10.0 THE INFLUENCE OF HUMAN FACTORS ON THE SAFETY OF AIRCRAFT ENGINEERING AND MAINTENANCE - A UKOTG PERSPECTIVE

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INTRODUCTION

The UK Operators Technical Group (UKOTG) is a Group within the British Air Transport Association (BATA) dedicating to encouraging the safe, healthy and economic development of UK civil aviation.

The UKOTG established a Human Factors Group some time ago to work on the development of clear guidelines and best working practice on this vital subject.

The UKOTG Human Factors Group consists of representatives of the following airlines:

- Britannia Airways
- British Regional Airlines
- KLM uk (Re-branded from AirUK)
- TNT
- Virgin Atlantic Airways

This Group represents aircraft, engineers and support staff from operators whose aircraft range from the biggest (Boeing 747-400) to some of the smallest (Jetstream 41, ERJ-145 etc.) and who carried over 25m passengers in 1997.

The reason for this scene setting is to illustrate the diverse interests of the UK Industry and to set the foundation for the reason for our passionate belief in the application of Human Factors initiatives to all aspects of our work.

THE MAINTENANCE REQUIREMENT

The aircraft maintenance requirement has fundamentally remained very similar throughout history and consists of the following basic stages:

* The Requirement (as stated in the Maintenance Review Board, Maintenance Planning Document and Aircraft Maintenance Schedule [AMS])

* The Task (originating in the AMS and ending up in a Workpack on the aircraft)

* The Release (which might result in re-visiting some areas of the Workpack for critical task review etc.)

Traditionally, the requirement and generation of the task have been carried out by office-based staff with the sharp-end staff implementing the task on the aircraft and releasing the product. Many companies have tried to bridge the gap between planning and production and only now is real progress being made by siting both parties together in order to fully engineer the plan prior to release.

The changes have mainly taken place in the following areas:

* The time available for maintenance (growing trend to maximize flying during the day and service at night, thus reducing the daylight downtime to major checks)

* The complexity of the maintenance (multiple systems, composite materials etc.)

* The pressure on the quantity and expense of qualified staff which can lead to the use of contracted staff with the complications of additional controls

* The need for more frequent and sophisticated training to cope with the complexity of aircraft

As these demands grow, so cracks can appear in the fabric of the maintenance and recently, Human Factors have played a major part in a number of incidents and consequently have entered the spotlight for engineering and maintenance organizations.

HOW DOES THE UK INDUSTRY DEFINE HUMAN FACTORS

The basic approach in the UK to tackling the issue of Human Factors is encapsulated in the words of former FAA Administrator Admiral Don Engen, who was quoted as saying in 1986 “We spent over fifty years on the hardware, which is now pretty reliable. Now it’s time to work with the people”.

The only link that this paper seeks to make between Human Factors and Aircraft Maintenance is one of safety. One can look at all other impacts but none can match the impact of a serious incident or accident. Hence the old adage - If you think Safety is expensive, try an accident.

So how do we link Human Factors with Safety?

It is our view that one of the best links between Human Factors and Safety is to adopt the well-recognised premise than an accident or incident can, in virtually all cases, be analysed as having been caused by a number of factors i.e. links in the chain.

In analysing how Human Factors can influence the links in the chain, one technique is to read across the universally adopted method of System and Aircraft Safety Analysis to Human Failures. There are many parallels which can be drawn once the Human is considered as part of a System e.g. The Human Part of an automatic process - flight director in cockpit or "Meat Servo." Assuming this as a basis, therefore, it is straightforward to consider that generally a Human Factors failure will have been one of the following types:

Single active failure

An "active failure" is a single Human failure, the result of which is to produce a deterioration in the performance of a system or the aircraft, for example, the failure to replace the oil filler cap on an engine or to plan a modification without giving sufficient thought to the consequences. The Safety Net, if present in the process will prevent this link.

Passive and undetected (dormant) failure

A passive failure is a Human failure which produces no immediately observable effect on the performance of a system. It can be of a subtle nature depending upon whether or not there is an indication of a failure. An example might be the breakdown of a management structure between management layers whereby a direct link is created between the source and result, bypassing an essential part of the process. The existence of an independent monitor is an obvious method of heading off such failures, however, the monitors themselves may fail in a passive manner.

Combinations of independent failure

It is possible that there may be combinations of active Human Failures that are not all in the same area and which might not be prevented by independent monitors in one area. This can result in a hazardous combination of active and undetected failures.

Common-Mode and Cascade failure

It is possible for the same root cause to affect each part of the human process, thereby allowing the same Human failure to have a knock-on effect throughout the structure and directly influence the end result i. e. the aircraft leaving maintenance in an unsafe condition.

This could be an issue such as a widespread company re-structuring or pay cut.

The faulty setting up or rigging of equipment in multi-channel systems provides one of the most frequent causes of common-mode failures attributable to maintenance.

Cascade failures also fit into this category, since they are a particular type of common-mode failure where a single failure, which in itself may not be hazardous, can precipitate a series of other failures.

Failure produced by the environment

One has to consider whether certain maintenance tasks are particularly vulnerable to some environmental conditions, particularly if they can cause common-mode failures. Poor lighting, lack of hangarage, lack of adequate tooling can all be classified here.

Accepting, then, that an incident or accident may involve many different aspects, it can be recognized that human factors may affect each and every link in a chain of events or it may be one on its own. The severity of the end result will then back-drive the measures which are then put in place against the Human failures.

In 1979, a large passenger airliner crashed in North America when an engine fell-off after take-off ostensibly due to failure of the pylon attach fitting. In fact, the investigation involved analysis of the procedures given to (and followed by) the crew, the pylon attachment design, the design and operation of the hydraulic system, the airline's maintenance procedure and the FAA's surveillance and malfunction reporting system. The view could be taken that Human Factors played a part in each of these items. The application of Human Safety Analysis to this incident might have shown that measures could have been taken to prevent the accident.

Of course, the impact on safety relies on the existence of a direct link between a human factors event and an incident or accident where safety is compromised. It is the existence of such a direct link that has focused so much effort in recent years on Human Factors and the methods by which the link can at worst be weakened and at best eliminated.

HOW DO HUMAN FACTORS IMPACT ON AIRCRAFT ENGINEERING AND MAINTENANCE

So how do Human Factors impact on Aircraft Engineering and Maintenance?

If one applies these failures to design, manufacturing, engineering and maintenance errors the picture of the possible links in the chain begins to emerge.

At the design and manufacturing stage, the link begins since, for example, critical parts must be identified and manufactured in accordance with the requisite standards. Such critical parts must then be subject to inspection and test requirements, as necessary, in the Aircraft Maintenance Schedule. The planning engineer cannot be blamed for not calling up a check that isn't in the Schedule. Similarly, the aircraft engineer cannot be blamed for failing to carry out an inspection he was not asked to do, unless the fault is something that is glaringly obvious.

* The designer can take steps to minimize the likelihood of certain maintenance errors, for example:

* Detailed design precautions e.g. idiot-proofing

* Making critical areas readily inspectable

* Devising adequate check-out procedures to cater for maintenance errors which could result in hazards

* Measures to ensure that the allowable deficiencies in the MMEL take account of the possible failure modes which could result from maintenance errors.

At the Engineering stage, there is a generally held view that maintenance errors are the only type of error and that engineering errors can have little effect on the end result of the maintenance check. This is a complete fallacy since the person who specifies the work to be carried out i.e. the person who tailors the Maintenance Schedule into tasks for the aircraft check has a much greater influence on the safety of the end result than the aircraft engineer himself. These Engineering areas can be characterized into the following areas - any of which can suffer from the type of human failure above.

* Administrative errors - straightforward errors in the documentation, the ordering of tasks or the omission of a particular step

* Technical errors - incorrect or incomplete information

* Monitoring errors - caused by improper monitoring and feedback of the results of checks

There are many other Human Factors which can have a direct effect on the links in the chain.

Pressure and Stress - either actual or perceived

Environment - too dark, too cold etc.

Circadian Rhythm - natural body variations on shift work

HOW TO CONFRONT THE ISSUE

Talking about Human Factors is one thing. Confronting the issue is another entirely and is the subject of much current debate in the Industry.

The first stage must be to ensure that the Company embraces Human Factors at all levels and in every area. Human Factors is not somebody else's problem**.** It requires commitment from the Chief Executive down and the Cleaner up. It is our view that creating a separate Human Factors function in a company, whilst apparently reassuring, is not the way to go. It must be made a part of each and every person in the organization's responsibility to be vigilant for Human Factors failures in their everyday work.

The best way, in our view, to implement Stage one is to organize briefing sessions for all members of the company, starting at the top. This can then be followed by more detailed "training" sessions. All members of staff must understand that the process applies to them and it also relies on the successful introduction of a "just" culture such that events which occur can be reported to allow detailed investigation and rectification action to take place. It will not be possible to introduce a Human Factors related program whilst all events are driven "underground".

The second stage is to review the outputs of the company which have an impact on safety and to review the sensitivity to events leading up to release to the types of Human Failures described above. Examples of this could be:

Aircraft Base Maintenance Outputs

Line Maintenance Release

Specified Tasks to be completed by Line Maintenance

Closure of an Air Safety Report

The third stage is to review the working practices in the company at all levels to establish whether the company is exposed to any failures and if so to ensure that measures are put into place to head off any problems.

The Human Failure analysis approach to company processes is offered as a solution to this problem.

The fourth stage is to ensure that all aspects are fully documented in clear, concise procedures which are part of induction and continuation training.

The fifth and final stage is to ensure that sufficient measures are put in place to prevent the matter of Human Factors from slipping off the company agenda.

THE ROLE OF THE JAR145 ACCOUNTABLE MANAGER

JAR145 requires that the maintenance organization nominates an Accountable Manager who has access to the funds and resources to ensure that the organization has sufficient staffing levels and resources.

UK CAA Research has shown that the nominated senior executives are generally of a sufficiently high stature in the structure of the organization that they are remote from issues that directly affect safety. This situation is driven from the interpretation of the requirement for full access to and control of resources. This can patently lead to a breakdown in the objective of the requirement which is to ensure that safety is not compromised by commercial issues. A gap therefore exists between the requirement for and implementation of the safety culture in the organization.

A solution is to achieve a "delegated" function approach which does not abdicate the authority but ensures direct influence on the safety culture. This delegated function enables a proper closed-loop review process between the Regulator, the Accountable Manager and the product. It is this solution that has been adopted in certain organizations in the UK to great effect.

THE LEGAL FRAMEWORK

It is important to ensure that the Accountable Manager review process is not affected by any legal framework in place. The ability for the industry and the regulator to be effective in the review process can be severely hampered by a legal framework which penalizes any identified failure. JAA is endeavouring to continue to work with industry to identify and pro-actively rectify problems through National Authority initiatives and UK Engineering actively promotes this approach.

THE TRAINING ISSUE

One of the most important issues which directly affects Human Factors is the training issue. Our industry relies on the ability to recruit the next-generation of engineer into our organizations. This begs the question whether with the perception of the industry currently that engineering and maintenance are not as attractive as the "soft" careers, would you encourage the next generation to follow an aviation career? If the answer is yes, why?

One of our major concerns in Northern Europe and certainly in the UK is the lack of engineering and maintenance personnel and we in the UK industry are taking active steps with local schools to ensure that engineering and maintenance becomes an attractive career.

This issue is patently so important since training remains essential regardless of the complexity of on-board fault isolation. No aircraft yet developed is capable of rectifying and releasing itself into service. Getting the Human Factors approach issue correct is therefore the critical factor affecting the future enhancement of safety.

HUMAN FACTORS - CHOICES AND WAY AHEAD

There are probably many choices and directions one can take to take the Human Factors issue forward.

Creating a Human Factors Office and creating a "closed-door investigative and corrective function for the subject is, in our view, avoiding the issue and is also symptomatic of a similar approach to Quality that generally fails. Confronting the issue involves getting the message across to everyone in the organization and is only successful when these people live and breathe the subject, as effectively as they do in their home life.

The way ahead then is clear to us in the UK industry. Against the background of industry experience there is a lot of work to do, but having embarked on a process of Human Factors education that all in the company can believe in and participate in, we believe that the major milestone is passed.

Our aim is to ensure that all major elements in the process are addressed in order that we can enhance the overall safety of the product by adding the Human Factors dimension to all other communicative, investigative and process tools that we already have.

Our aim as part of the aviation industry, is also thoroughly clear. The industry as a whole faces the challenge of embracing the role that Human Factors can play in the safety of Aircraft Maintenance and is at the forefront of the lobby which wishes to see the issue adopted at industry level and is taking steps to ensure a common approach to the problem and hopes that, through Conferences such as this and Industry Groups alike to see progress at this level.

It makes no sense to us that we approach a common problem separately.

In the meantime, we in UK industry will continue to strive to improve our knowledge of this complex subject.

By doing so, we firmly plan to play our part in achieving the 33% improvement in Air Transport accident rates that is required over the next ten years that is necessary to prevent an increase in aircraft accidents resulting from the growth of the industry.

Human Factors is a global problem, enhanced safety is a global target, however, people remain an untapped solution and tapping that resource is an aim that we must all achieve together!

REFERENCES

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