

## Human Factors in Aircraft Maintenance and Inspection

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## Summary

The events which have led to the intensive study of aircraft structural problems have contributed in no less measure to study of the human factors which influence aircraft maintenance and inspection. Initial research emphasis on aging aircraft maintenance and inspection has since broadened to include all aircraft types, both new and old. The role of today's aircraft maintenance workforce is indeed a complex one as it is strongly influenced by the need to maintain the broad technology mix embodied in the current fleet. Technicians must be equally adept at diagnosing and repairing "old-tech" 727, DC-9 type aircraft and "new-tech" 767, and MD-11's. Their skills must include ability to repair sheet metal and composite materials; control cables and fly-by-wire systems; round dials and glass cockpits. Their work performance is heavily influenced by others such as designers, technical writers, job card authors, schedulers and trainers. This paper describes activities concerning aircraft maintenance and inspection human factors.

In the past few years a number of very prominent air carrier accidents have highlighted the role of aircraft maintenance in aviation safety. The Aloha Airlines 737 accident and the United DC-10 accident at Sioux City, Iowa are two relatively recent events which were precipitated by maintenance and inspection problems. In response to these and earlier events the FAA's Office of Aviation Medicine has been assigned the task of investigating the role of human performance in the maintenance and inspection of air carrier aircraft. The FAA has developed a research program of study in several areas. These include Training, Human Error in Inspection, Work Environment, Job Performance Aids, Organizational Factors and Communication including study of hypermedia applications to enhancing information flow and accessibility. In addition a number of parallel activities are being conducted in this program including presentation of conferences dealing with several different human factors topics, and production of a Human Factors Guide for maintenance. This latter publication will present human factors information in a form usable by maintenance managers, designers, and FAA oversight personnel.

The research being accomplished in this program falls under the National Plan for Aviation Human Factors. The National Plan is focused primarily on research activities and merges the work of FAA, NASA and some elements of the Department of Defense. The Plan was developed with input from these and other government organizations, academia and private industry. The purposes of the National Plan are four-fold viz:

1. Identify significant human performance issues
2. Direct scarce resources to highest payoff
3. Transfer human factors technology
4. Communicate research needs

Scientific Task Planning Groups (STPG) met on several occasions to identify problems and formulate proposed research activity to address these problems. The STPG's covered four broad topics: Flight Deck, Air Traffic Control, Flightdeck - ATC Integration, and Maintenance. This last topical area covers both aircraft maintenance and airways facilities maintenance. This paper considers only aircraft maintenance.

The FAA maintenance human factors program addresses three sub-topics as specified by the National plan; a) Personnel and Training, b) Advanced Technology Systems, and c) Environment and Organization. The primary goal of this work is the enhancement of the performance of the human as a key element in the aviation maintenance system. Several activities or tasks within these sub-topics are described as follows.

#### Activity 1: Advanced Technology for Maintenance Training

This task deals with the development of advanced computer-based instruction systems. These new systems are called Intelligent Tutoring Systems (ITS). They embody more sophisticated software than traditional computer-based instructional systems. ITS software includes subject matter expert and instructor modules which are capable of adapting to individual student capabilities and needs. A prototype ITS for maintenance training has been developed. Future activity will concentrate on using and evaluating this ITS in realistic training settings.

#### Activity 2: Study of Human Error in Inspection

This activity involves laboratory and field study of factors which affect inspection accuracy and reliability. Particular attention will be given to visual inspection and non-destructive inspection (NDI) equipment and its use. Laboratory experiments have been devised to permit controlled study of factors which affect detection of various types of flaws or defects.

### Activity 3: Human Factors Guide for Maintenance and Inspection

This document will be a compendium of human factors information useful to maintenance managers, designers, and FAA oversight personnel. It will consist of information obtained from the current research program, (as described under other activities listed in this paper) and information from other sources. For example there is a very large literature on vigilance. This information base will be reviewed and material pertinent to the aircraft maintenance case will be extracted and appropriately structured to provide useful information to those with special interests in aircraft maintenance.

### Activity 4: Human Factors Conferences and Workshops

To date, five such conferences have been conducted. The purpose of these meetings is to bring together human factors experts, operational personnel, government representatives, airframe and system manufacturers, union representatives and others to discuss issues that are pertinent to maintenance human factors. These conferences facilitate communication among people with various viewpoints and expertise and help with problem solution by exchanging knowledge and experience. Conferences have been held on such topics as Training, Information Exchange and Communication, Work Environment and others. It is expected that these conferences will continue for the foreseeable future. The next planned conference will be held in January 1992 in the Washington, D.C. area with the topic "Design for Maintainability."

### Activity 5: Guidelines for Managing Communication

This activity focuses on development of guidelines for effective communication in maintenance organizations. Optimal methods for assuring two-way information flow will be developed and described as well as identification of organizational factors which facilitate communication.

### Activity 6: Job Performance Aids for Maintenance

Many industries have developed job performance aids for their particular activities. Some of these may be appropriated or modified for use in the air carrier maintenance industry. This task will examine several existing aids and select one for further development. After appropriate development, the selected system will undergo evaluation with a volunteer airline or airframe manufacturer.

#### Activity 7: Use of Hypermedia in Aviation Maintenance

A prototype system will be developed to determine the applicability of hypertext technology to aviation maintenance documentation. Hypertext technology will apply artificial intelligence concepts to such documentation as aircraft maintenance manuals. Appropriately applied, this technology could greatly reduce the time technicians spend in searching documents for needed information and could also contribute to reduction of maintenance error.

#### Activity 8: Study of Maintenance Work Environments

Work conditions can certainly influence performance of maintenance tasks. Such factors as ambient temperature and lighting, work site access and others can affect maintenance quality with a consequent effect on safety. This task will develop guidance on appropriate working conditions based on existing information for other industries and on information developed during on-site evaluations of air carrier maintenance work sites.

The study of aircraft maintenance human factors will continue for the foreseeable future. As the research progresses, additional topics in need of study have become apparent such as application of crew resource management (CRM) principals to aircraft maintenance. The program will make appropriate adjustments to assure that these additional topics are accounted for. Also those original tasks, as described in this paper, will continue to receive appropriate emphasis and directional changes if need be to provide maximum information to constituent groups.