Chapter 6. Program Development - Error Management

6-1. Needs Assessment/Analysis

The growing international focus on maintenance error reduction strategies has made many new investigation, analysis, and prevention/intervention strategies available to the maintenance organization. The challenge, therefore, is to build an error management program that is properly tailored for the environment in which it is to function.

Appropriate attention must be given to establishing an error threshold in order to define an error management program and to determine what resources and tools are required to support it. A low threshold error management program focusing on frequently occurring or common errors such as misdrilled holes would obviously require additional resources to conduct investigations and a large capacity analytical tool to track error data. On the other hand, a program with the high error threshold of investigating only major events reported to the FAA may require few resources, but would not collect sufficient information to identify trends before they lead to a significant error. A typical approach of successful maintenance organizations is to initially set a high error threshold and, as resources are developed and the process of investigating and analyzing errors becomes more efficient, the error threshold is able to be set at a lower level. Each maintenance organization must therefore establish its program in consideration that initial results may be inconsistent or minimal, but continued development of the program will further the ultimate goal of reducing errors and maximizing safety benefits.

6-2. Program Design

The design phase of an error management program should consider the following:

- Who should oversee or administer the program? [Section 6-3]
- How should errors be investigated? [Section 6-4]
- How should investigation results be validated? [Section 6-5]
- How should error data be tracked and analyzed? [Section 6-6]
- How can prevention/intervention strategies be implemented to prevent errors from recurring? [Section 6-7]
- How should results of the program be measured? [Section 6-8]

6-3. Program Administration

Although the error management program is best facilitated through a single support group, the success of the program will depend on active support of and participation in error reduction activities by all members of the maintenance organization. Individual responsibilities of positions or departments should be determined in the design phase. It is recommended that a formal program description be generated to include assignment of responsibilities that ensure the expectations are understood and implemented. Responsibilities inherent with an error management program that may be considered for assignment include:

- Senior management support of the program to include participation in periodic formal review to ensure involvement of responsible parties.
- Workforce representatives to support the program including participation in periodic formal review to ensure involvement of responsible parties.
- Quality Assurance/Flight Safety Department co-ordinate and schedule special audits, inspections and investigations.
- Maintenance Department resources participate in audits, inspection and investigations.
- Maintenance, Inspection, or Engineering, as appropriate, initiate, develop and implement prevention/intervention strategies.
- Quality Assurance/Flight Safety Department collect and analyze collected error data .
- Quality Assurance and Maintenance provide program results to Training Department for curriculum additions or revisions.
- Management/Human Resources implement disciplinary practices that are conducive to open and honest error disclosures by maintenance personnel.

6-4. Error Investigation Process

The error investigation process selected is of significant importance to the overall success of the error management program simply because it reveals the problem area. The means to collect the information surrounding an error may be based on a standardized form, on a computer database, or a combination of the two. The investigation may be conducted by self-reporting, by a single investigator, or by a committee. A great deal of research has been undertaken by airlines, regulatory agencies, and academia to evaluate existing investigative approaches and develop new ones.

Two examples of investigation approaches that focus on contributing factors to human error caused events are:

- **Round Table** - The Round Table essentially uses a group investigative approach. The employee involved in the error discusses the factors of the event with the Round Table committee. The round table process may not record data onto any type of permanent investigation record. Rather, the round table committee, upon hearing the testimony, will assign action items and take corrective action based upon its internal committee discussions. A typical make-up of the round table committee includes a labor representative, management representative, and local FAA representative.

- **MEDA (Boeing) - Maintenance Error Decision Aid (MEDA)** is a form based investigative tool. An investigator who is trained based on a program developed by Boeing, is assigned to investigate an identified mishap. The MEDA form provides a standardized format for the investigator to consider contributing factors and to assess their relationship to the error. In addition, the standardized format facilitates the collection and tracking of data regarding what may otherwise appear to be a wide array of unrelated errors. This information can be used to facilitate the necessary changes in support of the maintenance technician.

Establishing an awareness of other developments in human factors investigation techniques can be accomplished by participating in industry working groups and symposia focused on maintenance safety. The Air Transportation Association, Federal Aviation Administration, National Transportation Safety Board, and The Boeing Company have all sponsored efforts in this area and are willing to provide information by mail or through Internet sites.

Regardless of what process is used to investigate human errors, it is essential to the success of the program that all affected members of the organization are aware of how and under what conditions investigations will be conducted. Clarification or revisions to existing company disciplinary policies may be necessary to facilitate self-reporting and willing cooperation by personnel who participate in the error reporting and investigation process. This policy clarification/revision should serve to generate a non-threatening environment and encourage open reporting. A successful maintenance safety culture should recognize that errors are normal, and that the investigation process should always focus on factors that contribute to maintenance errors, not the person or the discrepancy. Therefore, a structured disciplinary policy is advisable that recognizes the importance of obtaining information over punishment, but does not tolerate deliberate or reckless unsafe actions.

6-5. Validation of Investigation Results

If the investigation is successful in identifying human factors oriented contributing factors, a validation process should then be conducted to confirm the findings and reveal how widespread the problem is. If an error is truly isolated to a maintenance crew or individual, appropriate prevention/intervention strategies would be far different than that for problems which are determined to be systemic. Isolation of a recurring maintenance error to a specific part of a maintenance program, or verification that it exists company-wide, is critical to the success of the design of the intervention strategies. Validating investigation findings, however, must be focused on the contributing factors—not the error itself—and routine information collection techniques including written statements and incident orientated investigations will quite often prove to be inadequate.

Special audits, inspections, and evaluations may be used to form the basis of the validation process. Validation techniques fall into the following categories:

- Unscheduled “FAA type” audits and spot checks, using FAA guidance and checklists, conducted by a small team of individuals comprised of both Quality Assurance and maintenance personnel.
- Maintenance procedural checks, called “operational audits” designed to evaluate the performance of specific maintenance tasks.

- Focused scheduled system audits patterned after C.A.S.E. procedures and checklists that are not only scheduled on a normal recurring basis, but are tailored around issues identified during error investigations.
- Ergonomic audit. See [Chapter 7] for further information.

6-6. Data Analysis

After an error is investigated and the event data is collected, there must be some process for analyzing the data to determine the extent of the problem as well as to determine a prevention strategy. Analysis can occur at two basic levels. First, single events can be analyzed to determine if preventative strategies can be developed stemming from one particular mishap. Analysis occurs because the organization does not want this particular mishap to occur again or it wishes to prevent another entire class of events through investigation of this single event. The second type of analysis involves the review of multiple mishap records in order to spot trends and to develop corrective actions that may apply to systemic contributors to error [Marx97]. As the amount of data collected grows it becomes immensely important to track, analyze, and trend numerous error related facts and resultant contributing factors, including: time and place of incident, training of personnel involved, documentation used, task turnover, etc. If the error threshold is set high and relatively few investigations are conducted, computerization may not be necessary to manage the data. Data basing, however, can be beneficial in large organizations where many users require access to the investigation data for corrective action purposes and where the number of investigations conducted exceeds the reliance on the support staff's memory. Computerizing the investigation process has also been shown to assist greatly in the investigation documentation process by using advanced programming and search concepts to simplify the entry of standardized descriptive data. This assures more accurate categorization and, therefore, retrieval of contributing factors trend data.

Some examples of data systems that have been developed and are in use are as follows:

- **BASIS - British Airways Safety Information System**; Developed by British Airways to store and manage discrepancies relating to flight and maintenance events.
- **TEAM - Tools for Error Analysis in Maintenance**; Developed by Galaxy Scientific. Follows MEDA format.
- **AMMS - Aurora Mishap Management System**: Developed by Aurora Safety and Information Systems, Inc. PC based investigation and analysis system
- **BFG - BFGoodrich Error Reduction Program**: Developed by the Maintenance, Repair, and Overhaul group of BFGoodrich Aerospace. MEDA formatted database that provides error analysis/ trending and corrective action follow-up.

6-7. Prevention/Intervention Strategies

The commonly understood objective of every error management program is that once an error is investigated and the contributing factors are identified, prevention/intervention strategies should be developed. Use of investigation data can provide the validation for new or revised practices, procedures, tooling, MRM and technical training or any other factors that have an effect on maintenance errors. Again, an essential element is full endorsement of the prevention/intervention strategy process by management. Without this management's visibility, the error management philosophy may not be taken seriously by the work force. Periodic formal review by management to evaluate the completion status of prevention/intervention strategies is necessary to maintain participation.

Participation in and accountability for the development of the prevention/intervention strategies should reside with the technical departments cited in the finding or concern. The plan should then receive management scrutiny as well as a follow up review after implementation. Each prevention/intervention strategy should include the following elements:

- Identification or description of the error
- Analysis of objective evidence obtained during the investigation and validation phases to determine the contributing factors to the error.
- Identification of planned corrective steps to address the factors contributing to the error.
- Implementation schedule, including a time frame for putting corrective steps in place.
- Identification of individuals or departments responsible for implementing the corrective steps
- Follow up status reporting requirements.

6-8. Program Metrics

In a busy maintenance organization, there is no greater waste of resources than prevention/intervention strategies that do not solve problems or will not be used. To ensure that the error management program is providing positive results, the organization should publish and distribute information describing program performance.

Preparing metrics information does not require complex data analysis procedures, nor should it be confused with an airline reliability program. It can be as simple as a bar chart plotting the number of like errors against time. The primary objective is to ensure that improvement, or lack thereof, is visually evident.

Examples of sources of metrics data include the following:

- Internally identified pre-delivery discrepancies
- Post delivery operational performance
- Crew reported maintenance discrepancies (logbook items)
- Records accuracy tracking through audits
- Regulatory audits with predetermined criteria