STRATEGIC PROGRAM PLAN

Prepared for the Aircraft Maintenance Division (AFS-300) of the Flight Standards Service in cooperation with the Office of Aviation Medicine (AAM-240)

Executive Summary

The Federal Aviation Administration's (FAA) Flight Standards Service Aircraft Maintenance Division, together with the Office of Aviation Medicine (AAM), developed and formalized the agency's Human Factors in Aviation Maintenance and Inspection research program. This program was implemented in response to a congressionally mandated requirement (Aviation Safety Research Act, Pl. 100-591, 1988), and is aimed at reducing the number of accidents and incidents resulting from human error in maintenance.

The research program is an industry-government-labor partnership that involves numerous airline operators, maintenance facilities, universities, research laboratories, and government agencies worldwide. It is planned, integrated, and coordinated with the **FAA**/**NASA** Aviation Safety Program (ASP), formally known as the ASIST Program.

Through these partnerships, the research program has created, implemented, evaluated, and measured a variety of prototype products to enhance training, job aiding, and information systems for aviation maintenance personnel. Since 1989, the research program has conducted annual conferences attended by thousands of participants, and has generated more than 400 technical reports, journal articles, and presentations. The research program has the international reputation of representing the "real world" of aviation maintenance and addressing maintenance human factors issues accordingly. It has raised the awareness of the importance of human factors to the aviation industry, and a number of organizations are implementing programs specifically designed to reduce maintenance errors.

The research program's national and international interest is so pervasive, the Human Factors in Aviation Maintenance and Inspection (HFAMI) program recently developed a web site for efficient dissemination of informational materials. The web site not only contains a wealth of topical information, but also introduces interactive applications to the aviation industry via the internet.

The **HFAMI** web site has been accessed from over 80 countries, and by more than 125 government and military agencies, including the National Transportation Safety Board (NTSB), Department of Transportation (DOT), the Department of Defense (DOD), and National Aeronautics & Space Administration (NASA). Nearly 300 educational institutions have accessed the HFAMI web site, as well as airline industries and aircraft manufacturers, including Delta Air Lines, British Airways, and Boeing. Additionally, over 1,300 commercial businesses have accessed the HFAMI web site since January 1997.

This strategic program plan describes the on-going industry-government-labor partnerships that characterize the human factors in aviation maintenance and inspection research program. The plan provides scientific explanation and rationalization of the need for applied human factors research and development. The plan delivers historical, current, and future research and development goals and

applied deliverables. Under continuing association with the aviation industry worldwide, the research program ensures that human performance is a central focal point of the aviation maintenance system.

The goal of the Human Factors in Aviation Maintenance and Inspection research program is to achieve significant reduction of aircraft maintenance accidents and incidents caused by human factors. Without such effort, the limitations of human performance will continue to be taxed by an increasingly demanding environment.

Program Mission Statement

To pursue applied research in human-centered aircraft maintenance and inspection safety issues and to develop products that provide applied practical solutions responsive to requirements from industry, labor, research, and regulatory agencies.

Goals

• Reduce aircraft maintenance and ground operation accidents, incidents, and related errors.

• Direct and coordinate industry and regulatory efforts nationally and internationally.

• Improve effectiveness and efficiency of the aviation maintenance and **FAA** Aviation Safety Inspector workforce.

Primary Activities

• Maintenance Resource Management

• Maintenance Error Reduction

• Job Task Analysis in Aviation Maintenance Environments

• Maintenance and Inspection Training

• Job Aids for Maintenance and Inspection

• Information Dissemination

• Communication and Harmonization

Introduction

Aircraft maintenance human factors is one of the last "frontiers" that can have significant impact on aviation safety. This introduction first explains why there is a growing requirement for applied research

in human factors for the aviation maintenance community. The section then defines human factors and how it can improve safety for the aviation maintenance community.

Growing Requirement for Maintenance Human Factors Research

Accidents and incidents are more likely to be caused by the actions of humans than by mechanical failure. Industry statistics show that human error contributes to nearly 80% of airline accidents and incidents, as illustrated below. This figure includes all aspects of human factors including operations, maintenance, and air traffic control. Because aviation systems are continually improving, the aircraft is seldom the cause of an accident and incident. Humans, rather than equipment, are more likely to be at the root cause of an accident or incident. Therefore, the best opportunity for safety improvement is to understand and manage the human factors that pose safety risks.

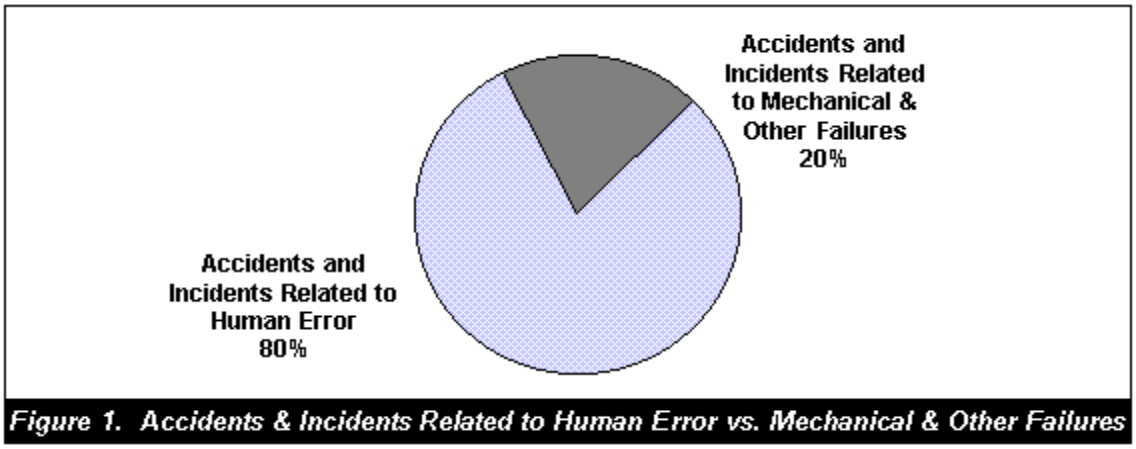


Figure 1. Accidents & Incidents Related to Human Error vs. Mechanical & Other Failures

Aircraft maintenance human factors research is particularly critical for improving aviation safety. **Table 1** is a partial list of airline accidents where the probable cause is maintenance related (see **Appendix A** for a complete listing). In each of these cases, a mechanical failure was not the true culprit, but rather some aspect of the maintenance organization related to human performance was a casual factor of the accident.

Table 1. Examples of Airline Maintenance Errors

DATE	AIRLINE	LOCATION	CAUSE
5/25/79	American Airlines DC-10	Chicago	Engine separation
5/05/83	Eastern Airlines L-1011	Bahamas	O-rings
8/12/85	JAL B-747	Japan	Bulkhead
4/28/88	Aloha Airlines B-737	Hawaii	Fuselage failure
1/08/89	BM Airways B-737	Manchester	Burner can
7/19/89	United Airlines DC-10	Iowa	Fan blade failure
9/11/91	Continental Express Embraer	Texas	Deicing boot
3/01/94	Northwest Airlines B-747	Narita	Engine separation
6/08/95	ValuJet DC-9	Atlanta	Turbine Failure
5/11/96	ValuJet DC-9	Florida	Hazardous Materials
10/2/96	Aeroperu B-757	Peru	Blocked Pitot Ports

One example from **Table 1** is an incident involving a "dragged engine on rollout" of a Northwest B-747 at the Tokyo Narita Airport in March 1994. The front of an engine fell from its mount causing its nose cowl to drag along the runway. The friction caused a small fire, which was extinguished by a ground crew. There were no injuries. The **NTSB** investigation showed a variety of maintenance actions that contributed to the incident, many of which were rooted in human factors.

The factors included the following:

• inadequate training for the specific engine maintenance and inspection task

• poor tracking of maintenance responsibility

• inadequate lighting in the maintenance workplace

• improper use of job card instructions

• work environment conducive to error

• **FAA** inspectors failing to apply FAA-developed human factors guidelines for adequate work environments

There is good evidence to project that such accidents can be expected to continue to occur. **Figure 2** shows that maintenance costs, passenger miles flown, and the number of aircraft have all exceeded the overall growth of the aviation maintenance technician (AMT) workforce (Air Transport Association, 1996) by substantial percentages. The obvious conclusion is that the AMT must raise efficiency to match

the increasing work load.

The proportionately smaller workforce is also faced with other factors which compound the workload problem. Advanced technology aircraft with sophisticated composite structures, computers, and avionics add to the skills and knowledge required to perform maintenance today. In addition, aging fleets require increased labor efforts to keep older aircraft flying safely.

To meet these challenges without sacrificing safety, individual technician responsibilities and skill levels must increase. The industry must work together to ensure that workers become more qualified and that maintenance tasks and procedures are adapted to meet human capability. Attention to human factors in aircraft maintenance will ensure not only continuing performance enhancement of the technician workforce, but also continuing flight safety.

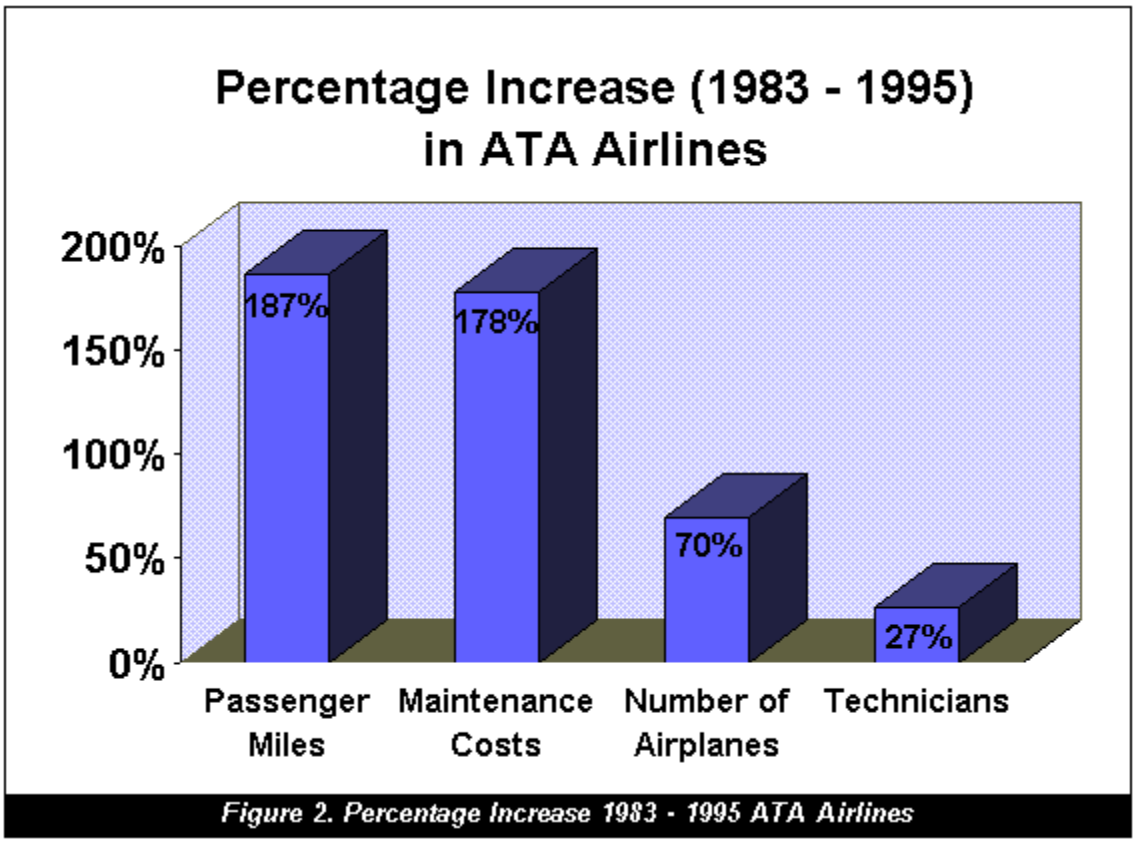


Figure 2. Percentage Increase 1983 - 1995 ATA Airlines

This strategic program plan details how the Aircraft Maintenance Division of Flight Standards Service (AFS-300) is responding to safety and human performance challenges via the Human Factors in Aviation Maintenance and Inspection research program.

How Human Factors Research Can Help

"Human Factors" refers to the study of human capabilities and limitations in the workplace. Human

factors include, but are not limited to, such attributes as human physiology, psychology, work place design, environmental conditions, human-machine interface, and more. Human factors researchers study system performance. That is, they study the interaction of humans, the equipment they use, the written and verbal procedures and rules they follow, and the environmental conditions of any system.

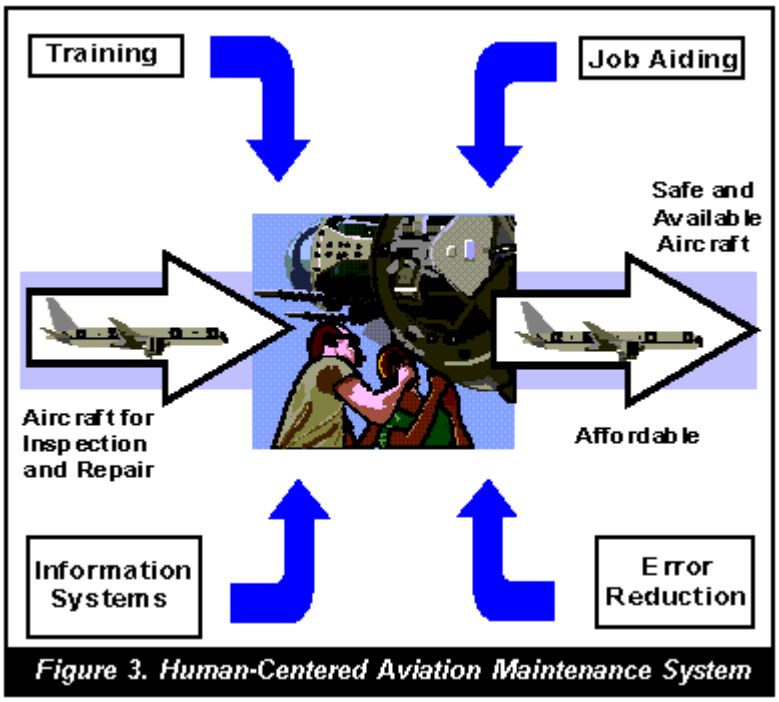


Figure 3. Human-Centered Aviation Maintenance System

Figure 3 illustrates the maintenance system, where the system starts with an aircraft ready for inspection and repair. Maintenance personnel, using tools and procedures within the maintenance environment, must maintain the aircraft. **Figure 3** indicates four human factors that affect the human maintainer: training, job aiding, information systems, and error reduction practices. When the system is optimized, the result is an aircraft ready for dependable and safe use, such that the costs are affordable to travelers and the operation is profitable to the airline. As **Figure 3** illustrates, in a complex system there are multiple approaches to optimizing system performance. The research program has identified seven primary research activities that address different aspects of the maintenance system:

• Maintenance Resource Management

• Maintenance Error Reduction

• Job Task Analysis in Aviation Maintenance Environments

• Maintenance and Inspection Training

• Job Aids for Maintenance and Inspection

• Information Dissemination

• Communication and Harmonization

Maintenance Resource Management

Maintenance Resource Management (MRM) has become an umbrella term that has yet to be clearly defined. Some current MRM programs may parallel the Crew Resource Management (CRM) programs used for improving team communication and performance in the cockpit. By defining resource management for maintenance and investigating related issues, this research will develop guidelines and related training and reference materials for MRM through extensive cooperation with the airline industry.

Maintenance Error Reduction

Error reduction is a key activity for the research program. The program seeks to develop methodologies or techniques to proactively minimize aircraft maintenance errors and enhance safety. General areas for research include error classification, identification, mitigation, and reduction.

Job Task Analysis

Job Task Analysis (JTA) is a technique used to determine the necessary knowledge, skills, and abilities required to perform the various tasks of a specified job. Job Task Analysis data is then used as the basis for developing curriculum.

A **JTA** is being conducted to gain an understanding of the current tasks that Aviation Maintenance Technicians perform. This project is an on-going grant that has been supervised by the **FAA** Technical Center through June 1997. The research project has cooperated with all sectors of the aviation maintenance community to update and upgrade the training standards for technicians performing maintenance in the current and future environment.

Maintenance and Inspection Training

Research activities in this category include studies for the improvement of maintenance training curriculum, delivery systems, and investigation of new technology for improved training methods. All prototype training products shall be pragmatic and aimed at affecting a measurable change in human performance in aviation maintenance and inspection. Related studies, such as investigations of personnel selection methods and workforce projections, are also included in this category.

Job Aids for Maintenance and Inspection

Job Aiding research acknowledges the requirements, capabilities, and limitations of human maintenance personnel. The research program identifies areas where human performance can benefit from improved or new support tools. The program develops prototype tools that support **AMT** performance. In addition, the program evaluates the feasibility and effectiveness of job aiding techniques and technologies, thereby improving safety through improved task performance.

Information Dissemination

Human factors research can only have an impact if the results and products of the research program are disseminated to the aviation maintenance community. The research program develops and distributes technical and scientific documentation via the **FAA** *Human Factors Guide for Aviation Maintenance and Inspection* and various research reports. Software prototypes for training or job aiding are provided to the industry via the internet and CD-ROMs.

Communication and Harmonization

Aviation safety is an international activity. For that reason the research program cooperates with a variety of international organizations, governments, and airlines. Examples of cooperative efforts include the joint working agreement among the Federal Aviation Administration (FAA), the Civil Aviation Authority (CAA) in the United Kingdom, and Transport Canada. Further, the research, engineering, and development team is active with the International Civil Aviation Organization (ICAO), International Air Transport Association (IATA), Air Transport Association (ATA), National Air Transport Association (NATA), and a variety of U.S. and international carriers. The work of the research program is presented at international conferences and showcased at annual conferences sponsored by the research program. In addition, the program supports harmonization of regulatory and guidance material with international bodies.

Background

Under sponsorship from the **FAA** Flight Standards Service, the FAA Office of Aviation Medicine has created a successful research program to investigate applied issues in human factors in aviation maintenance and inspection. This section reviews the formation of the research program and describes its basic structure for fulfilling its mission and goals, as listed in this strategic program plan. The section concludes with a discussion of program funding levels and the requirements for increased funding.

Formation of the Program

Responding to industry concerns, the Aircraft Maintenance Division of the Flight Standards Service, initiated human factors-related research beginning in 1987. A year later, the Aviation Safety Research Act of 1988 mandated research "…to develop a better understanding of the relationship between human factors and aviation accidents and between human factors and air safety…" The Aloha Airlines accident also occurred in 1988, prompting increased congressional and public concerns resulting with increased research funding. By 1989, the program was formalized with the formation of the **FAA** Scientific Task Planning Group (STPG). The STPG provided direct maintenance industry planning and involvement with the program. The *National Plan for Civil Aviation Human Factors* was developed in 1990 and formed a core foundation for the research program. The National Plan has been a major influence driving the maintenance human factors research and development program during the nineties.

Overview of the Research and Development Process

The research program interacts with many national and international groups to provide timely and needed research products. Figure 4 illustrates the overall process by which requirements are turned into products. Note that the research program is responsive to both government and industry requirements. Government requirements come from within the **FAA** (G-7 and Aviation Rule Making Advisory Committees [ARACs]) and from other governmental organizations, such as the National Transportation Safety Board (NTSB), the Department of Transportation (DOT/FAA Aviation Safety Action Plan - Zero Accidents…A Shared Responsibility), the White House (Commission on Aviation Safety and Security), the Joint Aviation Authority (JAA), and the International Civil Aviation Organization (ICAO). Industry requirements come from organizations such as the Air Transport Association (ATA) and its committees (e.g., Human Factors, Maintenance Training, Engineering and Maintenance, and Technical Information Communications Committee) as well as the Aviation Technician Education Council (ATEC), Professional Aviation Maintenance Association (PAMA), the International Air Transport Association (IATA) and the aviation groups of the Society of Automotive Engineers (SAE). In addition, the International Association of Machinists and Aerospace Workers (IAM & AW) has been a very active party in many of the research activities. After internal review and requirement prioritization, research is then executed via university grants, program contracts, and other vehicles.

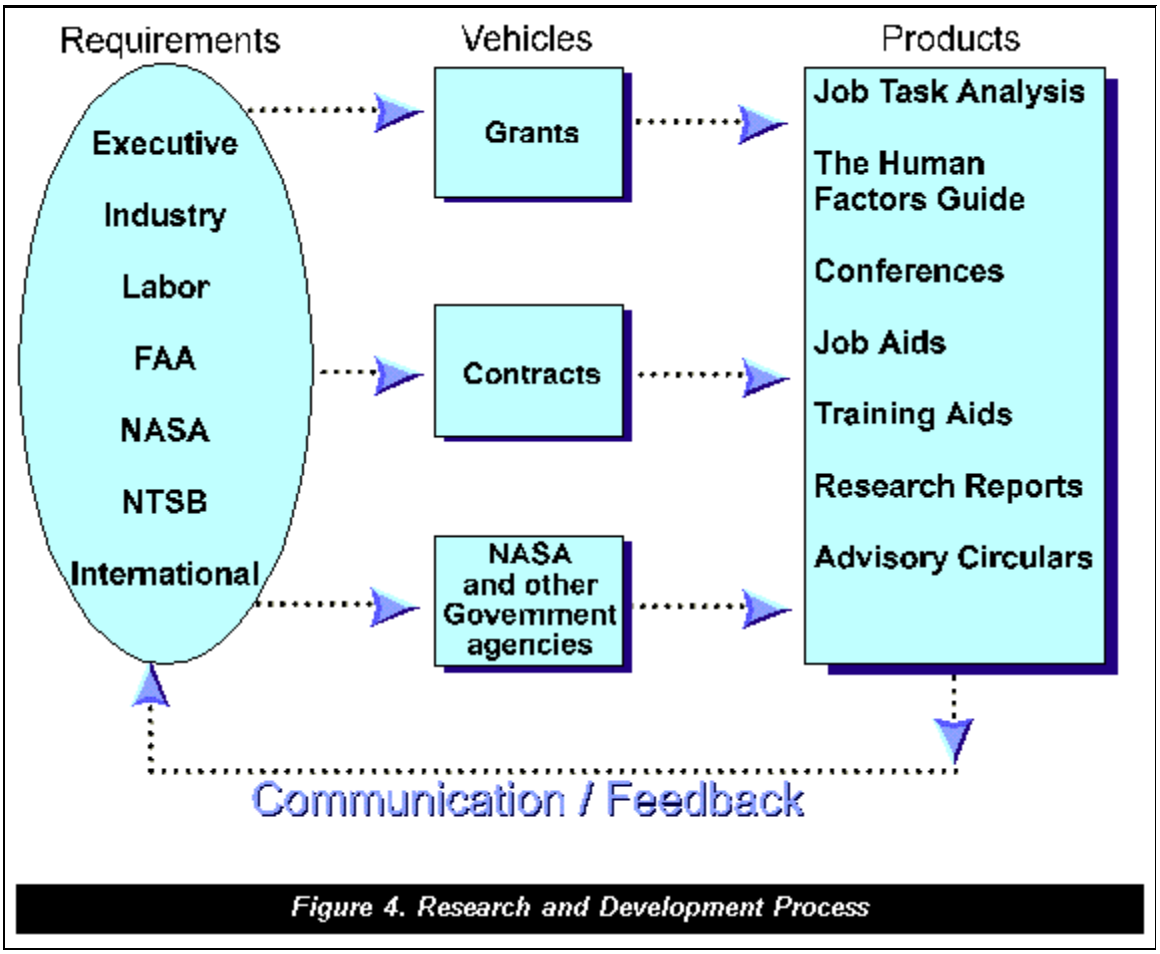


Figure 4. Research and Development Process

A field laboratory approach is used to complete research tasks, emphasizing on-site observation, measurement and testing at airline maintenance facilities. The products developed and evaluated by the research program include data to support regulatory efforts, Advisory Circulars and informal guidance material, prototype job aids and training systems. These products are communicated to industry, the military, and others via conferences and publications. The **FAA** human factors program distributes all of its research reports and software deliverables to industry via CD-ROMs and the internet. **Table 2** summarizes the widely distributed program products.

Table 2. Summary of Information Products

Communication Mechanism	Quantity
Conferences on Human Factors Issues in Aviation Maintenance and Inspection	Approximately one conference per year With an average of 145 attendees
CD-ROMs distributed to industry (annually for past five years)	
Human Factors Issues in Aircraft Maintenance and Inspection (1993-1997)	> 10,000 copies
Electronic Human Factors Guide	> 6,000 copies
Aircraft Maintenance Team Trainer	> 3,000 copies
Web site (hfskyway.com)	the web site has been accessed over 1 million times since January 1997
Research Reports/Presentation/Publications (1989-1997)	> 400 in multiple copy

Finally, the R, E&D process relies on a feedback loop, shown in **Figure 4**. Field evaluations of products and techniques provide feedback that is used to guide future work as well as information on the usefulness of products. In addition, the program seeks feedback from industry on completed research. Such feedback provides additional or adjusted requirements for future research.

Program Funding

Funding for the Human Factors in Aviation Maintenance and Inspection research program has traditionally been at relatively low levels, when compared to flight deck human factors. The pie chart in

Figure 5 shows that in FY 1997, aircraft maintenance research received 12% of the funding at a total of $1.265 M. In 1998 the $1.3M funding is a reduction representing 10% of the budget.

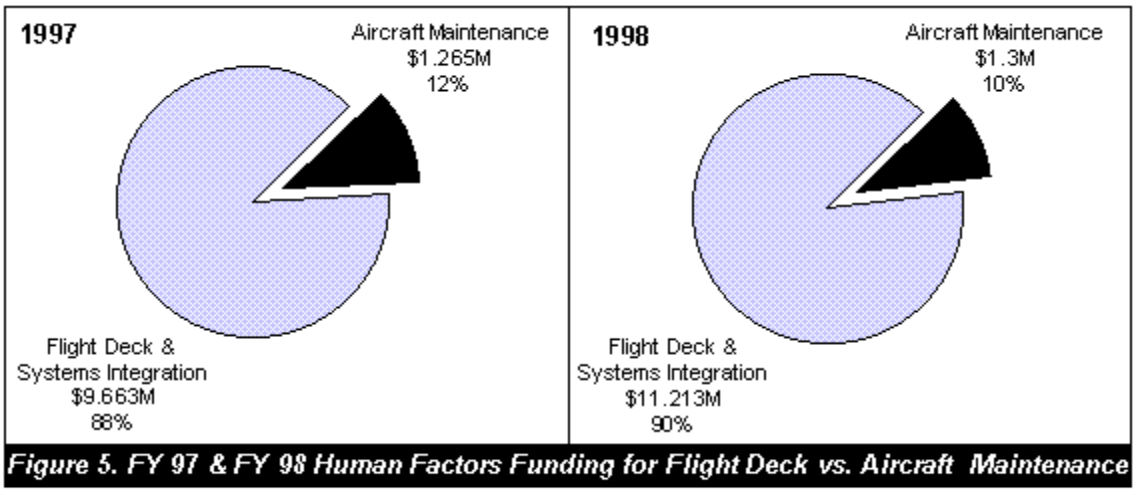


Figure 5. FY 97 & FY 98 Human Factors Funding for Flight Deck vs. Aircraft Maintenance

** FY 98 funding for the Human Factors in Aviation Maintenance and Inspection research program is $1.3 M. This funding represents 4.6% of the total FAA budget of $28M for all human factors research.*

The White House, **NTSB**, and **DOT** all agree that the time has come for maintenance human factors to receive additional funding to address important safety concerns. In 1995, the DOT/**FAA** Aviation Safety Action Plan (Zero Accidents…A Shared Responsibility) recommended that the Flight Standards Service devote additional research effort towards human factors for aircraft maintenance, focused on error detection and prevention. The 1997 White House Commission on Aviation Safety and Security Report identified numerous opportunities to improve airline safety, among them, extending the areas of FAA current human factors research. The research program needs appropriate funding to respond to the increasing requirements for aircraft maintenance human factors research.

Summary of Past Accomplishments

In order to understand where the research program is going, it is important to understand what the program has accomplished to date. The research program is embraced nationally and internationally by the **FAA**, industry, academia, and the human factors scientific community at large. The research team members have helped airlines implement and evaluate training for maintenance resource management and have assisted the **ATA** Maintenance Training Committee to "raise the bar" regarding requirements for advanced technology training. The FAA *Human Factors Guide for Aviation Maintenance*, developed by the research program, is recognized by industry maintenance personnel, other government industries, and military throughout the country and the world. The FAA Flight Standards Service has fielded the On-line Aviation Safety Inspection System (OASIS), which is a mobile computing job aid for the Flight Standards Service Aviation Safety Inspectors. These and other research products have made the transition, with overwhelming success, from the research program into government and industry.

This section highlights some of the key products that the research program has delivered. These products are organized by the primary activities of the research program. All of the research program's products, procedures, and reports contribute to continuing safety and improvement of operational efficiency

through improvements in human performance.

Job Task Analysis Products

Job Task Analysis projects can be broad or narrow in focus. The research program has conducted JTAs of both types.

AMT JTA

Regulatory efforts to revise the **FAA** airframe and powerplant mechanic certificate have led to the development of a proposed Part 66 rule. This rule prescribes new training and certification standards for technicians returning transport aircraft to service (Parts 25/29). Those who complete this training would receive the Aviation Maintenance Technician (Transport) AMT-T certification. The change in the certificate structure implies that corresponding training requirements will be needed. The **JTA** supported the regulatory effort by collecting survey data on tasks performed by **AMT**s across all segments of civil aviation. A total of 2,434 validated surveys were collected from 84 facilities. Respondents rated 303 tasks in 20 subject areas in three categories: frequency, criticality and difficulty to learn. The JTA results provide data to support the regulatory changes and provide an objective basis for AMT-T curriculum development.

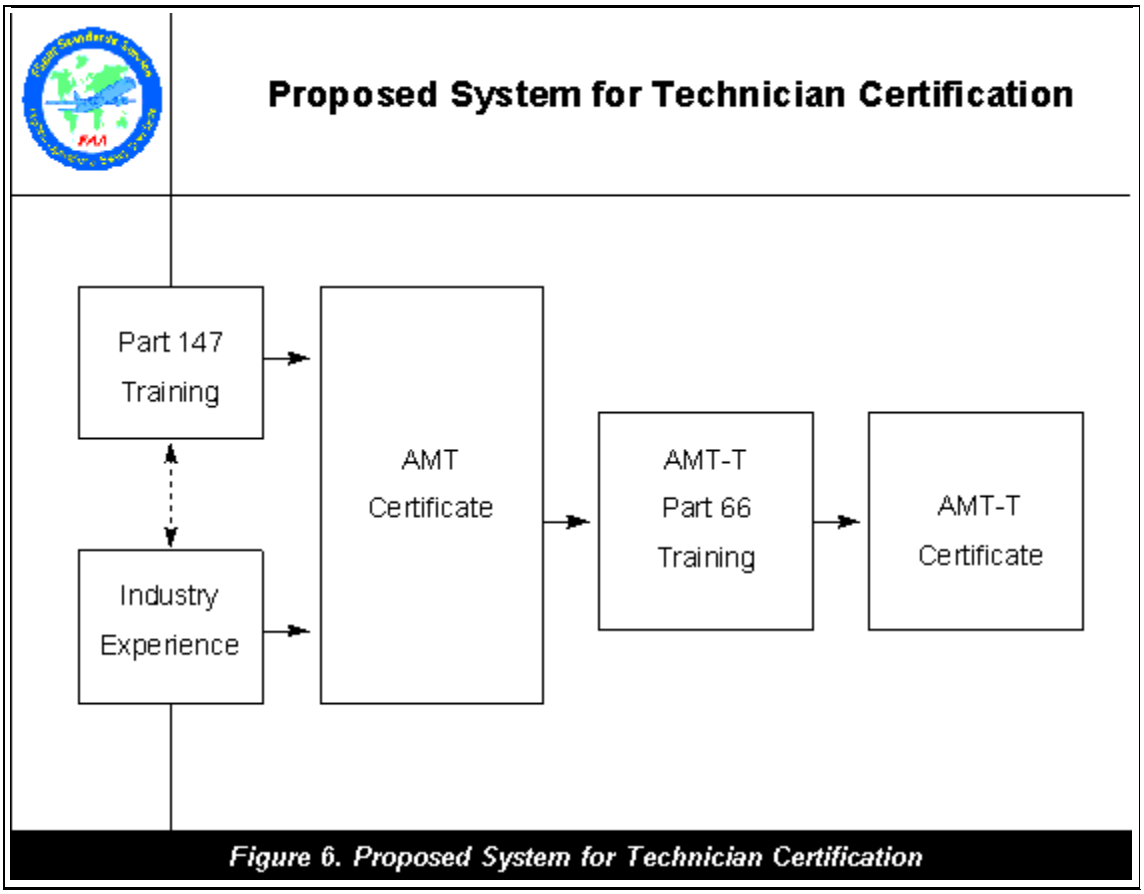


Figure 6. Proposed System for Technician Certification

Supervisory JTA

Airlines indicated that maintenance personnel receive a lot of technical training, but supervisory positions within maintenance have not been systematically studied. A Job Task Analysis was conducted that focused on analyzing the tasks of first and second level aircraft maintenance supervisors (foremen and lead mechanics). A detailed listing of tasks was created for three broad categories of supervisory tasks: Administrative, Operational, and Personnel. This **JTA** identified the need for improved training for new foremen and lead mechanics. A preliminary curriculum outline for leadership training was also developed in conjunction with two airline partners over a six-month period.

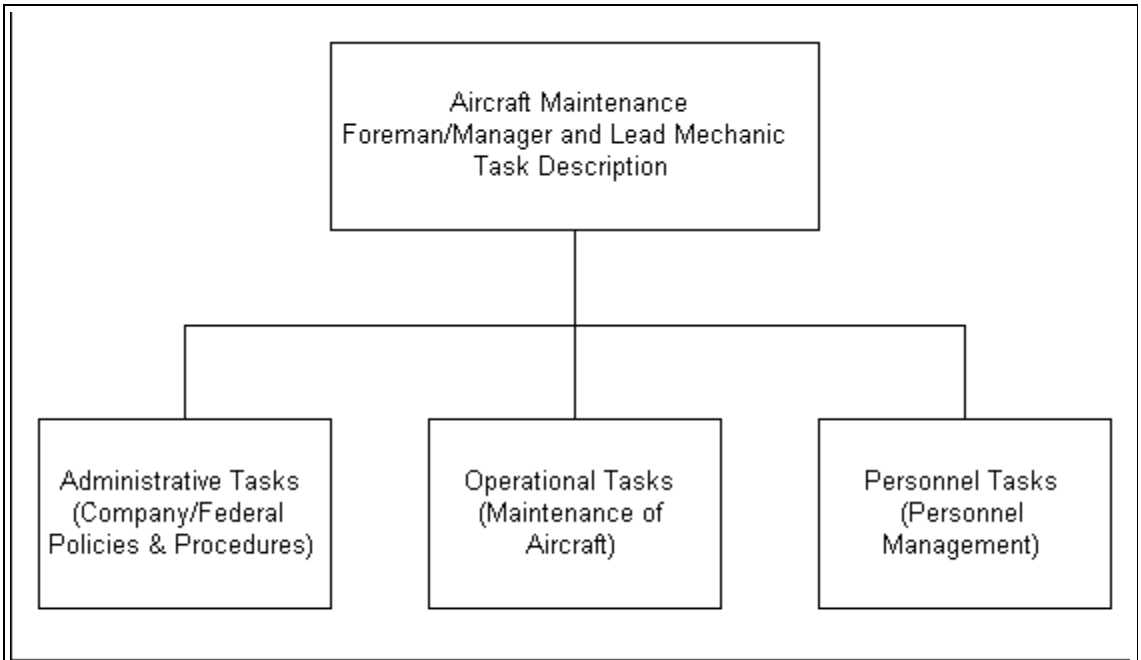


Figure 7. High-level Supervisory Tasks

Maintenance Resource Management Products

Maintenance Resource Management is a relatively new focus area for the program. The first major product was the prototype Team Situation Awareness Training Curriculum.

Team Situation Awareness (SA) Training Curriculum

Airlines have requested expertise related to situation awareness in maintenance. The research team responded with a prototype training curriculum. The objective of this curriculum is to equip Technical Operations personnel with the skills and abilities to develop an awareness and understanding of factors that affect SA in the maintenance domain and team processes. Five **SA** concepts are taught: 1) Shared Mental Model, 2) Verbalization of Decision, 3) Better Shift Meetings and Teamwork, 4) Feedback, 5) SA Errors. Materials include Microsoft Power Point slides, group activities, and a facilitator's handbook. The SA Training Curriculum shall be included on **FAA** CD-ROM '98, which has been published

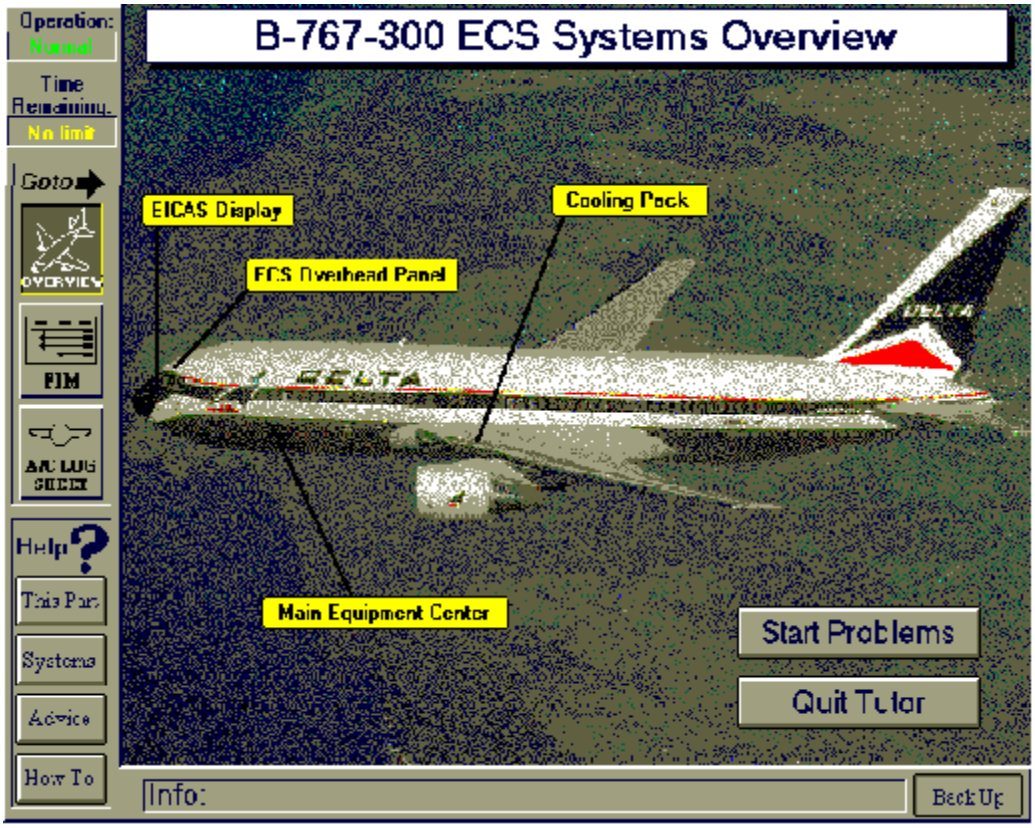
annually since 1993.

Training Products

Completed prototype training products include the Environmental Control System Tutor, the Team Situation Awareness Training Curriculum, the System for Training Aviation Regulations and the Aircraft Maintenance Team Training Program. These systems use a combination of instructional methods for training delivery. The training research answers industry's request for demonstrations of advanced technology for training maintenance technicians.

Environmental Control System Tutor (ECS)

The **ECS** Tutor uses intelligent simulation for maintenance training. It simulates the operation of the ECS for the B-767-300. As the student operates and troubleshoots the system, the simulation maintains models for student, instructor, and expert knowledge. These models allow the ECS Tutor to provide remediation and advice to the student. ECS was included on **FAA** CD '94.

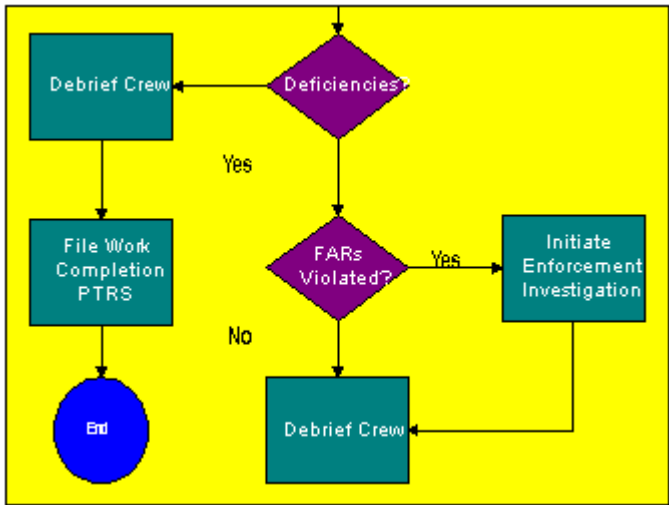


System for Training Aviation Regulations (STAR)

Aviation maintenance trainers lament the "boring" task of training **FAA** regulations using conventional instructional methods. **STAR**-**AMT** provides Part 147 school instructors with a computer-based tool to

help convey the role the Federal Aviation Regulations (FARs) play in the daily operations of aviation maintenance. The system is heavily infused with multimedia to motivate student interest. Scenario-based training techniques are employed to place students in true-to-life work scenarios where FAR-dependent decisions need to be made. STAR-AMT has several different learning environments: Overviews, Scenarios, Challenges, and Resources. STAR-AMT is included on FAA CD '97.

FAA has also expressed a requirement to deliver on-the-job computer-based training for Aviation Safety Inspectors (ASI). The purpose of **STAR**-ASI is to be an on-the-job training aid for Aviation Safety Inspectors. It is designed to function as both a training tool for new inspectors and a reference resource for seasoned inspectors. Like STAR-AMT, STAR-ASI has Scenarios, Challenge Questions, a Glossary and a Document Browser. In place of the Overview learning environment, STAR-ASI has the Inspection Task Flow Chart learning environment. STAR-ASI is included on FAA CD '97.



Aircraft Maintenance Team Training

This tool is a multimedia computer-based team training program that trains aircraft maintenance technicians (AMTs) on team skills that are critical in performing aircraft maintenance tasks. The goals of the software are: to provide AMTs a systematic exposure to a teamwork skills curriculum, to allow users to learn at their own pace, to monitor the progress of users in acquiring team skills, and to motivate the users to learn and use the skills through an interesting, media-rich and interactive environment. Aircraft Maintenance Team Training was published on a stand-alone CD in 1997.

Job Aiding Products

The next group of products is the job aiding products. These products include the Performance Enhancement System Program which evolved into the On-line Aviation Safety Inspection System (OASIS), the Ergonomics Audit Program, the Coordinating Agency for Supplier Evaluation Job Aid, the Documentation Design Aid, and the Turbine Repair Automated Control System. These products capitalize on advanced technology information systems.

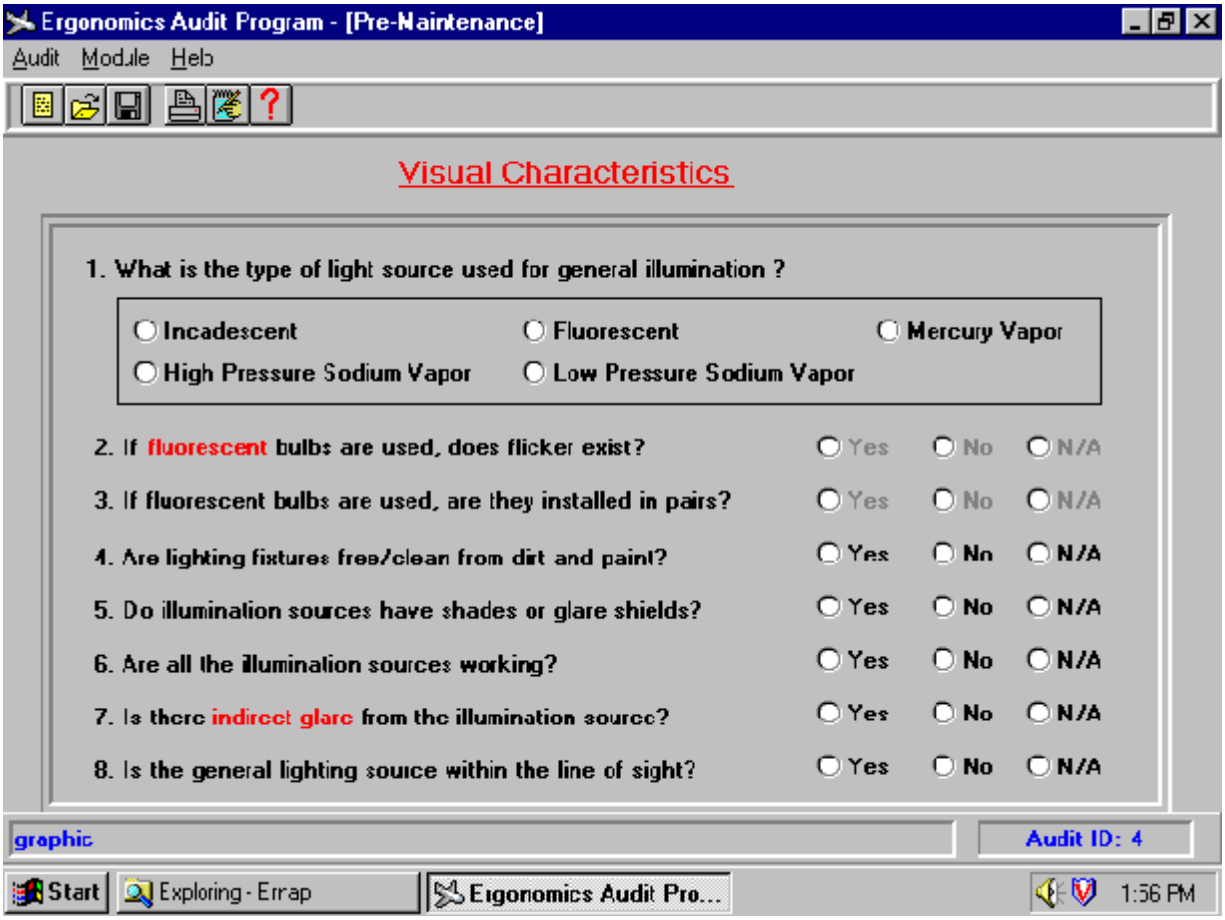
Performance Enhancement System (PENS) Program & OASIS

The Performance Enhancement System is an electronic performance support system designed for **FAA** Aviation Safety Inspectors. It provides data entry and validation support, as well as on-line access to policy guidance such as Federal Aviation Regulations, Airworthiness Directives, and Inspector's Handbooks. This system has evolved into the On-line Aviation Safety Inspection System (OASIS), which is currently being used by the FAA Flight Standards Service. This effort is an excellent product of a research, engineering, and development project running the gamut from conceptualization to full scale development for all FAA Aviation Safety Inspectors worldwide. The **PENS** prototype was included on

FAA CD ‘94.

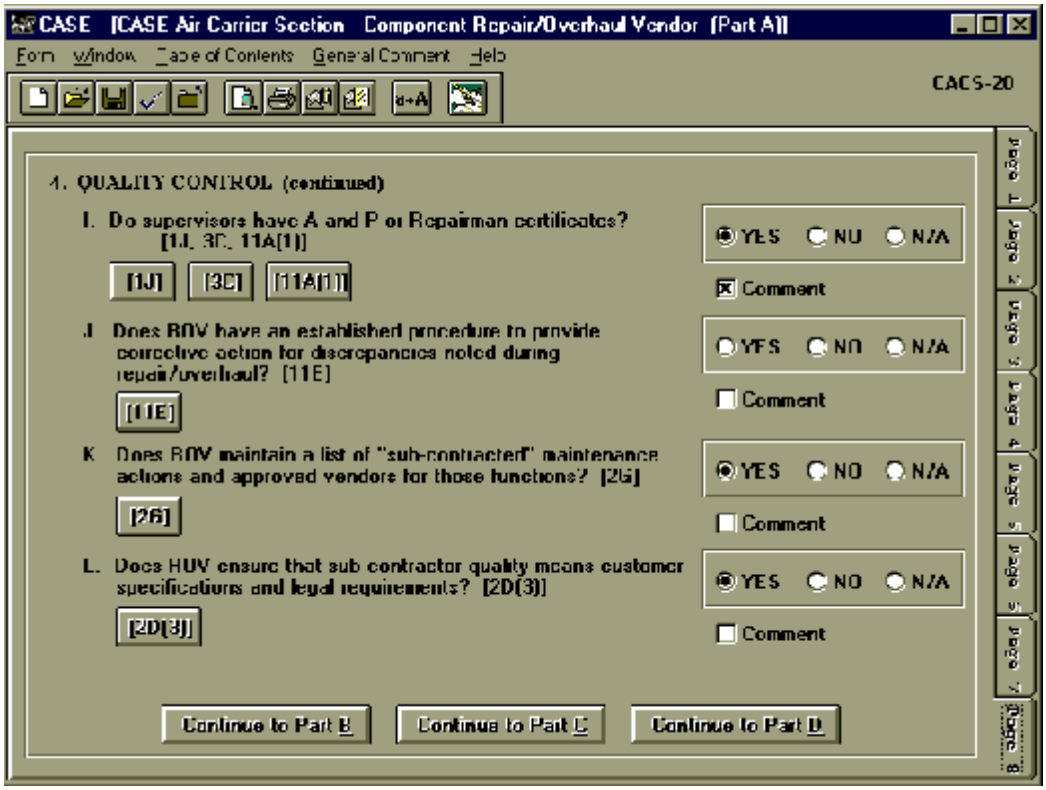
Ergonomics Audit Program (ERNAP)

Industry personnel requested a job aid that would permit them to conduct human factors audits without retaining a human factors consultant. **ERNAP** is a computerized job aid to help managers evaluate or design ergonomically efficient procedures for maintenance and inspection. ERNAP is simple to use and evaluates existing and proposed tasks and setups by applying ergonomic principles. ERNAP also suggests ergonomic interventions based on its evaluation. ERNAP allows the auditor to maintain audits for further reference. ERNAP was included on **FAA** CD ‘96.



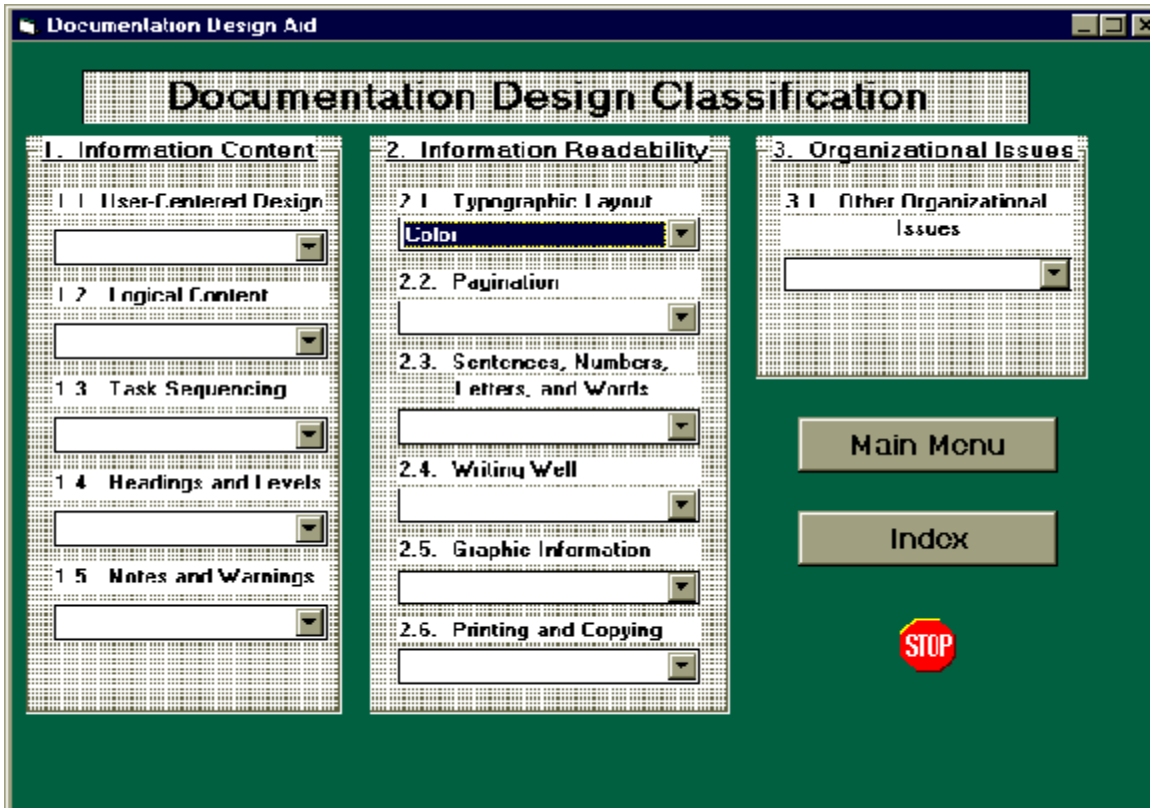
Coordinating Agency for Supplier Evaluation (CASE) Job Aid

Airlines and suppliers asked for an electronic checklist tool for collecting supplier evaluation data. The **CASE** Vendor Audit program contains electronic CASE forms for auditing suppliers such as fuel vendors. These checklists are integrated with standards and regulation references to enable quick look-ups. The CASE Vendor Audit program also includes a facility for saving/retrieving audits and a report generation module for printing the results and findings of the audit based on the completed checklist. CASE was included on **FAA** CD '96.



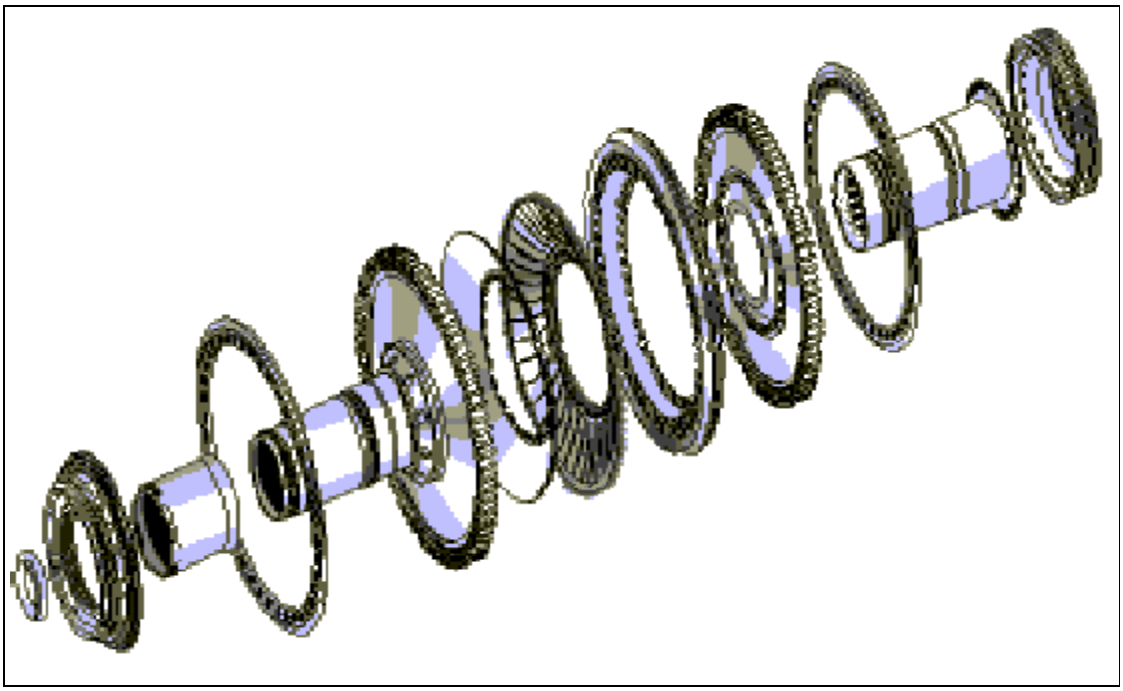
Documentation Design Aid (DDA)

Airline documentation writers asked for help to ensure that their procedures use Simplified English and follow proper human factors conventions. Two versions of the **DDA** were developed to improve the ability of technical writers and engineers to write more usable documents. The paper-based version lists the rules in a format suited to the user's needs. A computer-based version adds reasons for the rules and examples of their use. Both versions were similarly effective in allowing users to find and make changes in existing aircraft maintenance task documentation. The DDA shall be included on **FAA** CD '98.



Turbine Repair Automated Control System (TRACS)

Industry expressed the requirement to have easy access to manufacturers and regulatory information. **TRACS** is an integrated software tool which aids airline technicians in tracking, repairing, and returning jet engine parts back to serviceability. The prototype system gives technicians and inspectors the ability to log critical information and data, access manuals and orders, and sign-off on repair steps in the shop environment. The operational TRACS is included on **FAA** CD '97.

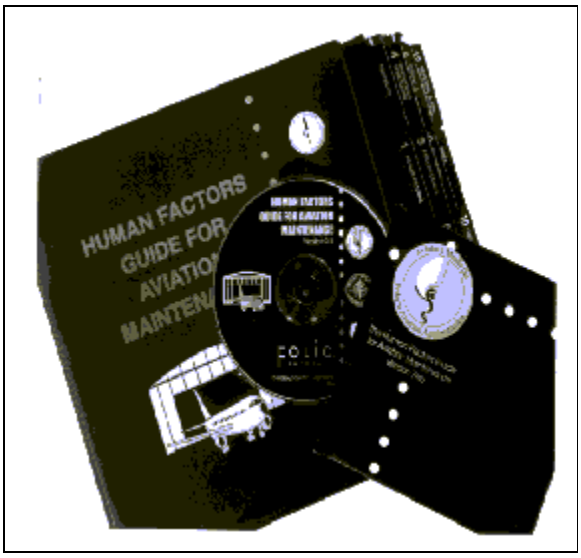


Information Dissemination Products

The research program disseminates reference materials on human factors information to the aviation maintenance community at large. These reference materials can be used by people throughout the maintenance organization.

Human Factors Guide

Industry participants involved with the FAA Human Factors in Aviation Maintenance research program requested practical human factors guidance that could be used on the shop floor. In addition, maintenance managers requested information that could be used to make informed decisions with respect to human factors issues in aviation maintenance, including pointers on where to find additional information or help. *The Human Factors Guide for Aviation Maintenance* was first completed and published in 1995. Three additional chapters were added in 1996 to make fifteen in all (see **Figure 8**). The *Guide* is designed to be used in aviation maintenance environments and is written for maintenance management. However, it contains information and guidance that can be used by people with various responsibilities within maintenance organizations. The *Guide* is available in hardcopy, on CD-ROM, and on the internet at http://www.hfskyway.com.



HFAMI Web Site

The Human Factors in Aviation Maintenance and Inspection (HFAMI) Web site is an on-line information exchange for the Human Factors in Aviation Maintenance Research Program. It includes an interactive forum for human factors professionals as well as a repository for electronic and multimedia reference documents and programs. The HFAMI web site has been accessed over 1 million times since January 1997.


HFAMI Home Page - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Location: http://www.hiskyway.com/
Instant Message Internet Lookup New&Cool
Human Factors in Aviation Maintenance and Inspection
Documents
Research & Development
Job Aid
Training
List Server
Related Links
Search
Map
Document Done
Find
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Inbox - Micr...
HFAMI H...
WinGIF 'H...
FlexED32 v...
Exploring - ...
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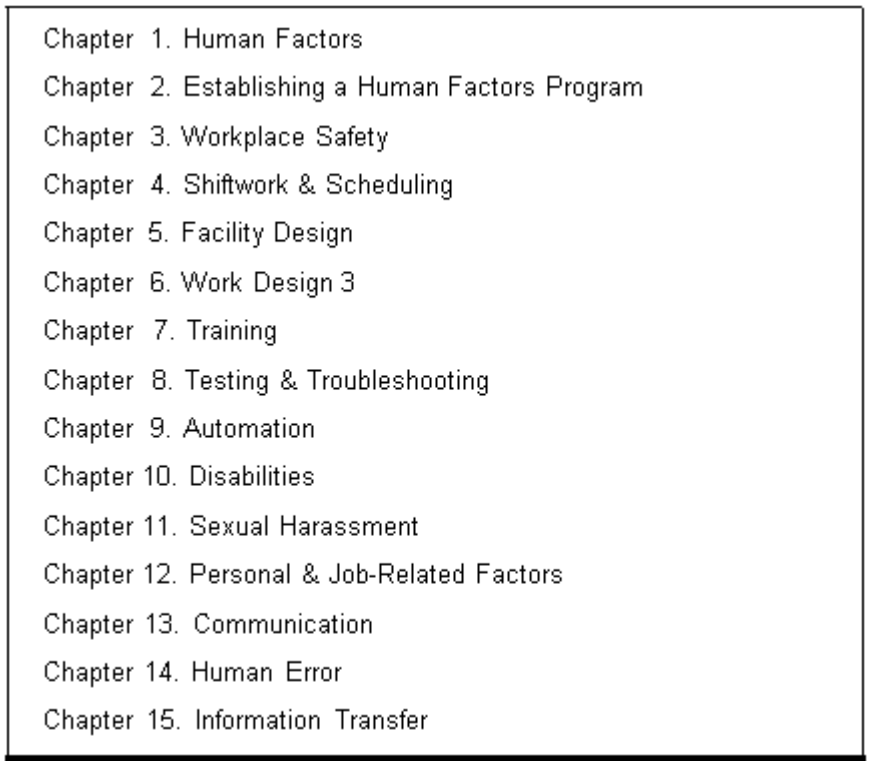


Figure 8. Human Factors Guide Chapters

Hypermedia Information System (HIS)

Government, industry, and academic personnel have requested a means for easy access and search of all of the research results. Thus the Hypermedia Information System was developed. HIS is an electronic reference of over 4,000 pages of publications from the Human Factors in Aviation Maintenance research program, including phase reports and conference proceedings. HIS makes it easy to find information about specific topics with its hypermedia links and fast, full-text search engine. HIS is updated annually on the **FAA** Human Factors Issues in Aircraft Maintenance and Inspection CD-ROMs.

Communication and Harmonization Products

Annual conferences have been the standard forum for providing communication of research results and industry needs. Eleven Human Factors Issues in Maintenance and Inspection conferences have been conducted, as listed in **Table 3**.

Table 3. Human Factors Issues in Maintenance and Inspection Conferences

TOPIC	LOCATION	DATES
Human Factors Issues in Aircraft Maintenance & Inspection	Washington, DC	October 12-13, 1988
Information Exchange and Communications	Alexandria, VA	December 13-14, 1989
Training Issues	Atlantic City, NJ	June 12-13, 1990
The Aviation Maintenance Technician	Alexandria, VA	December 12-13, 1990
The Work Environment in Aviation Maintenance	Atlanta, GA	June 19-20, 1991
Maintenance 2000	Alexandria, VA	January 22-23, 1992
Science, Technology, and Management: A Program Review	Atlanta, GA	August 5-6, 1992
Trends and Advances in Aviation Maintenance Operations	Alexandria, VA	November 16-17, 1993
The Human Factors Guide	Albuquerque, NM	November 8-9, 1994
Maintenance Performance Enhancement and Technician Resource Management	Alexandria, VA	January 17-18, 1996
Human Error in Maintenance	San Diego, CA	March 11-12, 1997

1997 Activities

This section details the 1997 activities of the Office of Aviation Medicine's Human Factors in Aviation Maintenance and Inspection research program. The activities are organized by the primary activities defined in the Introduction: Maintenance Resource Management, Maintenance Error Reduction, Job Task Analysis, Maintenance and Inspection Training, Job Aids for Maintenance and Inspection, Information Dissemination, and Communication and Harmonization. With the exception of the **JTA** activity, the period of performance for each of these tasks is April 1, 1997 through March 30, 1998. The period of performance for Phase III of the JTA is January 1996 to October 1997.

Figure 9 illustrates how the FY 1997 budget is allocated.

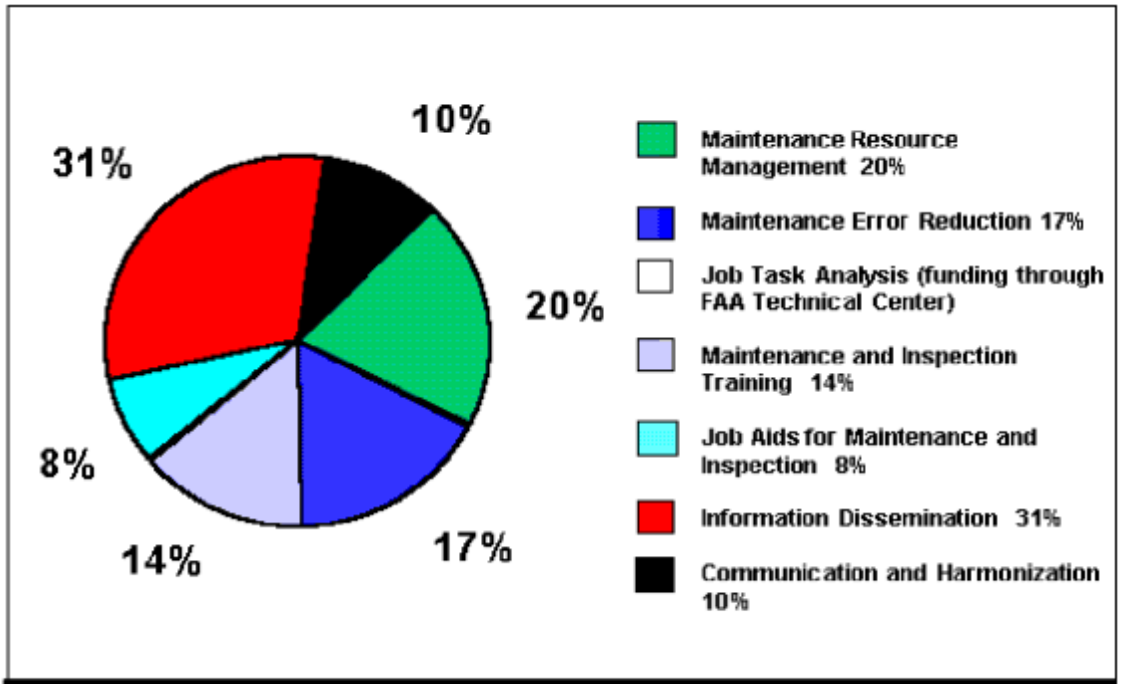


Figure 9. Allocations of FY 1997 Budget

1997 Activities for Human Factors in Aviation Maintenance and Inspection Research Program

Maintenance Resource Management Activities for FY 1997

TASK	REQUIREMENT	PRODUCT	RESEARCHER & GOVERNMENT/ INDUSTRY PARTNE
Develop Industry Guidance Materials for Maintenance Resource Management (MRM)	Develop FAA report and Advisory Circular for MRM similar to those for Flight Crew Resource Management (CRM).	Summary report on CRM principles that are applicable to MRM. The report shall include a prototype curriculum for MRM. (3/98) The report content shall be eventually converted to an AC on MRM. (6/99)	Researcher Galaxy Scientific & University of Southern California *Dr. Michelle Robertson* Industry Partner Airlines
Evaluate Team Situation Awareness (SA) Classroom Training for Maintenance Personnel	Evaluate the Team SA training program that has been developed under the research program by studying and developing SA principles for the aircraft maintenance work environment.	A field evaluation of the effectiveness of the Team SA classroom training. Performance measures shall be developed to determine what effect the training has on safety and human errors. (10/97) A summary report documenting the evaluation effort. (3/98)	Researcher SA Technologies *Dr. Mica Endsley* Galaxy Scientific & Uni of Southern California *Dr. Michelle Robertson* Industry Partner Continental Airlines *John Stelly* *Karin Porter* *Bret Powers*

Maintenance Resource Management Activities for FY 1997 ***(continued)***			
TASK	**REQUIREMENT**	**PRODUCT**	**RESEARCHER & GOVERNMENT/ INDUSTRY PARTNE**
Develop Line-Oriented Human Factors Training (MRM)	This research shall complete the MRM training program by developing recurrent training for line maintenance personnel.	Training plan and content for line-oriented maintenance scenarios for aviation maintenance technicians (MRM). These scenarios will combine recurrent technical training and MRM teamwork and SA skills in a simulated environment. The training shall be developed in collaboration with a major airline training director and AMT subject matter experts. (3/98)	Researcher Galaxy Scientific & University of Southern California *Dr. Michelle Robertson* Industry Partner Continental
Develop Prototype Maintenance Resource Management Computer-Based Training (CBT) Program	Improve safety through distribution of research-based materials for Maintenance Resource Management (MRM) training.	A prototype CBT program that provides consistent, flexible training for use by individual maintenance personnel. The CBT program shall be divided into short training modules that provide concentrated instruction on selected MRM concepts and skills. The CBT shall be designed so that it may be used as a stand-alone training system with no prerequisites. The program will be delivered on FAA CD 98 in Spring of 1998.	Researcher Galaxy Scientific *Ben Sian* Industry Partner Airlines

Maintenance Resource Management Activities for FY 1997 *(continued)*			
TASK	**REQUIREMENT**	**PRODUCT**	**RESEARCHER & GOVERNMENT/ INDUSTRY PARTNE**
Distance Education for Maintenance Resource Management (MRM)	There is a need to test the feasibility of distance education across the internet to determine if this technology should be approved by the FAA as a training delivery mechanism.	A prototype distance education system shall demonstrate current cutting-edge technolo-gy, such as: real-time lectures; bulletin boards for announcements; interactive chat rooms for class discussions and student-to-student collaboration; direct mailing of class materials; on-line testing, registration, and demonstration of problem-solving activities. (3/98) This training facility will be developed and evaluated with the requirement of maintenance personnel at one or more cooperating airlines.	Researcher Galaxy Scientific *Dr. Terry Chandler* Industry Partner Airlines

Maintenance Error Reduction Activities for FY 1997

TASK	REQUIREMENT	PRODUCT	RESEARCHER & GOVERNMENT/ INDUSTRY PARTNE
Develop and Evaluate Human Factors Interventions for the Reduction of Ground Accidents/Incidents	The airline industry has identified ground accidents/incidents as a major concern with both safety and cost impacts.	A model human factors intervention program for ground accident/incidents at a partner airline's line operations and line maintenance functions. (9/97) Measurement of the effectiveness of the interventions, comparing incidence rates between facilities where interventions are implemented with those where they are not. (3/98)	Researcher State University of New York at Buffalo *Dr. Colin Drury* *Caren Wenner* Industry Partner Northv *David Nikota* *Joan Kuenzi*
Review and Make Recommendations on Maintenance Error Reporting Systems	The status of maintenance error reporting systems indicates the need to identify current roadblocks to greater system usage and benefit in the U.S., with particular emphasis on what issues must be addressed for the FAA to facilitate improved maintenance safety through maintenance error investigation and analysis.	Report summarizing the features of systems or methods for identifying, data reporting, and analyzing maintenance error reporting systems (e.g., ASRS, BASIS, MEDA, MESH, SDRS, SPAS/RADS, self disclosure programs). (8/97) Recommendations regarding maintenance error reporting systems, substantiated by risk assessment. Evaluation of obstacles to data sharing and disclosing of error information.	Researcher Galaxy Scientific *David Marx* Government and Industr Partner Airlines NASA Boeing
Study of Norms and Work Habits	There is a need to understand how workplace norms effect maintenance safety and to develop strategies to address unsafe norms.	Report documenting good, bad, and indifferent norms that exist in aviation. (12/97)	Researcher Galaxy Scientific *Phil Hastings* Government Partner Transport Canada *Gordon Dupont*

Job Task Analysis Activities for FY 1997

TASK	REQUIREMENT	PRODUCTS	RESEARCHER & GOVERNMENT/ INDUSTRY PARTNI
Analyze the Job Task Analysis (JTA) Data Collected in Phase II.	The last JTA study was completed in 1970. Industry needs to have an up-to-date listing of the knowledge, skills and abilities needed to be an effective AMT today.	Subject area summaries with a list of relevant systems and components. (10/97) A listing of core tasks which are relevant to all industry segments. (10/97) A list of focus tasks which are relevant to an area of specialization. (10/97)	Researcher Northwestern University *Ed Czepiel* Industry Partner Airlines Repair Stations

Maintenance Inspection Training Activities for FY 1997

TASK	REQUIREMENT	PRODUCTS	RESEARCHER & GOVERNMENT/ INDUSTRY PARTNI
Curriculum for Meeting Certification Requirements for the AMT-T Rating (as Proposed in New Part 66 Rule)	The proposed new AMT-T rating has implications for Part 147 training schools. Guidance is needed for Part 147 schools and Inspectors to understand what curriculum is acceptable for meeting the certification requirements.	Evaluation of the integration requirements for proposed Part 66 and current Part 147 rules. (8/97) Curriculum, including hourly allocations by topic. (8/97) Regional evaluation with Part 147 school representatives and airline personnel to present curriculum and obtain feedback. (10/97) Report that shall be converted to an Advisory Circular. (6/98)	Researcher Galaxy Scientific *Charles White* Purdue University *Michael Kroes* Industry Partner Part 147 Schools & ATA Maintenance Training Subcommittee

Maintenance Inspection Training Activities for FY 1997 ***(continued)***			
TASK	**REQUIREMENT**	**PRODUCT**	**RESEARCHER & GOVERNMENT/ INDUSTRY PARTNI**
Study of Maintenance Personnel Qualifications	Exploratory comparison of maintenance training, qualification and certification between CFR 14, FAR Part 121 air carriers and Part 145 maintenance providers and repair stations is needed to determine if regulatory changes are needed.	Develop survey data detailing training, qualification and certification requirements for technicians at third and fourth party (tier) maintenance facilities and in-house airline maintenance facilities. (9/97) Report documenting methods and findings for use by Flight Standards Service in regulatory efforts. (3/98)	Researcher Galaxy Scientific *Raymond Goldsby* Industry Partner Airlines Repair Stations ATA Maintenance Training Subcommittee
Develop Advanced Models for Training New Airline Maintenance Inspectors C-BITS (ASST)	Improved inspection training guidelines. The models shall form the basis of a Computer-Based Inspection Training System (C-BITS/ASST) for new aircraft inspectors. The C-BITs program shall enable development of guidelines for inspection training.	Realistic models that can accurately predict inspector performance for aircraft visual inspection tasks. (8/97) Functional description of proposed C-BITS/ ASST program. (3/98)	Researcher Clemson University *Dr. Anand Gramopadhye* *Dr. Brian Melloy* Government and Industr Partner Lockheed Martii Aircraft Division *Jack Alberts* Don Cope Hy Small Daniel Patterson Rich Lyons Terry York US Airforce

Job Aids for Maintenance and Inspection Activities for FY 1997			
TASK	**REQUIREMENT**	**PRODUCT**	**RESEARCHER & GOVERNMENT/ INDUSTRY PARTNE**
Develop and Validate Job Aids for Maintenance Documentation	Maintenance procedure writers and forms designers need to obtain Simplified English (SE) assistance instantly at their point of work along with the Document Design Aid (DDA) guidance. Also need to verify that mechanics commit fewer errors when using workcards designed with the help of documentation job aids.	A Simplified English job aid will be added to the Document Design Aid which provides an interface to the SE rules and dictionary. (8/97) Measurement of the effect of the documentation changes by assessing mechanic behavior. (1/98) Report documenting the development and evaluation. (3/98)	Researcher State University of New York at Buffalo *Dr. Colin Drury* *Maya Murthy* *Abdul Sarac* Industry Partner US Airways *David Driscol*l
Investigate Delivery of Reference Material to Line Maintenance Personnel	Industry is moving toward the electronic delivery of maintenance information. There is a need to assess the current status of wireless technology in a ramp environment and to study the human factors usability issues of such systems.	A feasibility/usability study of wireless technology and pen computer technology for providing maintenance information to ramp personnel, conducted in conjunction with a partner airline. (8/97)	Researcher Galaxy Scientific *Phil Hastings* Industry Partner Continental *Tom Green* EDS *Dave Weiss* *Jose Lizarzaburu*

Information Dissemination Activities for FY 1997			
TASK	**REQUIREMENT**	**PRODUCT**	**RESEARCHER & GOVERNMENT/ INDUSTRY PARTNE**
Update Paper and Electronic Human Factors Guide (E-Guide)- Version 3.0	The content of the Guide is undergoing major revision and the electronic version is the primary means for dissemination of the Guide.	Revise Chapter 7: Training (11/97) New chapter on Maintenance Resource Management. (11/97) Addition of human factors job aids or checklists where applicable tools can be identified for use by maintenance personnel. (1/98) Update content/references where needed. (1/98) Update E-Guide reflecting changes to the paper Guide. (6/98) Distribute to industry, military (DOD) and other government agencies, nationally and internationally.	Researcher Sisyphus Associates *Dr. Michael Maddox* Industry Partner ATA Human Factors Committee
Develop and Distribute the Annual CD-ROM of Research Program Deliverables	Provide human factors information (evaluations and guidelines) by distributing compilation of research results and training and job aiding prototypes to industry.	FAA CD 98 (CD-ROM #6). (3/98)	Researcher Galaxy Scientific *Dr. Terry Chandler*

Information Dissemination Activities for FY 1997*(continued)*

TASK	EQUIREMENT	PRODUCT	RESEARCHER & GOVERNMENT/ INDUSTRY PARTNE
Support and Develop the Human Factors in Aviation Maintenance and Inspection (HFAMI) Web Site	Provide industry with a means for rapidly accessing program deliverables and human factors information.	Selected information from FAA CD 97 (CD-ROM #5) shall be available on the internet. (3/98) A list server communication system for human factors in maintenance discussion groups. (monthly news) The updated internet version of the Human Factors Guide. (6/98)	Researcher Galaxy Scientific *Dr. Terry Chandler*
Develop Electronic Reference Program for NTSB Accident Reports	Provide a tool for researchers and industry to study past maintenance-related accidents. Common causes may be identified and similar errors can be prevented through knowledge of past errors.	An electronic reference program containing NTSB reports for those accidents that have been traced to maintenance error. (12/97) The NTSB reference program will be available on FAA CD 98.	Researcher Galaxy Scientific *Jeff Norton* Government Partner NTSB *John Goglia*

Communication and Harmonization Activities for FY 1997			
TASK	**REQUIREMENT**	**PRODUCT**	**RESEARCHER / GOVERNMENT INDUSTRY PARTNER**
Support Conference 12: Human Factors Issues in Aircraft Maintenance and Inspection	Conferences have been a valuable means for communicating results and obtaining needs from industry. As of this year, the conference will be a joint effort between Britain's CAA, Transport Canada and the FAA.	Distribute announcement of conference to FAA mailing list. (11/97) Coordinate and publish conference proceedings. (2/98) Present research program results at conference. (3/98)	Researcher Galaxy Scientific *Veronica Danley* Government Partner Transport Canada *Gordon Dupont* UK CAA *David Hall*
Coordinate with Transport Canada to Produce Maintenance Human Factors Video	Industry can benefit from a video that illustrates maintenance human factors errors that can lead to accidents.	25 minute video on the maintenance human factors aspects of a recent accident in which 11 human factors errors were made. (3/98)	Researcher Galaxy Scientific *Dennis Flath* Government Partne Transport Canada *Gordon Dupont*
Participate in Industry Conferences and Symposia	Provide expertise on maintenance human factors issues at International and national aviation symposia and conferences.	Communicate findings of the research program as invited to participate in industry conferences.	
Deliver Reports of Research Conducted	Communication of the results of the research is vital to the program to reduce human errors and improve safety in maintenance.	Quarterly progress reports. Final Phase Report detailing research performed. (6/98)	Researcher Galaxy Scientific *Veronica Danley*

Current Activites

The Human Factors in Aviation Maintenance and Inspection research program has set a major goal for

contributing to the reduction of error in aircraft maintenance.

GOAL: Reduce maintenance-related accidents and incidents resulting from human error by 20% by the year 2003.

The program shall periodically measure its success in achieving this goal by analyzing the number of fatalities caused by aircraft maintenance-related accidents and incidents resulting from human error. Data for this analysis will be collected from the U.S. National Transportation Safety Board and the Annual International Study of Airline Safety Statistics published by Boeing Commercial Airplane Company.

The following sections summarize the direction of the research program for each of the primary activities.

Maintenance Resource Management (MRM)

MRM tasks shall develop, implement, evaluate techniques and distribute advisory materials, guidelines, and prototype training media related to MRM.

Maintenance Error Reduction

In the next five years, the program shall develop and evaluate human factors interventions with partner airlines. In addition, the program will support the development of an advisory circular with guidelines for implementing error investigation and reporting systems.

Job Task Analysis (JTA)

Job Task Analysis tasks shall continue to identify and analyze the critical knowledge and skill requirements for aviation technicians to perform safely and competently.

Maintenance and Inspection Training

The research program shall continue to investigate issues which impact safety. Such training tasks shall help deliver information on human factors, maintenance resource management, workplace safety, and other such topics. The training research will also continue to push the envelope of instructional technology to find optimal delivery mechanisms for distance education, on-the-job learning, and just-in-time training.

Job Aiding

Future research shall focus on "leading edge" technologies that have promise for enhancing human performance, reducing human error, and ensuring improved safety. These technologies shall be applied to work forces including not only airline maintenance personnel, but also the **FAA** Aviation Safety Inspectors, as appropriate.

Information Dissemination

The research program will distribute human factors information to the aviation maintenance community. Information shall include an electronic database of NTSB reports of accidents related to maintenance error, updated *Human Factors Guide for Aviation Maintenance*, and research reports distributed via CD-ROM and the internet.

The research program shall continue to support aircraft maintenance rule-making by developing related advisory material and by participating in aviation rule- making as required.

Communication and Harmonization

The most important factor that shall continue to drive the research program is constant communication with the aviation maintenance industry and with regulatory agencies worldwide. Such communication ensures that the research remains pragmatic and the research products are implemented into the industry as they are developed.

Task Details

The following slide presentations give an overview of how the **FAA**/**AAM** research program fits in with the **DOT** strategic plan, the FAA strategic plan, and the AVR strategic plan and how each project fits in with specific goals and objectives as well as sub-goals.

Strategic Plan Slides

Department Of Transportation Strategic Plan

Vision: A visionary and vigilant DOT leading the way to transportation excellence in the 21st Century

Mission: Serve the US by ensuring a fast, safe, efficient, accessible, and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future

Corporate Management Strategies

- **Customer Service:** Deliver the result our customers want through a DOT that is more practical, works better, costs less
- **Research and Technology:** Advance transportation research and technology through strategic planning, exchange of information, education and partnerships
- **Information Technology:** Improve mission performance through secure, reliable, compatible, and cost-effective information systems that help us achieve our strategic goals

Department of Transportation Strategic Goal: SAFETY

Promote the public health and safety by working to the elimination of transportation-related, death, injuries, and property damage

We will measure our success by achieving the following outcomes:

- Reduce the number of transportation related deaths
- Reduce the number and severity of transportation related injuries
- Reduce the dollars loss from high-consequence, reportable transportation incidents
- Reduce the number of reportable transportation incidents and other related economic costs

Federal Aviation Administration Mission: SAFETY

By 2007, reduce aviation fatal accident rates by 80 percent from 1996

Performance Goals:

- **Fatal accident rate:** By 2007, reduce the US aviation fatal accident rate per aircraft departure, as measured by a 3-year moving average, by 80 percent from the 3-year average for 1994-1996
- **Overall Aircraft Accident Rate:** Reduce the rate per accident pre departure
- **Occupant Risk:** Reduce the risk of mortality to a passenger or flight crew member on a typical

SAFETY Strategic Focus Areas

Regulatory Reform: Implement a regulatory process that is timely, responsive and consistently applied

Safety Information Sharing and Analysis: Develop partnerships with the aviation community to share data and information supporting safe, secure aviation

Surveillance/Inspection: Develop new approaches to working with others on inspection and surveillance and targeting FAA resources where they do the most good

Accident Prevention: Based on detailed root-cause analysis, prevent accidents before they happen through appropriate, targeted, systematic interventions in the aviation system

Global Leadership

Commitment to worldwide improvement to improve safety, security, and system efficiency globally through:

- International Safety Oversight
- International Regulatory Harmonization

Corporate Cross-Cutting Strategies Providing Continuous Improvement:

- **Partnership.** Mission goals must be achieved through many kinds of partnership with customers and stakeholders. Partnership with the transportation community is the only way to achieve the mission-based goals.
- **Communication.** Communication must be two way, listening and speaking. FAA will communicate with external customers and partners, employees and unions.
- **Risk Management.** FAA must target regulations and resources where they do the most good. FAA will use its newly developed risk management policy and other tools to target resources where they will do the most good.

Corporate Cross-Cutting Strategies Providing Continuous Improvement:

- **Research, Engineering, and Development.** FAA will take full advantage of its acquisition capability to support research, engineering and development as a major strategy to develop and field new technologies that help FAA achieve its mission and meet customer needs.
- **Rapid Deployment of Existing Technology.** FAA must not only research, develop, and acquire new technology, but it must move quickly to deploy both technology it has developed and technology from other sources, including commercial-off-the-shelf (COTS) and non-developmental item systems.

Federal Aviation Administration Mission: SAFETY

In partnership with NASA, Department of Defense, and other public and private organizations scientifically study issues and technologies (especially human factors) to improve policies, procedures, and equipment.

Focus Area: Safety Information Sharing and Analysis

- Identify and address the root causes of aviation accidents
- Voluntary sharing of safety information Voluntary Disclosure Advisory Circular (AC-00-58)

Aviation Safety Programs (Advisory Circular (AC-120-66)

Mission of the Regulation and Certification Organization

The mission of the AVR organization is promote aviation safety in the interest of the American public by regulating and overseeing the civil aviation industry. To fulfill this mission, AVR establishes aviation safety standards, monitors safety performance, conducts safety education and research, issues and maintains aviation certificates, licenses, and manages the FAA rulemaking program

- Establishes safety standards governing:

  1) the design, production quality, and airworthiness of aeronautical products

  2) the operation and continuing airworthiness of aircraft, training of airmen and aviation mechanics

  3) the medical qualifications of airmen and air traffic controllers
- AVR manages the rulemaking program which is the primary means by which safety standards and policy are drafted, opened to public comment, and finalized
- AVR monitors safety performance by:

  1) conducting reviews of products and reviewing safety data for trends

  2) conducting safety inspections and surveillance

  3) investigating violations and initiating enforcement action

  4) participating in accident and incident investigations
- AVR conducts aviation safety education, and conducts and sponsors related research

Primary Customers:

- **Air Operators Certificates:**

  FAR PART 121 (Large Transport)

  FAR PART 135 (Commuter Operations)

  FAR PART 91 (Public Use)
- **Air Agency Certificates:**

  FAR PART 145 (Repair Stations)

  FAR PART 147 (Maintenance Schools)
- **Aviation Industry Organizations**
- **ICAO**
- **Joint Aviation Regulations (JAR)**
- **Transport Canada**

Targeting Performance Areas:

- Contribute to aviation safety by developing policies and /or standards, programs, and systems to reduce the number of aviation accidents and incidents related to human factors.
- Contribute to aviation safety by developing policies and/or standards, programs, and systems to reduce the number of aviation accidents and incidents related to production systems, certification, and maintenance errors.
- Improve industry compliance with aviation standard through adoption of voluntary internal audit and voluntary self disclosure programs.

AVR Performance Goals:

1. By 2007, reduce the fatal aviation accident rate by 80% of baseline levels primarily attributed to human error.

2. By 2007, reduce fatal aviation accident rate by 80% of baseline levels primarily attributed to elements in productions systems, certification process, or maintenance programs.

3. Increase the participation of industry in AVR partnership programs by 20% over the 1996 rate by FY 2002.

AVR Sub-Performance Goals:

AVR Performance Goals 1:

Sub-goal 2: Annually, the FAA will take those actions necessary to ensure that at least 85% of all open National Transportation Safety (NTSB) safety recommendations are in an “acceptable status,” and that at lease 60% of all FAA safety recommendations are classified as “acceptable” (AVR Performance Goal 1&2)

Sub-goal 5: By September 30, 2000, develop an advisory circular to implement, on a voluntary basis, a maintenance resource management system (MRM), based on technical recommendations for the results of the FY97-98 MRM report. MRM establishes methods for improved team performance and communication that should reduce human performance error

AVR Sub-Performance Goals:

AVR Performance Goals 2:

Sub-goal 13: By September 30, 2000, complete rulemaking to establish new ratings and training requirements for aviation maintenance personnel

Sub-goal 14: By September 30, 2000, implement Flight Operational Quality Assurance (FOQA) which provides maximum potential for use of a virtual data pool and data sharing for multiple airlines to determine national trends of relevance to identify problems in flight operations, personnel performance, and aircraft maintenance

Sub-goal 18: By September 30, 2002, complete a rule governing repair stations (14 CFR PART

145) to reflect technical advances in aircraft maintenance practices or aircraft technology, to require quality assurance systems, and to establish training programs covering employees who perform work for the repair station

AVR Sub-Performance Goals:

AVR Performance Goals 3:

Sub-goal 21: By September 30, 1999, identify and rank the most significant safety threats; identify the root causes and life cycle to failure for top-ranked safety threats and develop interventions

AVR Performance Goals 4:

Sub-goal 32: By September 30, 2001, increase industry participation rate in internal audit and self disclosure programs by 5% over that of the 1996 rate

Task Details Slides

Identification and Creation of Classification Methods for Maintenance Error Causation

AVR Performance Goal(s) 1, 2, 3, 4; Sub-goal(s) 14, 18, 21 ,32

- Requirement: Existing need for rules of causation to be used by FAA inspectors and air carrier/repair station event investigators
- Regulations Affected: FAR 121.373, FAR 135.431, AC 120-16C
- Product: Recommendations, guidance materials, and workshop at 13th Annual Human Factors in Aviation Maintenance Symposium
- Output: Causation taxonomy describing causal models and causal biases. Statistical data on nature of investigator biases and investigative tools, recommendations for rules of causation for airlines, repair stations, FAA inspectors and attorneys
- Outcome: Improved human error investigation at air carriers and repair stations, improved FAA oversight of air carrier investigations, and reduction in maintenance errors
- Delivery Date: September 2000

Improving Operations and Oversight of Contract Maintenance

AVR Performance Goal 2 Sub-goal 18

- Requirement: FAA request to gain insight on relationships between Aviation Safety Inspectors, Principle Maintenance Inspectors, Contract Mantenance Organizations, and Air Carriers
- Regulations Affected: FAR Part 65, FAR Part 145, FAA Policy (including FAA Airworthiness Inspectors Handbook), NTSB recommendations, GAO report

recommendations

- Product: Recommendations and guidance material
- Output: Description of the current relationships, issues and probems that may exist, and recommendations on ways and means of reconciliation
- Outcome: Solutions to issues and problems.
- Delivery Date: September 2002

Automated System of Self Instruction for Specialized Training (ASSIST): An Effort to Minimize Inspector Errors

AVR Performance Goal 2 Sub-goal 13, 18

- Requirement: Use of advanced technology for aircraft inspection training to minimize inspector errors
- Regulations Affected: 14 CFR Part 121.375
- Product: A computer-based inspection training software system (ASSIST) and workshop at 13th Annual Human Factors in Aviation Maintenance Symposium
- Output: Multimedia tool used by aircraft inspectors and A&P students for training and re-training on aircraft inspection
- Outcome: Reduction in inspection errors, improvement in inspection performance, standardization of inspection training process, and reduction in problems inherent to OJT
- Delivery Date: September 2000

Maintenance Personnel Duty Times

AVR Performance Goal 1 Sub-goal 2

- Requirement: Examination of how hours worked by AMTs impact the maintenance environment in response to a petition for rulemaking to the FAA and recent NTSB recommendations
- Regulations Affected: FAR 121.377
- Product: Guidelines that can be used to reduce and/or mitigate the safety-related effects of worker fatigue in aviation maintenance work environments
- Output: Exploratory research as a first step in assessing current FAR regulations concering duty limitations for maintenance personnel
- Delivery Date: March 1999

Assessment of Industry Use of FAA A/C Maintenance Human Factors Research Products

AVR Performance Goal 3

- Requirement: A formal assessment of the aviation industry's perception and acceptance of the importance of human factors in maintenance, including the extent of perceived cost savings and error reductions related to human factors interventions
- Regulations Affected: None
- Product: Recommendations for industry and government on how to measure and implement products from the research program
- Output: Research findings that quantify the extent to which the program results have impacted safety and efficiency in aviation maintenance work environments
- Outcome: Insurance that the research program is addressing industry issues most often affecting safety and human performance effectiveness. Research findings will drive future program direction.
- Delivery Date: March 1999

Development of Systems to Facilitate Shift Change Over Aircraft Maintenance

AVR Performance Goal(s) 1, 2

- Requirement: Identify potential limitations of existing shift change processes and develop standardized procedures that offer solutions/human factors interventions to minimize errors
- Regulations Affected: FAR Part 121, FAR Part 135, FAR Part 145
- Product: Detailed guidelines and procedures that outline a standardized shift change process, which can be translated into a computer-based tool for use by mechanics, inspectors, and supervisors
- Output: Analysis of shift change at representative sites, development of industry-wide best practices, documentation of guidelines and procedures
- Outcome: Well-defined shift change procedures based on sound principles of human factors design, which can be applied to minimize shift change errors
- Delivery Date: March 1999

Development of Guidance and Support Material for the Certification of Aviation Maintenance Training Programs Using the AMT/AMT-T Integrated Curriculum

AVR Performance Goal 2, Sub-Goal 13

- Requirement: Develop a training curriculum that integrates AMT/AMT-T requirements into a seamless educational program, and develop guidelines for certification and operation of training programs using the integrated curriculum

- Regulations Affected: FAR Part 147, FAR Part 66
- Product: Guidelines for certification and surveillance of aviation maintenance technician training programs using the AMT/AMT-T Curriculum, and workshop at 13th Annual Human Factors in Aviation Maintenance Symposium
- Output: Certification standards and procedures necessary for FAA approval for use in individual AMT training programs
- Outcome: Properly designed curriculum that increases effciency in the learning process, resulting in more technically compentent AMTs. These guidelines will be potential support material for future development of an agency Advisory Circular
- Delivery Date: September 2000

Identification and Documentation of Best Human Factors Practice for Engine NDI/NDT Inspections

AVR Performance Goal(s) 1, 3; Sub-goal 2

- Requirement: Examination of human principles to the NDI process in response to the NTSB's recommendation that aircraft inspection, particularly NDI, be improved to reduce accident rates
- Regulations Affected: FAR Part 121, FAR Part 145, FAR Part 43
- Product: Recommendations for applying human factors principles to each component of engine NDI operations
- Output: Identification and documentation of best human factors practice for engine NDI/NDT inspections. Provide review and incorporation of principals into the AC
- Outcome: Application of human factors techniques to enhance the reliability of engine inspection and to reduce engine failures related to NDI processes
- Delivery Date: September 1999

Development of Advisory Circular on Qualifications and Certification of NDI/NDT Personnel

AVR Performance Goal(s) 1,2; Sub-goal(s) 2,3

- Requirement: Update guidance on human factors issues involving the certification and qualification of nondestructive testing personnel in response to the NTSB's recommendation that aircraft inspection personnel qualifications, particularly NDI, be improved to reduce accident rates
- Regulations Affected: FAR(s) Part 121, Part 145, Part 147, Part 65, Part 43
- Product: Preparation and support material for an Advisory Circular (AC) covering qualification and certification of NDI personnel
- Output: Data collection on existing standards in U.S. and international NDI environments and preparation of support material for an AC

- Outcome: Guidance that integrates and clarifies certification and qualification standards, which eliminates the diversity of approaches to the certification process
- Delivery Date: September 2000

Development of Process to Improve Work Documentation in Repair Stations

AVR Performance Goal(s) 1, 2, 3; Subgoal(s) 2, 18, 21, 32

- Requirement: Assess human errors/human factors issues in contract maintenance repair process with special attention to documentation issues, in response to NTSB recommendations and GAO report to Congress for improved oversight of repair stations
- Regulations Affected: FAR Part 145, FAR Part 121
- Product: Recommendations on how repair stations can use current human factors best practices to improve documentation quality and reduce errors due to documentation deficiencies
- Output: Research findings that address potential errors inherent in performing aircraft maintenenance remotely from the airline and recommendations for improvement in work documentation at repair stations
- Outcome: No systematic data exists on repair station errors. This research is a first step towards documenting and controlling human errors in repair stations
- Delivery Date: September 2000

Technology-based Solutions for Process Management in Aviation Maintenance

AVR Performance Goal 2, Sub-goal 18

- Requirement: Examine the applicability of commercial, off-the-shelf (COTS) Electronic Document Management/Product Data Management (EDM/PDM) software to the aviation maintenance environment, particularly repair station facilities
- Regulations Affected: None
- Product: Stand-alone prototype of EDM/PDM applied to a representative maintenance procedures
- Output: Electronic processes that mitigate deficiencies in the applicability, usability, and implementation of current aviation maintenance operation by providing improved tracking, automatic updating, and easy information “look up.”
- Outcome: By improving the effectiveness and efficiency of the processes that drive maintenance, complete and accurate information can be made available at the right place and the right time, directly supporting mechanics, staff, and managers
- Delivery Date: March 1999

Creation of Prototype for Safe Maintenance in Aviation: Resource Training Center

- Requirement: Create and service a distance education, web-based training center and evaluate its feasibility and utility in response to the Gore Commission's directives to the FAA to capitalize on advanced technology for improving aviation safety
- Regulations Affected: None
- Product: A web-based training center with an interactive seminar on maintenance resource management-related issues
- Output: An internet resource and learning center (SMART) for the delivery of on-the-job training to maintenance personnel, and delelopment of standards for quality web-based training and delivery
- Outcome: An economical and logistically efficient forum for providing continuing education to AMTs
- Delivery Date: March 1999

Creation of Annual CD-ROM #7

- Requirement: Develop a medium for distributing technical and scientific products generated by the research program
- Regulations Affected: None
- Product: Annual Human Factors in Aviaiton Maintenance CD-ROM
- Output: Research results, the Human Factors Guide to Aviaiton Maintenance, and software prototypes for training and job aiding are provided to the industry via CD-ROM
- Outcome: Approximately 4,000 CD-ROMs containing reports, multimedia job aids and software prototypes will be developed for FAA distribution
- Delivery Date: March 1999

Support for FAA/CAA/Transport Canada Symposia

- Requirement: Cooperative efforts by the FAA, CAA, and Transport Canada to organize standard forums for disseminating research results to the international aviation maintenance industry
- Regulations Affected: None, Global Harmonization
- Product: Annual Human Factors in Aviaiton Maintenance Symposia and meeting proceedings
- Output: Dissemination of information through meetings and proceedings on how human factors principles can improve international aviation safety through the reduction of accidents and incidents
- Outcome: The widest possible international dissemination of research and sharing of

experiences of maintenance organizations, allowing research results to impact those who benefit most

- Delivery Date: February 1999

Job Task Analysis of the Aviation Maintenance Technician

AVR Performance Goal 2, Sub-goal 13

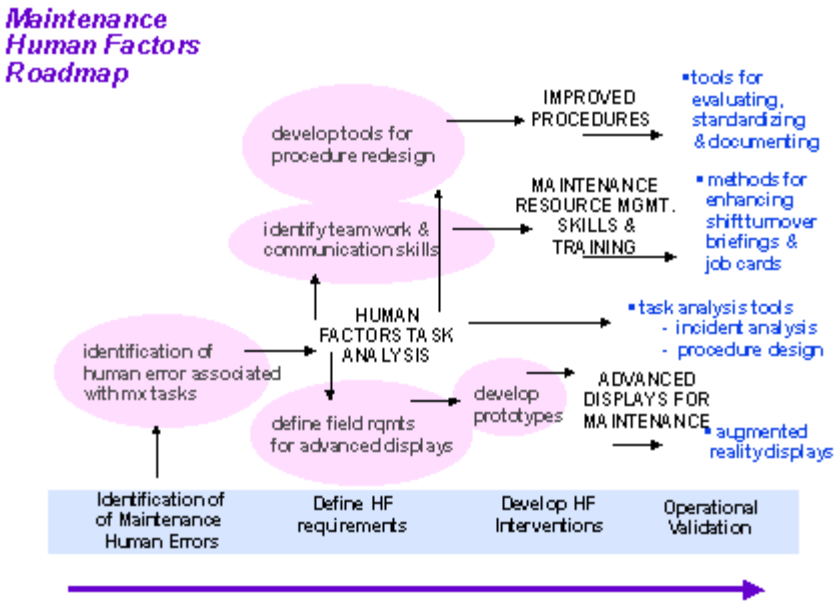
- Requirement: Update the Allen Study (1974) Study, which includes an industry-wide survey of tasks AMTs perform and the basic AMT school curriculum.
- Regulations Affected: FAR Part 65, NPRM FAR Part 66, FAR Part 147
- Product: Survey data and analysis, recommendations from industry and AMT school representatives on content of a revised FAR Part 147, numerous presentations at industry and FAA meetings
- Output: Guidelines to revise the curriculum included in the current version of FAR Part 147
- Outcome: Regulatory support to revise FAR Part 147, reference data for FAR Part 66 and other related rulemaking
- Delivery Date: March 1999

NASA Slides

NASA Aviation Safety Program Maintenance Human Factors

- **Research Goals**
  - To better understand human error and human factors associated with maintenance tasks
  - To develop interventions and task aids that reduce human error and enhance safety and effectiveness in maintenance operations
- **Plan Elements**
  - Improved procedures
  - HF task/risk analysis tools
  - MRM skills, training, and evaluation
  - Advanced displays for maintenance aiding

Maintenance Human Factors Roadmap



Conclusion

The research program has emerged as the most significant program of its kind related to human factors in aviation maintenance. The aviation industry, the Department of Defense, national and international organizations, and governments around the world participate in the annual conference and use the products and reports that the program generates each year.

The success of the program is based on the commitment to the application of solid scientific principles to deliver pragmatic solutions. The research shall continue to be driven by user requirements. The research shall continue to use the aviation maintenance environment as the most important daily laboratory to conceptualize, design, develop, implement, and test procedures and products to enhance human performance.

References

The research program has generated nearly 400 reports/publications to ensure information is widely disseminated throughout the aviation industry. The bibliography is 41 pages in length and is not included herein. The bibliography is on the worlwide web at www.faa.gov/avr/afs/300/afs300c/html/hotlinks.

Appendix

Appendix A: Maintenance-Related Accidents as reported by

the National Transportation Safety Board

DATE	AIRLINE	LOCATION
7/30/71	Pan American	San Francisco, CA
2/8/76	Mercer Airlines, Inc.	Van Nuys, CA
5/25/79	American	Chicago, IL
9/20/81	World Airways, Inc. Flight 32	Over North Atlantic Ocean
9/22/81	Eastern (935)	Colts Neck, NJ
9/22/81	Air Florida Airlines, Inc.	Miami Int'l Airport, Miami, FL
1/13/82	Air Florida, Inc.	Near Washington Nat'l Airport Washington, DC
3/24/82	TigerAir, Inc.	Marana, AZ
2/15/83	Eastern Air Lines Flight 194	Miami, FL
5/5/83	Eastern	Miami Int'l
6/2/83	Air Canada Flight 797	Greater Cincinnati Int'l Airport Covington, K
11/11/83	Eastern Airlines Flight 836	Miami Int'l Airport
2/28/84	Scandinavian Airlines Systems Flight 901	JFK Int'l Airport Jamaica, New York
2/19/85	China Airlines	300 Nautical miles northwest of San Francisco, CA
5/28/85	American Airlines	Jamaica, New York
9/6/85	Midwest Express	General Billy Mitchell Field Milwaukee, WI
4/8/86	United Airlines Flight 732	Chicago, IL
5/25/86	Continental Airlines Flight 199	Corpus Christi, Texas
4/28/88	Aloha Airlines	Maui, Hawaii
8/31/88	Delta Air Lines, Inc.	Dallas Ft.-Worth, Int'l Airport Dallas
2/24/89	United Airlines Flight 811	Honolulu, Hawaii
3/18/89	Evergreen Int'l	Saginaw, Texas
7/19/89	United (232)	Sioux Gateway
12/30/89	America West Airlines Flight 450	Tucson, Arizona
5/3/91	Ryan Int'l Airlines, Inc. Flight 476	Windsor Lock, CT

7/11/91	Nationair Canada	King Abdulaziz Int'l Airport, Jeddah, Saudi Arabia
9/11/91	Britt Airways,d/b/a Cont'l Express (2574)	Eagle Lake, TX
11/8/61	Imperial Airlines, Inc.	Byrd Field, Richmond, VA
3/1/94	Northwest Airlines Flight 18	New Tokyo Int'l Airport
12/14/94	Phoenix Air	Fresno, CA
6/8/95	ValuJet (597)	Atlanta, GA
8/21/95	Atlantic Southeast Airlines, Inc.,	Carrollton, GA
1/7/96	ValuJet Airlines Flight 558	Nashville, TN
5/11/96	ValuJet Airlines	Miami, FL
10/2/96	Aeroperu	Pasamayo, Peru