7.0 HUMAN FACTORS IN AIRCRAFT MAINTENANCE A REGULATORY VIEW

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There's a growing consensus that addressing the causes of human errors is one of the few remaining ways to get a real improvement in safety. It seems unlikely the planes can get much safer, so the people will have to. The question for the airworthiness authorities is, what is our role in the process?

Directly, there's not too much we can do. As Ernest Gann said; "*Rule-books are made of paper—they will not cushion the impact of metal on stone*." Indirectly though, there's plenty we can do, and we can start by making sure that our rules are not part of the problem. In Canada we've been fortunate in having an opportunity to re-draft our entire Aeronautics Code, and we've tried to take advantage of the situation by incorporating human factors awareness into the new regulations. In the process, we had to seriously change our approach to several items that had previously been articles of faith.

First, we decided to keep the rules to a minimum and base them on the principle of "regulation by objective." That's the equivalent of the FAA's "performance based regulation." The idea is that, wherever possible, we avoid specifying how to do something. Instead, we establish the objective to be met, set out some guidelines, and then leave it up to the certificate holders to meet the objective in the way that best suits them. Of course, we still remain the final arbiters of whether the objective has been met. The actual drafting of the rules is done in conjunction with representatives of the main industry groups, so that keeps us down to earth.

While the new Canadian Aviation Regulations themselves (the CARs) are very lean, they are supported by a comprehensive code of standards. These standards also provide a lot of scope for innovation. Allowing different approaches provides a safety valve in itself. If we try to regulate everything up to the hilt, so that every organization does its maintenance in exactly the same way, the only avenue left for competition would be who could cheat the most. By leaving organizations some room to maneuver, the competition centers instead on who can comply with the requirements most efficiently.

The next major principle we adopted goes right to the heart of the human factors issue — establishing accountability. We looked at the work already done with flight crews, such as Cockpit Resource Management (CRM) and there's obviously a lot to be learned there. But we came to recognize there are significant differences between the flight deck and the hangar floor. One of those differences is the social environment. The flight-crew has always been led by an authoritarian figure, the pilot in command. To some extent, CRM has concentrated on fostering assertiveness among the other flight-crew members, to overcome some of the negative aspects of this power difference, and create a team approach.

By contrast, maintenance people have pretty well always been treated as a team. I am speaking strictly about large air carrier maintenance. General aviation, air taxi and bush operations, being smaller, are still full of rugged individualists. Until recently though, large air carrier maintenance operations were notable for the lack of a truly accountable person at the working level. It was a team without a quarterback. Dr. Ron Lofaro of the FAA has drawn attention to this difference between the flight deck and hangar environments, and pointed out the lack of a clear authority figure by describing the technician as being "on the blame line." In other words, while no one is totally responsible, the technician is in there somewhere.

Now, that can't be right. I suggest the problem began with ICAO Annex I, which has traditionally allowed an Approved Maintenance Organization (AMO) to exercise the privileges of an Aircraft Maintenance Engineer (AME). Apart from a brief mention in Annex VI, that's still about the only reference to AMOs in the whole Convention, although that's about to change. Several authorities have argued for a more definitive statement on the AMO's role, and these efforts are now beginning to show results. The latest amendment to Annex I no longer speaks of the AMO having AME privileges. Instead, it refers to the AMO's appointment of individuals. The difference is subtle, but important. The reason for shifting emphasis to the individual is simple — an AME's main job is to make decisions regarding the satisfactory completion of maintenance tasks. People make decisions. Organizations don't. Too often in the past, we've seen aircraft signed out because the signatories have been persuaded it isn't up to them to decide — that they're merely communicating a company decision. In addition, an amendment to Annex VI, outlining standards for AMOs, has now been developed. It's already been commented on by the Member States, so we can expect its introduction fairly soon. Both Annex I and Annex VI require persons who sign a maintenance release to meet the same standards as an AME.

In the absence of any clear statement from ICAO, many people assumed that an AMO's only role was to act as an AME. That's the one function we think an AMO should not have! However, that's not to say the AMO is without purpose. On the contrary, a sound organization is essential, to manage a whole range of things that can't be left to individuals. Taking this approach, an AMO can be regarded as a group of AMEs marching in step. The AMO keeps the pace. It provides structure, standards, procedures and a formal hierarchy, within which the AME can do his or her job. What it should not do is attempt to make the AME's professional decisions, although it may establish the standards against which those decisions will be made. The bottom line here is that the AMO and AME systems need not be mutually exclusive; they're complementary. The CARs recognize this by assigning to each of these elements the role it's most fitted to assume.

We believe that establishing accountability is the key to an effective code of conduct. Accordingly, we've paid a great deal of attention to that feature. We've carefully defined the responsibilities of the Air Operator, as distinct from those of the AMO. Even where these entities are one and the same, we've recognized this by covering the functions with different certificates. (Incidentally, we're pleased see the JARs now also include this feature). We've outlined the responsibilities of the various parties when maintenance is contracted, defined the role of the quality department and, as I mentioned earlier, established the respective functions of the AMO and the AME.

The AME's responsibility is worth a little more discussion, because it's fundamental to our whole program. Under the CARs, only licensed AMEs are permitted to sign a maintenance release. If an AME is not satisfied with a maintenance task, he's expected to withhold his signature, company pressure notwithstanding. His supervisor may sign for the item himself (assuming he also holds the license) but he should do this with some caution. The standards require an AME who signs a release for work done by another person to have personally observed the work to a sufficient degree to be satisfied it's been completed satisfactorily. It's pretty hard to do that from an office on the hangar mezzanine!

In the drive to focus accountability as finely as possible, we've for the most part stayed away from a Required Inspection Item (RII) philosophy. First, this kind of requirement tends to be inconsistent with regulation by objective. But also, we felt it had problems from a human factors perspective. We were concerned that the advantage of a "second pair of eyes" could be offset by a relaxation in vigilance caused by the knowledge that the second inspection would be taking place. There are no hard data on either side of this question, and there's anecdotal evidence to support both theories, so you can take your pick. However, we have considerably strengthened the Quality Assurance function, and ensured that QA inspectors will be making random checks of all functions, but more especially on the critical items, so I think it's fair to expect a net gain in overall quality.

As an example, let me explain how this principle was applied to the independent control check. Like a lot of authorities, we had a long-standing “directive” or “prescriptive” type requirement, for work on engine and flight controls to be subject to two separate releases. It gave us a warm feeling, but people still assembled controls wrong with depressing frequency and the second inspection often didn’t catch the error. We considered eliminating the independent check altogether, and came quite close to doing just that, but in the end caution won out. We’re going to try to have our cake and eat it too. We decided to keep the second inspection but still focus the accountability in one place. Accordingly, the current rule still calls for an independent inspection, but that inspection is not subject to a maintenance release. The AME who signs the release for the control system work itself, takes sole responsibility for the entire job. The standards applicable to control maintenance require the AME to obtain a second opinion from a competent person, but that in no way alleviates his responsibility for the correct assembly of the controls. Now, it remains to be seen whether this change is just too subtle to make a difference, but it can’t hurt to give it a try.

The independent check procedure is, in fact, a small-scale example of the entire Quality Assurance (QA) approach. The CARs require QA to be completely independent of production. Not only independent of the performance of the work, but also independent of the maintenance release. There is no “buy-off / buy-back” procedure. The QA inspector is a little like a theater critic. He gets to write a report that may have a considerable effect on the play’s run, but he doesn’t get to go backstage and rearrange the scenery.

The primary emphasis in QA is along the lines of the Japanese *Kaizen* philosophy. The aim is not to find and fix individual defects, but rather to identify the causes and gradually improve the entire system. The AMO is required to establish a link between the QA findings and the personnel-training program. This closes the loop when human failures related to training deficiencies are detected. Similar links apply to findings resulting from faulty procedures, equipment, record keeping, etc.

Record keeping is another area where we have gone to a great deal of trouble to identify responsibility. We already had quite comprehensive record keeping requirements, but we have now streamlined them, reduced the information recorded to the essentials, and clearly identified who has to record what, and when. The principle we applied is that in any communication, the person sending the communication bears the responsibility for ensuring that the person receiving has understood. This applies particularly for example, in the case of shift hand-over. The CARs make clear that if it becomes necessary to hand over a job mid-way, the person handing over must sign a release for those parts of the work that are completed, and attach a detailed description of the outstanding items. If that’s too difficult, the answer is simple — just stay and finish the work yourself!

I have just touched on the highlights here, but I hope they show we already have a framework of regulations that will support operators and maintainers in their efforts to address human factors. We now have to decide, in conjunction with industry and the other national authorities, what to do in the way of data collection, analysis and promotion, and what part the regulators should play in all this. My best guess is that the eventual role for the aviation authorities will be one of facilitator and advocate, with little or no need for direct regulation. But before we make any decisions along these lines, we need to gain a wider understanding of this whole complex topic of why and how people make mistakes. This forum is an excellent place to do that.

Promotion may well be our biggest problem. Enabling new solutions by enlightened regulation is one thing. Persuading certificate holders to take full advantage of all the options available is something else. It's not good enough to just talk about human factors; real action is going to be needed to change the inappropriate practices and faulty procedures that set the stage for errors. We are going to have to incorporate an awareness of the issue into every facet of our work. Some of our biggest AMOs are still using procedures from the old *Engineering and Inspection Manual*, which was based on a "regulation by directive" philosophy, and discontinued years ago. There are several reasons for this, including lack of knowledge of the options and simple inertia. In some cases, the organizations would like to change, but the outdated procedures are locked in by employee contracts. There are clearly pitfalls in including this kind of item in the collective bargaining process, especially at a time when the old assumptions regarding what procedures are the safest are being challenged. Changing entrenched attitudes is going to be a major part of the human factors effort.

When you get right down to it, a lot of what we call human factors relates to communications of one kind or another. Pilots communicating with AMEs; air operators communicating with AMOs; all of us communicating with our peers; and, at the very end of the line, man communicating with machine. Ergonomics is where the human factors work began, and man-machine communication remains the hardest communication of all. The machine, unlike a human, is not going to try to work out what we really mean. It's going to do just what we tell it to do. Because machines don't care!

I began with a quote, so I'll finish with one. Rudyard Kipling had this all worked out a long time ago. Here's what he said about the man-machine interface, speaking from the viewpoint of the machine.

Remember, please, the Law by which we live
We are not built to comprehend a lie
We neither love, nor pity, nor forgive
If you make a slip in handling us, you die!