Chapter 1
Phase V Overview

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1.0 Introduction

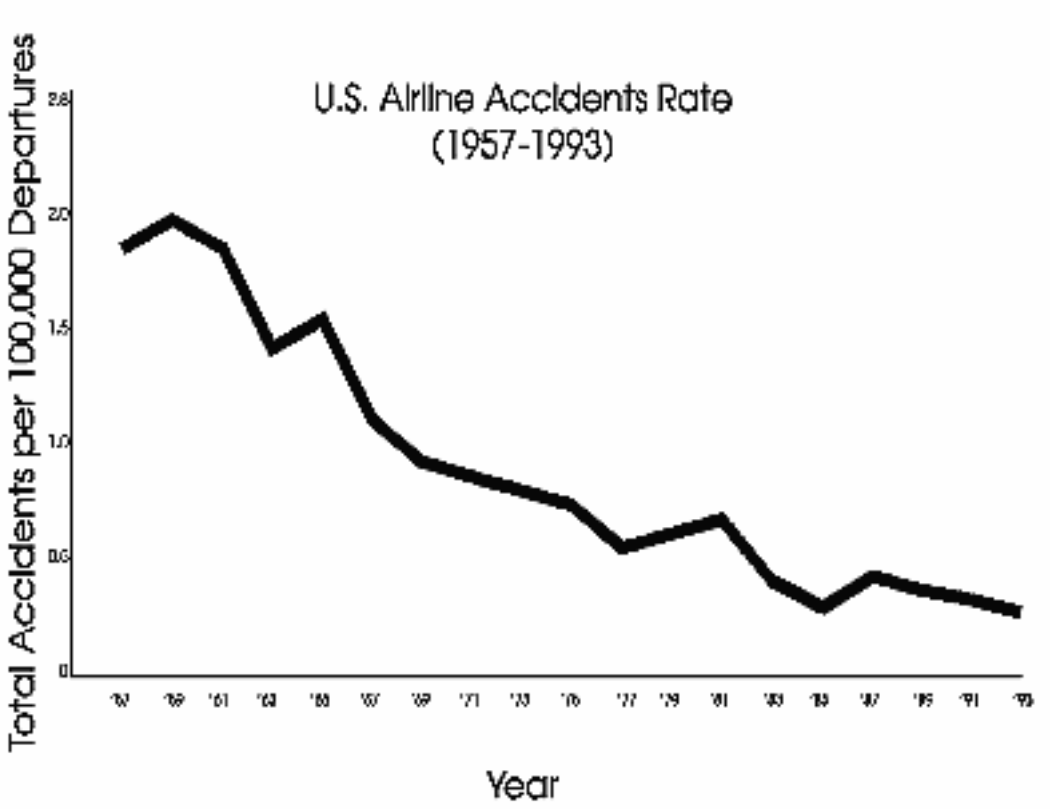

Figure 1.1 U.S. Airline Accident Rate per 100,000 Departures (1957-1993)

NTSB, *U.S. Air Carriers Operating Under 14 CFR 121*, All Scheduled Service (Airlines), 1994

Aviation safety is most commonly measured by accident rate vs. 100,00 departures. Trends, depicted in Figure 1.1, show that aviation safety benefits from continuous improvement, meaning that this earth's safest transportation is becoming even safer. Hardware is the primary reason that aviation safety is improving. Modern power plants and aircraft systems have increasing reliability. Aircraft, air traffic control, and airport navigation, landing, and communications digital systems have also contributed to the safety factor. Some suggest that the extent to which hardware can increase safety has reached an assemtote; it is not likely to make much more improvement. However, attention to the human as operator and maintainer of the aviation safety system, has the highest potential for additional safety enhancement. In fact, human error is the #1 cause of aviation incidents and accidents (NTSB).Since 1989 the FAA Office of Aviation Medicine has conducted research related to human factors in aviation maintenance. The research program is the world's largest such study of human performance in maintenance. Involving universities, government laboratories and private industry, the research addresses many aspects of human performance in maintenance. The research ranges from basic scientific experimentation to applied studies in airline work environments. The applied studies represent the largest part of the program.

The human factors in aviation maintenance research program uses airline and industry maintenance facilities as the primary laboratories. FAA inspectors working on airline air worthiness have also helped to define, develop, and evaluate products of the human factors research.

In the six years of the research, the Office of Aviation Medicine has conducted and published proceedings of nine workshops on Human Factors in Maintenance and Inspection. The research team has published over 200 technical papers. Three CD-ROMs have been published and distributed to over 3,000 recipients.

This report documents the primary research and development efforts conducted in the fifth year of the research program. As in previous years, the report represents a broad spectrum of human performance research and development, each shall be described briefly in the remainder of this introductory chapter.

1.1 Job Aiding for Aviation Safety Inspectors (Chapter 2)

The Performance Enhancement System (PENS) is an ongoing research and development effort to empower FAA Aviation Safety Inspectors (ASIs) with mobile computing software and hardware. The chapter describes two mobile computing applications, one for government (PENS) and the other for industry (CASE).

PENS provides ASIs with a mobile computer to collect and analyze data in the field. The system, described in the chapter, also permits ASIs electronic access to critical data like the Federal Aviation Regulations and the FAA Inspectors Handbooks. The chapter also describes an extensive field test of PENS and ongoing evaluations of emerging mobile computing hardware and software technology.

The airlines share a system to audit providers of goods and services. The system is named Coordinating Agency for Supplier Evaluation (CASE). The CASE system is comprised of paper forms and a hard copy instruction guide book to complete the forms. The CASE mobile computing software has integrated all information into a complete digital system. The chapter 2 appendix describes the CASE software.

1.2 Computer-based Training for Regulatory Documents (Chapter 3)

The System for Training Aviation Regulations (STAR) combines multimedia training software and the FAA Human Factors Information System (HIS) to provide a mix of training and digital documentation. The training system is being designed to present cases, or scenarios, to learn about the Federal Aviation Regulations and other regulatory documents for maintenance. The chapter describes how STAR instructional design and training system analysis were conducted. Descriptions of STAR functionality are also included.

1.3 Digital Documentation Systems (Chapter 4)

The research program has a rich history applied to digital documentation systems. The Human Factors Information System (HIS) is a hypertext multimedia software system that was developed for FAA CD-ROMs 1-3. This special purpose system was designed to meet specific FAA hypertext requirements and to minimize costs associated with mass production and distribution of certain FAA databases. This chapter describes the design and evolution of HIS. It also shows interface examples of how HIS is applied to the CD-ROMs and to the digital *Human Factors Guide*.

1.4 On-Ramp to Information Superhighway (Chapter 5)

The Office of Aviation Medicine has distributed research results via three CD-ROMs, as previously described. This media has worked well as the number of installed CD-ROM computers has increased in government and throughout the aviation industry. The research related to the "FAA Information Skyway" is developing the hardware/software infrastructure to, eventually, distribute research results via the Internet.

The chapter describes a user assessment of the on-line information needs of the aviation maintenance community. The chapter describes the kinds of services that are needed and likely to be provided by an "Information Skyway." The initial World-Wide Web has been established and is operational. The chapter describes the services/reports that are currently available. It also describes future directions.

1.5 Development of an Airline Human Factors Program (Chapter 6)

This project was done in cooperation with Northwest Airlines, at the DC-9 base in Atlanta. The goal was to establish a human factors task force to review a variety of human performance issues associated with the inspection department.

The chapter describes how the task force was formed and the composition of worker and management participants. Also described are a variety of opportunities for improvement in decision making and communication in the maintenance process.

1.6 An Audit System for Maintenance Human Factors (Chapter 7)

The purpose of this task was to provide a valid, reliable, and usable tool for evaluating human factors in maintenance tasks. A software tool was designed and developed as a product of this research. As reported in the chapter the majority of the work went towards the ergonomics audit information with the software development task being secondary. The chapter includes hard copies of most of the forms contained in the software program. The final version of the ergonomics software package shall be included with the digital publication of the *Human Factors Guide*.

1.7 Checklist Reliability (Chapter 8)

Maintenance workcards are the technician's equivalent of the pilot's checklist. The workcard is meant to ensure that maintenance is performed in the correct order and that no step is omitted. The chapter reports on a study of how the design of workcards affects their use and the subsequent potential for error.

The chapter describes a task analysis of workcard usage conducted in an airline maintenance environment. The research analyzed maintenance data from the Aviation Safety Reporting System to determine if workcard usage or non-usage contributed to safety infractions. Also reviewed is application literature on human error with respect to checklists. The chapter ends with a description of the creation and evaluation of a workcard for shift turnover.

1.8 Cooperative Work with Aging Aircraft Inspection Validation Center (Chapter 9)

The Office of Aviation Medicine has engaged in cooperative research with the FAA Technical Center via the Aging Aircraft Inspection Validation Center (AANC). The research supports the Visual Inspection Research Program at Sandia National Laboratories in Albuquerque, NM. The chapter describes the process of visual inspection and describes an evaluation measuring visual inspection performance.

1.9 Individual Differences in Inspection Performance (Chapter 10)

Numerous research studies have shown a wide range of individual performance differences among inspection personnel. This basic scientific study measures relationships between NDI task performance and psychometric measures of mechanical ability and attention-concentration. The chapter describes a battery of mechanical aptitude tests, a simulated NDI task, and the ability of the tests to predict performance. The exciting answer to these predictive questions can be found in the chapter!

1.10 Study of Teamwork in Maintenance (Chapter 11)

Most maintenance activities are conducted by teams of aviation maintenance technicians (AMTs). Therefore, team planning, coordination, and communication are critical to safe and efficient completion of all maintenance tasks. This chapter reports on a study of teamwork in maintenance and outlines a training program focusing on teamwork. The chapter reports the results of an evaluation of a teamwork training program conducted in a FAR 147 school. The chapter ends with a technical specification for a computer-based training system for team training.

1.11 Advanced Certification Initiatives (Chapter 12)

FAR 65 addresses the certification of aviation personnel other than flight crew members. Over the past few years the FAA, in cooperation with an Aviation Rulemaking Advisory Committee (ARAC), has been revising Part 65 to address competencies and requirements for Aviation Maintenance Technicians. This chapter reports on the ARAC activities and impending rule changes. This chapter also considers methods to create an "advanced certification• system that could be administered by private industry instead of FAA.

1.12 Human Factors Workshop-Appendices

The Office of Aviation Medicine has conducted nine workshops on Human Factors in Maintenance and Inspection. The proceedings from eight of these workshops are published in hard copy and on the FAA CD-ROMs. The ninth conference was held in November, 1994, and focused on review of the *Human Factors Guide for Aviation Maintenance*. Few speakers at the ninth meeting spoke on topics other than specific chapters of the *Guide*. Therefore, a dedicated 9th Meeting Proceedings shall not be published.

The appendices of this report contain papers from the 9th meeting that are not directly related to the *Human Factors Guide*. The first speaker was Dr. Jon L. Jordan, Federal Air Surgeon. Dr. Jordan's paper reviewed the five year progress of the research program. He highlights major program products and looks to the future of the research program.

Dr. Patrick Walter is the Director of the Aging Aircraft Inspection Validation Center at Sandia National Laboratory. His paper describes the research program at Sandia. The appendix also contains a paper from Mr. Eddie Rogan, Human Factors Engineer - British Airways. Mr. Rogan describes the human factors research at British Airways with specific reference to the Managing Engineering Safety Health (MESH) system. MESH is a method for reporting, analyzing, and mitigating human error in maintenance.

Also included in the appendices is a list of attendees who participated in the Agenda 9th Workshop.

REFERENCES

NTSB, Broad Cause/Factor Assignments, 14 CFR 121 Operations, 1992