5.0 ERROR CONTROL SYSTEMS AT NORTHWEST AIRLINES

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INTRODUCTION

Almost three years ago, a 747-200 bound for JFK from Hong Kong was touching down in Narita, Japan for an overnight layover. Flight and landing roll-out were routine. From the report on the incident, "Engine thrust reversing was normal on all four engines until coming out of reverse at about 90 knots. The airplane was stopped on a taxiway and the (front of the) engine was seen touching the ground. A fire near the number 1 engine was extinguished by local firefighters. All passengers were deplaned through portable boarding stairs about 30 minutes after the airplane came to a stop on the taxiway."

What caused this incident? Initial indications were that the fuse pins that held the pylon diagonal brace sheared in the incident. The upper fuse pin was recovered intact, however, the two diagonal brace fuse pins and their retainers were not found. The aircraft involved in this incident had undergone a maintenance check at the Minneapolis heavy maintenance facility a month before, and had flown 18 flight cycles since that check. Following the Narita incident, the missing set of retainers was found on a maintenance stand at this facility.

While Northwest Airlines Technical Operations staff were interested in bringing human factors principles into their work organization, this event served to catapult the issue to a high priority. Subsequently, we began the development of a human factors program for error control within Technical Operations.

SYSTEMS APPROACH TO ERROR CONTROL AND MANAGEMENT

Northwest uses a "systems approach" to analyze human error in maintenance. We believe that by combining different methods of dealing with human error, we will be more successful at reducing the risk for future error in our maintenance facilities. A positive by-product of this approach is increased communication with other aspects of our company (e.g., Flight Operations, In Flight, And Ground Operations). Increased communication alone will serve to reduce the risk of human error in situations where these different operations must work as a team. The error control methods fall into three broad categories: (1) Error Data Collection Tools, (2) Education and Training, and (3) Workplace Human Factors and Ergonomics.

ERROR DATA COLLECTION TOOLS

In early 1995, Boeing representatives introduced Northwest Airlines to their paper-based system called MEDA. Northwest participated in the MEDA trial. In October of 1995, the Aurora Mishap Management System was introduced to the maintenance workforce for their use. It is still in use today.

Maintenance Error Decision Aid (MEDA)

The MEDA program is a paper-based system for analyzing errors. It was created by human factors personnel at Boeing and is used by many air carriers. More information can be found in Chapter 3 of this report.

Aurora Mishap Management System (AMMS)

In October of 1995, Northwest began its association with Aurora Safety and Information Systems. Their system (AMMS) is a computer-based data collection tool similar in concept to MEDA. AMMS investigators come from both the IAM and the management within the heavy check hangars in Minneapolis, where the system is primarily in use.

People involved in a given error are interviewed by trained investigators who use the system to guide them through the event and possible causes for that event. These people are asked for ideas on preventing this kind of event from happening. Data is collected and analyzed to look for trends. Using these trends, Northwest assembles an Employee Involvement Group (from both contract and management) to study the problem. They take into account what the people involved had to say about preventive strategies within each report, and then decide on a course of action. This course of action is weighed against each error report to assess how well it would solve each scenario. Cost data for each event (if available) is also used to assess the return on investment for a preventive strategy.

The system was introduced to one cost center within the Minneapolis facility as a beta test. At the beginning of this test, Dave Graham, then Director, 747 Maintenance, and Eugene "Dutch" Drescher, then District IAM-FAA representative, informed the workforce that they would have immunity from punishment from the company if they participated in this system after reporting an error.

Shortly after this introduction, Dave Graham was given responsibility for all Minneapolis heavy check hangars. The system was put in place in the other hangars during the Autumn of 1996. Unfortunately, questions of immunity and discipline have compromised the system's use in all areas. Management is currently using the system. Contract personnel are waiting for clarification on how participation in this system will impact the current disciplinary policy, or if the policy will change.

There are two challenges that face us as users of this system: (1) how to motivate people to talk about the errors they have just committed without fear of being punished for something that was beyond their control; and (2) how do we as managers change our way of thinking from a more punitive to a more enlightened system of management in order to learn from mistakes and reduce the error in our hangars? Part of the AMMS is the Disciplinary Review Board (DRB). The purpose of this board is to objectively analyze the facts in a mishap and come to a decision as to the level of copability involved.

For more information on this subject, the reader is referred to Chapter 6 of this report. The author, David Marx, has extensive expertise in MEDA, AMMS and the DRB, as he has been an integral part of all three efforts.

People are reluctant to change, even if given the promise of a better work culture, if that promise is not demonstrated in word and in deed. Northwest Airlines management is in the process of discovering how to mesh the AMMS with their existing mode of discipline, and demonstrate the way in which it will handle human error and learn from events that occur. The IAM is working with management to come to consensus on how this new culture will look and act.

EDUCATION AND TRAINING

Human Factors Awareness Seminar

A seminar in Maintenance Resource Management is being provided for the aircraft maintenance organization. It provides an awareness that what a person does out on the floor affects others, and is affected by factors such as stress, and suboptimal communication.

Seminar Development

There are many companies, some represented at this meeting, whose main product is courseware for this very purpose. Our own Flight Operations department has an extensive program for Crew Resource Management that they have used for many years. However, we as Technical Operations saw the opportunity to demonstrate the concepts that we wanted to teach, by involving the "end users" in the process of development. Our development team is lead by Phyllis Dozier, an instructional systems design expert. Her role is important in that the product that we are striving for is to be much more interactive than a traditional class. Joan Kuenzi, the Senior Human Factors Specialist for Technical Operations, was also involved in the development as a subject matter expert or (SME). The remainder of the team was made up of people from the International Association of Machinists and Aerospace Workers (IAM) and the Aircraft Technical Support Association (ATSA) who provide technical training for our workforce. The development team for the seminar determined that it would not be called a "class" because it was not like any of the other classes that were available to mechanics; it is an interactive session in which the participants discuss the content among themselves.

Seminar Content

The majority of the seminar is devoted to having the participants discuss and internalize the concepts presented in our Maintenance Resource Management model(Figure 5.1). Other aspects of our seminar include video vignettes designed, scripted and acted by our workforce. These vignettes serve to illustrate some of the points covered under the model. The model is based on one used in Flight Operations, Systems Operations Center (SOC), and In Flight Services, however, we used SMEs to tailor the content to maintenance.

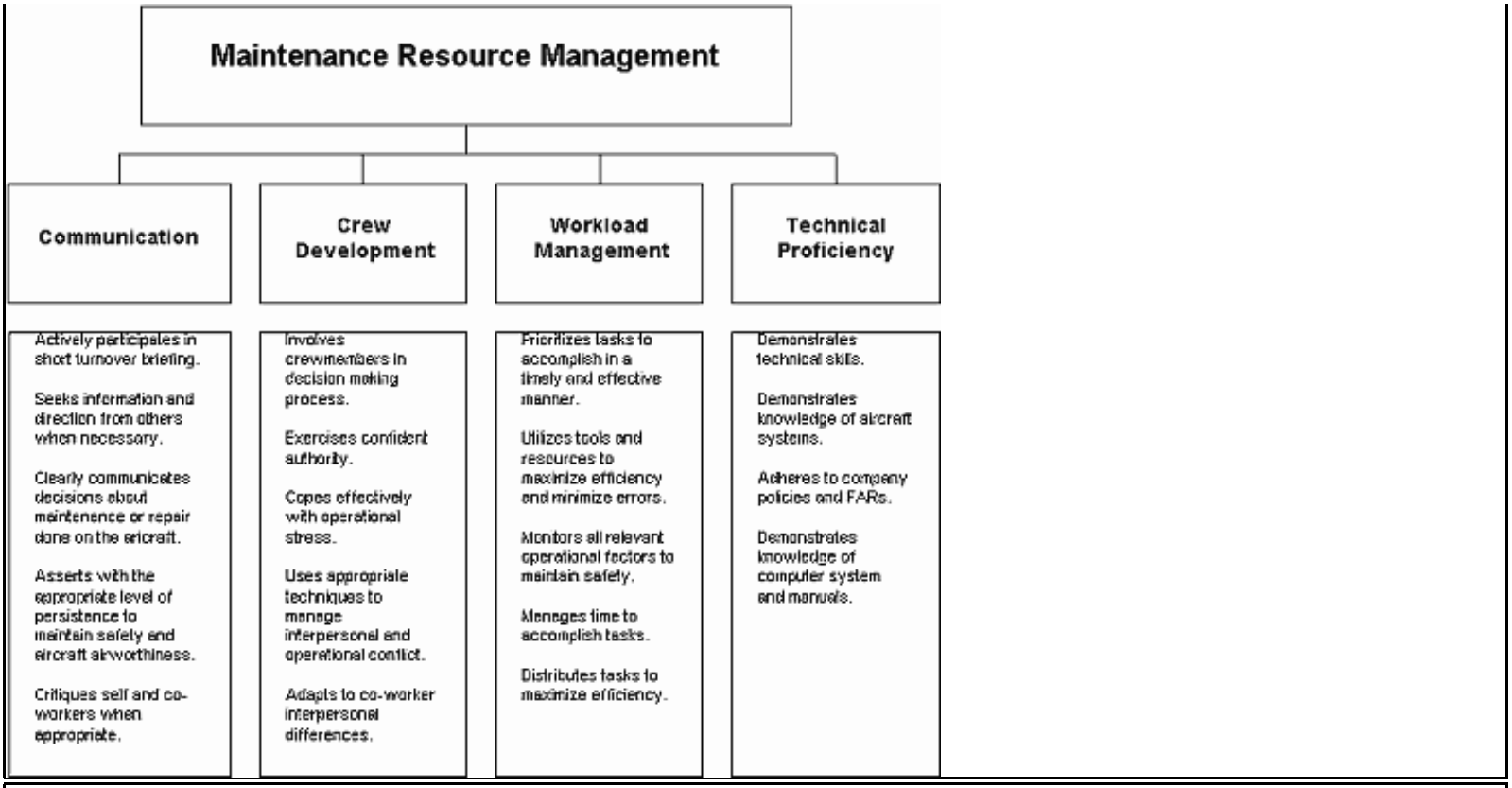

Figure 5.1 Maintenance Resource Management (MRM) model.

Status

The seminar was prototyped in Minneapolis on May 16, 1996. To date, over 1300 people have participated in the seminars. Participants range from mechanics to managers, and include people from Engineering, Quality, Inspection, Shop personnel, and Process Improvement. We are currently prototyping the seminar for introduction to the Line Maintenance Organization, both domestically and internationally and our other heavy check facilities in Atlanta and Duluth. Our goal is to provide this seminar both to the people who work on the aircraft, and to those who work with them.

AMMS Training

All people who use the AMMS to record events have had training from Aurora Safety and Information Systems that include:

1. The theory behind the system and how human error is defined
2. How to use the system
3. Interviewing techniques and who to interview
4. How to look at the data to construct preventive strategies
5. How to assess the impact of preventive strategies using errors in the data

The course was tailored by the company to fit our schedule, including off shift work, and used our own data to teach concepts within the course. Representatives from Northwest Airlines were allowed to evaluate a prototype of the course and our evaluation was taken into account in the final content and layout of the course.

This third piece completes the error control puzzle. The previous pieces served to collect data on the errors and make our workforce aware of their part in reducing human error. Human Factors and Ergonomics (HF/E) principles address the mismatches within the Human/Maintenance interface. Several projects currently address HF/E-related issues in our work environment: (1) Task Analytic Training System (TATS), (2) Structured On-the-Job-Training (SOJT), and (3) Aircraft Maintenance Information-Task (AMI-Task). The following sections will discuss each of these initiatives as well as future plans related to Human Factors and Ergonomics.

Task Analytic Training System (TATS)

Initially provided by Boeing, TATS uses job analysis methods to break a given task into component parts. The purpose of this program is to assess what information needs to be provided (in the form of on-the-job training) to someone new to the area in order for that person to be considered competent on that task. The technique uses people who already perform the task, has them break down the task as a group, and assess the steps and information needed to do the task, and design the task aid used for On-the-Job training.

Structured On-the-Job-Training (SOJT)

The need for a Structured On-the-Job-Training project was driven by the Federal Aviation Administration. There was a concern in 1995 that mechanics were being assigned to tasks for which they had received no formal training. At that time, Northwest had informal on-the-job-training, in that workers who had done the jobs taught those who had not. SOJT was developed to formalize the OJT by providing structure. The purpose of this program is to assess what information needs to be provided (in the form of on-the-job-training) to someone new to the area, in order for that person to be considered competent on that task. The technique uses people who already perform the task. With a facilitator to guide them, this group breaks down the task, assesses the steps and information needed, and then designs a task aid to be used in training. To date, all check hangars in Minneapolis and Duluth, Minnesota, and Atlanta, Georgia have completed the design phase of the project. The implementation process is currently underway.

Aircraft Maintenance Information (AMI-task)

AMI-Task (Aircraft Maintenance Information - Task cards) is a system developed to provide a combined text and graphics maintenance Workcard to the production floor. The Workcards created for use within Northwest Airlines have been implemented with several features to clearly delineate separate work steps, and the skills required to accomplish those work steps. Duplicate access has been virtually eliminated from the aircraft work package through the auto-generation of Access Workcards, using databased information from the routine Workcards scheduled during the aircraft visit. In addition, having the Aircraft Maintenance Manuals digitally available (in the same desktop-publishing system - currently under development) will allow for direct links between Aircraft Maintenance Manual and Aircraft Workcard information. This will both speed revision processing and allow for a closer audit of Workcard information without adding resources.

Other Human Factors/Ergonomics projects

Currently, there are joint efforts between our Human Factors Specialist and the Technical Operations Safety, Health, and Environmental Management (SHEM) department, as well as with the Process Improvement department. All of these efforts are aimed at modifying physical aspects of the work that have a negative impact on human performance.

SUMMARY

There is no single way to reduce maintenance related human error. At Northwest Airlines, we believe that the key lies in taking a systems approach to human factors. Only by looking at the problems we face from several angles can we truly begin to see a more realistic picture. Only then can our efforts to minimize the risks for human error be realistically focused. The projects and initiatives discussed within this paper serve to increase communication between and within workgroups, to lessen the probability for risk of injuries and errors, and to create a more positive culture in which to work.

MR. DAVID B. GRAHAM

David B. Graham is the Director of Base Maintenance Operations for the Minneapolis/St. Paul facility at Northwest Airlines, and is responsible for 727/MD80/757/DC10/747 heavy maintenance. Previously, his responsibilities included Director 747 Aircraft Refurbishment Modification And Renewal, Manager Aircraft Structures, Senior Foreman Aircraft Structures, and Mechanic. He is a member of ATA MOC subcommittee and was recently asked to be part of IATA Human Factors Working Group. David is also a member of NWA Technical Operations Human Factors Steering and Planning committees. He received his A&P license at Colorado Aerotech.

MS. JOAN KLEMAN KUENZI

Joan Kleman Kuenzi has been the Senior Human Factors Specialist with Technical Operations at Northwest Airlines for just over a year. She has a M.S.I.E from the University of Wisconsin-Madison specializing in Sociotechnical Systems, and a B.A. in Psychology from the University of Minnesota-Twin Cities. Her experience in Human Factors/Ergonomics has come from work design to reduce injury/error in maintenance, control room design for nuclear power stations, musculoskeletal disorders research, and job/task analysis. Joan is also a member of NWA Technical Operations Human Factors Steering and Planning committees, and serves on the ATA Maintenance Human Factors Subcommittee.
