6.0 MOVING TOWARD 100% ERROR REPORTING IN MAINTENANCE

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INTRODUCTION

Before I begin my presentation, I'd like to ask the air carrier representatives in the audience to participate in a small field study. Will each air carrier representative please stand up?

I'd like you to answer these questions. If we were to go to your facility, could we, with the help of your business colleagues, track down data on each hydraulic pump failure that has occurred in your aircraft fleet during the month of January 1997? Could we find the hours or cycles of each pump when it failed, and could we find shop reports for each repaired pump? Could we go to your reliability group and find the historical trend on hydraulic pump failures and compare that trend to the failure rate in January? If the answers to these question are predominately yes, please remain standing. If the answers are predominately no, please sit down.

For those of you still standing, I have a second set of questions. If we were to return to your facility, could we, with the help of your business colleagues, track down data on each shift turnover error that has occurred in your operation during the month of January 1997? Could we find an investigation record for each turnover-related error? Could we also go to the reliability group and find historical trends on the shift turnover-related error rate and compare those to the shift turnover-related error rate in January? If the answers to these questions are predominately yes, please remain standing. If the answers are predominately no, please sit down.

Without the benefit of seeing the actual results to this survey, my experience tells me that nearly all air carrier representatives would remain standing after the questions about the hydraulic pump, yet nearly all would sit down after the questions regarding shift turnover. So what is it that makes this small field study at all interesting? It is that the hydraulic pump, in our lifetime, will likely never again be the cause of a jet transport accident. Yet, when the next maintenance-related accident occurs, there is a reasonable probability that a poor shift turnover will have been involved in the accident.

It is interesting to consider the disparate treatment that we afford mechanical versus human failure. On the mechanical side of the airline operation, nearly all failures are investigated, analyzed, and monitored for their effect upon reliability and safety. Mechanical reliability programs, engine condition monitoring programs, shop findings - all of these have contributed to making equipment failure a small piece of commercial aircraft accidents. So why is it we can track equipment failure with precision, yet human errors still go undetected or hidden within an air carrier's operation? Human error, after all, contributes to 80% of commercial jet accidents.

It has been a full decade since the Aloha Airlines disaster - a decade since we first came together for these maintenance human factors conferences. In that time we have learned that maintenance error contributes to 15% of air carrier accidents and that maintenance error costs the US industry more than 2 billion dollars per year. We've adapted flight-crew resource management programs for use in maintenance and thanks to the efforts of many of you, we've developed a number of analytic tools for the assessment and reduction of maintenance error. Yet what we have done to help facilitate internal airline reporting of error can be described in two words. Very little. In fact, there are many who say that we will never convince a technician to report his or her error inside the company.

I, for one, am simply unwilling to believe that actual event data is beyond reach. While we haven't made much advance in the last ten years, I'd like to believe that ten years from now most of the air carrier representatives would remain standing after the question regarding shift turnover.

So what I will address today is the concept of 100% error reporting, and its logical progression: the human reliability program. It is the concept that through 100% error reporting, we can track, analyze, and develop prevention strategies to effectively manage human error. As the hydraulic pump demonstrates, this is not a new idea. It is the simple idea that in any endeavor to improve a system's performance, the first step is data collection, event data in particular.

THE HISTORY OF MECHANICAL RELIABILITY PROGRAMS

First, a little history for those unfamiliar with what we have so successfully done on the equipment side of the industry.

The first generation of formal air carrier maintenance programs was based on the belief that each functional part of the aircraft needed periodic disassembly inspection. Time limits were established for service, checks, and inspections. Periodically, the entire aircraft was disassembled, overhauled, and reassembled to maintain the highest level of safety. This was referred to as "hard-time" maintenance.

As the industry grew and more complex aircraft entered service, literal application of the "hard-time" maintenance process became obsolete. Each component and part no longer required scheduled overhaul on a fixed-time basis. A second primary maintenance process known as "on-condition" evolved. The on-condition process was assigned to components on which continued airworthiness could be determined by visual inspection, measurements, tests or other means without disassembly, inspection, or overhaul. In the US, the FAA controlled these programs by approving hard-time or on-condition check periods individually for the aircraft, engines, and components. This new method of reliability control was oriented toward mechanical performance rather than the previous method of predicting failure points through mandatory teardown inspection.

In the 1960's, the FAA first began to approve reliability programs internal to air carrier maintenance organizations. These programs allowed air carriers to explore the relationship between component age and component reliability and to make changes necessary to optimally manage equipment performance. It is important to recognize that these programs involved a high degree of self-determination on the part of the airline. The rapid advance in aircraft and process technology simply forced the FAA to move toward performance measurement.

As a result of this new relationship between the FAA and its air carriers, what exists now at the typical large carrier is a sophisticated system of data collection, data analysis, and corrective action. It is an expansive system of people that includes everyone from the technician removing the failed components to the regulator conducting oversight. It is also a structured set of processes that distinguishes critical from benign failures, a system that allocates resources based upon the needs of the aircraft. It is a system that has provided us with unimaginable equipment reliability. Where in the early days of flying, a pilot might worry about multiple engine loss, the typical young commercial pilot today might wonder if she'll ever experience an in-flight shutdown during her entire career. So while we in the maintenance community have been looking toward the pilots with admiration of their flight deck human factors programs, the greatest insights for maintenance human factors, and the potential for the greatest benefit may be sitting right under our nose within our own mechanical reliability programs.

Yes, some attitudes would have to change and some new techniques developed, but the potential rewards are great. Imagine a human reliability program sitting right beside your mechanical reliability program, building a culture where technicians, pilots, ground crew, and cabin crew all feel a duty to report their errors, participate in error investigations, and actively participate in the development of prevention strategies. Imagine a system where sophisticated analysis tools spot trends and develop systemic solutions to less critical errors while structured engineering processes provide comprehensive fixes to errors endangering safety of personnel or safe operation of the aircraft. Imagine a system where engineering and quality assurance groups put human error on the agenda for every reliability control board meeting. Imagine a system where the regulatory agency spends less time tracking down violators and more time monitoring the effectiveness of the carrier's approved error management program. Put simply, imagine a program where human error is afforded the same status and same expenditure of resources as the lowly hydraulic pump.

MOVING TOWARD 100% ERROR REPORTING

There is a growing momentum to consider the human reliability program as a cornerstone of a full-fledged human error management system. Yet, there can be no human reliability program without consistent data collection. More specifically, there can be no human reliability program without near 100% reporting. So what I would like to discuss today are some issues that stand in the way of more extensive error reporting and investigation. These are issues we must address if we are to ever have an effective human reliability program.

Recognize that Errors can be Predicable Events

We have grown comfortable with equipment reliability data - every month the typical carrier will pour over charts and graphs of equipment failure data. It is upon this data that an air carrier will manage much of its maintenance resources. When faced with the data that 400 hydraulic pumps failed prematurely last year, nearly all of us would predict similar results this year if we did nothing different.

Yet faced with 400 shift turnover errors in 1996, many engineering and maintenance executives will argue that this data says little about shift turnover errors in 1997. After spending their careers faced with a comedy of employee errors, many senior managers settle into the belief that human errors are just random unpredictable events. To say that 400 shift turnover errors occurred last year is only to say that 400 people had a bad day.

The truth, however, is that human error, just like equipment failure, *is* predictable. Not in the sense that we could walk out on your hangar floor and predict where the next error will occur. Nor can we, as we discussed earlier, tear down a piece of equipment and predict when it will fail. But we can collect actuarial data on human error, just as we do with the hydraulic pump, that will be helpful in establishing the probability of future error. If human error data collection is to have any practical benefit, human error data must be considered to be as meaningful as hydraulic pump failure data.

Identify Error Reporting Thresholds

We cannot assess the true contribution of any error management strategy until we believe that all errors are reported. Yet, it is impossible to investigate every single error made by a pilot, technician, or ground agent. Rather, reporting thresholds for human error must be established, just as they are for equipment failure. A passenger service unit light bulb burns out - we don't track this failure in a reliability program because the criticality of the failure, from either a safety or economic perspective, does not justify the expense of tracking these items. We must do the same on the human side. We must understand that humans err at incredible frequency; many errors are caught before any undesirable consequences occur. What I am not suggesting is that each and every human error in your operation needs to be investigated in order to provide benefit. Rather, I am suggesting that consistent guidelines be created to assuring that historical data has meaning. For example, we would all agree that in-flight shutdown data is meaningful data. We do believe that nearly all IFSDs are reported, and we can assume that a statistically significant increase in the IFSD rate is likely the result of some identifiable intervening cause.

The same credibility can be given to human error data, as long as the thresholds are properly selected. Failures that endanger safety of flight, errors costing above $1,000 in damage - it is thresholds like these that can make a human reliability program both manageable and productive.

Develop Criticality Assessment Tools

There appears to be an unwritten rule that says: If you have had an adverse event, you must have a corresponding corrective action. If you don't take specific corrective action, you open yourself to liability from the regulatory authority, a potential injured plaintiff, the media, and/or your boss.

Yet let's consider your previous efforts to reduce the frequency of, for example, shift turnover-related errors. If you are like most managers, you've conducted a review and implemented prevention strategies after the occurrence of a particular high visibility event. Yet for your review team, the data is sparse. You have the investigation results from this one incident to guide your strategy for the elimination of all future turnover-related errors. The problem is that humans are creative, leading to a variety of error scenarios, each with a little twist not evident in your single high visibility event. Implementing a human error prevention strategy based upon data from the one event just about ensures that errors will continue to occur, until the next high visibility outcome causes your review team to get back together once again.

If instead, you recognize that to best modify the shift turnover process, it is important to understand the contours of the problem; you decide to investigate a larger population of shift turnover errors, each time finding a slightly different story. The pieces of the puzzle are coming together with an effective set of prevention strategies on the drawing boards. Now, however, you've had to violate the rule that no documented event can go without an immediate corrective action.

The exposure to liability is a concern we will face with 100% error reporting. Having knowledge of errors, without specific corrective action, arguably opens you up to liability. Therefore, just as we did for equipment failure, we must develop criticality assessment methods that will allow the less critical errors to be distinguished from those endangering safety. We do not implement a new prevention strategy every time a hydraulic pump fails, because failure of the pump is considered normal and acceptable. Yet we take immediate action if an engine disk fails, because the known criticality demands that efforts be made to prevent reoccurrence.

Human error can be viewed in the same light: each known error having some risk of being a precursor to a much more catastrophic event. If we are to significantly increase the investigation and documentation of errors, we must have methods to separate the critical errors from the masses of purely economic events.

Develop a Supportive Disciplinary System

The road to a reporting culture is riddled with potholes. And if we get past the potholes, we find that our typical approach to discipline is a gate, making movement nearly impossible. Quite simply, we cannot ask an employee to come forward to discuss his error without considerable disciplinary reform. Employees must be certain of how they will be treated after reporting an error. Systems that reserve the unilateral right of punitive action may provide flexibility for the manager, but they do not provide the necessary assurances needed to promote open and honest communication with an erring employee.

We must come to the realization that discipline will be counterproductive in the vast majority of errors, although essential for the small percentage of errors involving intentional violations that put passengers' lives at risk. As John Kern, Chair of the ATA's Safety Council, would say, we must define the "box" inside which incidental human errors can be reported without punitive action being taken. We must draw a line in the sand, proscribed blameworthy intentional behavior, that every employee can see. Crossing the line mandates discipline, staying away from the line guarantees that no disciplinary action will be taken.

We must additionally consider discarding concepts like immunity and amnesty that only tell the world that someone at fault is getting away with culpable behavior simply because a safety expert wants the data. Just think about hearing on the news that a drug dealer was given immunity for his testimony. To most of us, words like immunity and amnesty serve only to undermine our faith in the justice system. Now consider announcing over the aircraft's public address system that the airplane was grounded for an hour while the error of a technician was fixed - but not to worry, he was given immunity so that he would talk about his error. The problem of reporting is not that immunity is needed, it is rather that the disciplinary system itself needs fixing.

Establish Affirmative Duties

I don't think anyone here will be shocked by the suggestion that the typical aviation professional does not feel a duty to report his or her error. Although it may be required by the air carrier's policies and procedures, that does not ensure that people report. Fear of punishment, shame, expediency, a feeling that no good will come if they do report mistakes - all of these contribute to the failure of aviation professionals to raise their hands and say "I've made a mistake."

Yet, it would be naïve to stand here and tell you that a simple disciplinary system modification will be all that is necessary to effect 100% reporting. We are battling years of labor/management distrust - not to mention the reality of a world in which a supervisor may subtly reprimand his erring employee while claiming no disciplinary action was taken.

What we must ultimately do is develop a culture where each aviation professional, whether labor or management, feels a duty to report his error and a duty to truthfully participate in an investigation of the error. Just as we feel a duty to give aid when we are first to the scene of an automobile accident, just as we give help to a child who has lost his parents, reporting our mistakes must become more than a cultural norm; it must become reflective of a core belief of what it means to be an aviation professional.

Adopt a Carrier/Regulatory Relationship Similar to that for Mechanical Reliability Programs

The advent of high technology aircraft forced air carriers and the FAA to work together in new ways. Continuous airworthiness maintenance programs and mechanical reliability programs were recognition that the FAA was not in a position to investigate or monitor each failure occurring within an air carrier's fleet. It meant that some level of self determination was needed for the airline, with the regulatory authority monitoring system effectiveness. The technology of new aircraft such as the 777 make this point even more clear - not everyone can or should be an expert on the working of an ARINC 629 data bus. So each carrier, having resources considerably greater than the local Flight Standards Office, must develop internal systems designed to monitor and maximize the safety and performance of their aircraft fleet.

We must do the same for human error where, arguably, the variation and extent of human error far exceed equipment failure. The system would be one of data collection, data analysis, and corrective action approved by the FAA. Human reliability for less critical tasks would be monitored by the FAA through the carrier's human reliability program, thus allowing time to address, on an event-by-event basis, those human errors endangering safety of flight or involving highly culpable behavior.

CONCLUSION

Many of us at this conference have been working in the field of maintenance human factors since before the Aloha disaster in 1988. We have poured our hearts and souls into preventing accidents like the ValuJet accident in the Florida Everglades. For some of us, the road has been too riddled with political and scientific potholes - causing us to abandon the idea that human factors in maintenance will ever save a life. Yet many stay true to the course - fighting to bring human factors into the mainstream of maintenance process. Perhaps it is time to re-evaluate where we have gone. Yes, we have developed human error reduction methods and tools, but how much more do we really know about the precursors to the tragic accidents like Aloha ten years ago and ValuJet today?

There are many of us who believe that the human reliability program is a good idea, yet there are many who are likely saying, "I'll believe it when I see it." Unfortunately, this may be a program where seeing it will only come after believing in it first. So I encourage you to give human reliability a chance within one area of your operation, even if you investigate only one issue. Grab the MEDA form, pick a hangar and investigate every shift-turnover related error for a period of 90 days. Get a small team together at the end of the 90 days, and using your MEDA data, look for ways to improve the shift turnover process. Find a few other airlines who would agree to do the same, and get representatives from your teams together to share ideas. A beginning like this may snowball into a full fledged human reliability program.

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David has a BS in Mechanical Systems Engineering and is a former aircraft design engineer for the Boeing Company. David served as a consultant to airlines in the areas of maintenance program development, aging aircraft, and extended twin operations. David also served as a team member or team leader on a number of maintenance evaluations and maintenance error audits for US and foreign airlines. Five years ago, David organized the maintenance human factors and safety group at Boeing and led the development of the Maintenance Error Decision Aid (MEDA).

David has more recently served as VP of Commercial Aviation Systems at Aurora Safety and Information Systems, Inc. At Aurora, David led the development of the Aurora Mishap Management System, a turn-key approach to human error management. Currently finishing his last year of law school at Seattle University, David has committed his energies to the development of disciplinary systems that are supportive of human factors learning. In conjunction with Seattle University School of Law, the FAA, and a number of US carriers and labor unions, David is performing research on the inter-relationship between mishap culpability and aviation safety. Additionally, David teaches a two day course entitled, "Improving Aviation Safety through Disciplinary System Design."