them all a task to do on their own, and they will do it in 20 different ways.

So don't regulatory standards solve this? What are the requirements for a new commercial aircraft design? They will include such things as; range/payload, airfield performance, block speed, cost (to buy or lease), operating cost, reliability, supportability, maintainability, and above all safety. But, which of all these are mandated by the Regulatory Authority who issues the Type Certificate? Only one is – safety.

How do we achieve the required safety levels then? It is all based on the 'R' word – Reliability of systems and components. But, whose definition do we use? The designer's…the operator's…the regulator's? They are not the same. The designer wants reliability to be good enough to achieve certification, but not so good that the company doesn't sell enough replacement spares. The operator wants to leave the gate every time, on time. The regulator is looking at safety levels of system failure consequences expressed as little probability numbers. These reliability definitions are not all same.

Type Certification is simply a snapshot in time, based on design assumptions and testing, and with the best will in the World, this single snapshot cannot be true for every operating scenario the aircraft will encounter, not least when we consider such variables as utilisation rates, block times, geographical locations, maintenance policies and so on. So, after entry into service, do we simply cross our fingers and hope for the best? To a large extent, yes we do!

The aeroplane still has the ability to take us by surprise and do something we did not expect. Take a look at last year's Qantas A380 incident in Singapore. Yes, the aircraft got back on the ground safely, and there is a lot of praise for many aspects of the design, but look at what the flight crew had to deal with: 54 fault messages, loss of one hydraulic system, failure of fuel transfer system, partial loss of ailerons, partial loss of anti-skid braking, manual gear extension only, and of course they were flying on three engines. There were four crew members in the cockpit coping with a dynamic situation and unexpected aircraft behaviour. One member of the crew said afterwards; "It did many things we simply didn't understand."

However, all is not lost – the aircraft is talking to us! We design increasingly sophisticated aircraft and complex systems, and try to cope with this complexity through a plethora of monitoring systems such as FDM, CVR, HUMS, Airman, ECCAIRS, CAIMS, FDAU, ACMS…the list goes on. The question is not simply are we listening, but more to the point, do we know HOW to? Who looks at the data, and what is it we are looking at? Do we consider the effect of environmental / operational variation on reliability & safety? What is it that we are trying to measure, and is it our intention to validate the design assumptions that gave us Type Certification? If not, it jolly well should be, otherwise, we cannot know whether or not we are still operating safely.

We are talking about the correct sort of feedback, all the way back down the line to the designers. We already get lots of feedback, but we do not always make proper use of it – we don't listen. During the development and test phase, feedback to design can be patchy, messages may be ignored if they are unpalatable or in the lower number range of the risk analysis. Failure Mode and Effects (FMEA) and reliability figures can be either developed by designers without independent checks, or developed by reliability departments without reference back to design, or are overlooked.

During the Type Certification process, the presented Safety Case may not be independently checked. Review of the documentation is often carried out based on trust that the analyst has got it right – the reviewers may only question reliability figures that appear to be particularly optimistic. After entry into service, the Safety Case is not routinely checked to confirm reality fits expectation. If all this is true, and I strongly believe it is, what do we do about it? Operators already have a tool at hand that they are required to use - Reliability Control. The ICAO Safety Management Manual describes equipment faults thus:

"5.2.4 The likelihood of system failures due to equipment faults is in the domain of reliability engineering. The probability of system failure is determined by analysing the failure rates of individual components of the equipment. The causes of the component failures may include electrical, mechanical and software faults.

5.2.5 A safety analysis is required to consider both the likelihood of failures during normal operations and the effects of continued unavailability of any one element on other aspects of the system. The analysis should include the implications of any loss of functionality or redundancy as a result of equipment being taken out of service for maintenance. It is therefore important that the scope of the analysis and the definition of the boundaries of the system for purposes of the analysis be sufficiently broad so that all necessary supporting services and activities are included."

That is certainly pretty clear. We have lots of information sources around us to gather the necessary date. These include pilots reports, technical logs, on-board maintenance system readouts, maintenance worksheets, workshop reports, functional check reports, stores issues, air safety reports, technical delays and incidents…the list is almost endless. The key comes with the correct integration and analysis of all this. We need to compare operational reliability with established standards and apply confidence testing of expected and achieved results. In order to correctly interpret the trends, do we train the analyst? The answer sadly, is often 'no'. We must also be clever enough in our analysis methodology to consider the circumstances of an event, e.g. in-flight, during maintenance, etc., the effectiveness of maintenance or modification action, environmental factors, ageing aircraft, and so on. Last but by no means least, what about the effectiveness of fault messages displayed in the cockpit or in the maintenance data downloads – are the messages fully understood? Do they lead to the appropriate corrective action being taken?

Corrective action covers a multitude of sins: changes to maintenance, operational procedures or techniques; maintenance changes including inspection frequency and content, functional checks, overhaul requirements and time limits, addition or deletion of tasks; amendments to approved manuals (including crew manuals); initiation of modifications; special inspections and fleet campaigns; spares provisioning changes; staff training; manpower and equipment planning. Then of course, whatever changes are made to address an issue must be monitored to ensure they have not actually made things worse – it can and does happen.

In order to achieve all this, it is essential that the data trail starts with the right stuff. If an operator removes a component, the repair shop needs to know as a minimum, not simply which aircraft it came off, but essentially, what was the reason for removal? Hands up all those who have seen labels on removed equipment that give reason for removal such as; 'U/S', 'Broken', or the dreaded 'Not known.' If you do not know why you took it off, then why did you? What were the symptoms, what fault diagnosis did you carry out? We need to be much more proactive in giving repair shops the information they need, just as they need to feedback their findings in as much detail as possible.

Without the correct feedback, going to the correct place, where the correct action can be taken, we are in danger of falling into any one of the many traps waiting for the unwary. The analysis may be based on a small percentage of the total population of that unit and thus not necessarily fully representative of the fleet. Poor fault diagnosis, incomplete reasons for removal and inconclusive data from repair can lead to there being too much guesswork in the analysis, which is where many such systems fall down.

So, do we understand what we are hearing? Are the flight crew and ground crew getting too much information to enable clarity of analysis? How does rapid on-wing Line Replaceable Unit (LRU) replacement at the gate to achieve dispatch reliability, impact on the technical knowledge of the engineer performing the task? Will he ever get feedback of the repair shop findings on that unit he has sent back to stores? Almost certainly not.

We still constantly hear the mantra about the need for more data sharing; and quite right too. This kind of information must be shared with operators of similar equipments, aircraft manufacturers, equipment manufacturers and regulators. Finally of course, there must be an effective feedback loop to the originator.

Yes, we have a good safety record and yes, our aircraft are highly reliable for their increasing complexity. But, in many ways the human at operator level is getting left behind in understanding how to interpret indications coming from these complex beasts, and thus the analysis and feedback of those indications is less robust than it should be, so the right stuff does not get fed back to the designers to close the loop.

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