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From: Aviation Maintenance Human Factors Program Manager, AAR-100  
To: Airworthiness TCRG

Subj: AVIATION MAINTENANCE HUMAN FACTORS SECOND QUARTER '04  
REPORT

Ref: (a) Aviation maintenance human factors execution plans  
(<http://www.hf.faa.gov/maintfunded.htm>)

1) Each project is listed below.

a) An Evaluation of Broadband Applications to Aircraft Maintenance Safety

Researchers accomplished the following: (1) interviewed mechanics and managers at two major airline line maintenance facilities on a wide variety of topics related to how computer/broadband applications might be used to support troubleshooting and diagnosis for line and scheduled maintenance, (2) conducted a literature search of case-based reasoning applications that might be applied to computer systems to aid in aircraft maintenance diagnosis and troubleshooting, (3) researched the marketplace for commercial software systems that aim to assist mechanics with diagnosis and troubleshooting

Future milestones include: developing three surveys: (1) an attitudinal survey about an existing computer application used at a particular line and scheduled maintenance facility; (2) an attitudinal survey about the potential development and use of "quick reference" materials in line maintenance; (3) a survey about how mechanics would like to interact with a system that archives maintenance case histories to assist them in cases that are not easily solved using existing troubleshooting materials. Emphasis will be placed on how mechanics would like to search for and add case history information to such a system.

Researcher was notified that BF Goodrich will not participate in the broadband survey that was developed by CAMI. Last quarter, NASA Ames assumed CAMI's BF Goodrich survey due to CAMI personnel changes.

*All available information indicates the project is on track; however the BF Goodrich survey will not be completed.*

b) Vision Testing Requirements for Certain Persons Maintaining and Inspecting Aircraft and Aircraft Components

NASA Ames: Researchers accomplished the following: (1) Laboratory settings were adjusted in preparation for participants, (2) lighting conditions were set, and the stimuli were examined from an experimental 2m distance, (3) many changes were made to the experimental code. A border was implemented to highlight the detection target in the practice phase of the experiment. This takes location ambiguity out of the experiment and leaves the focus on the detection task. The starting level of the contrast was experimented with. Auditory signals were added to indicate when a stimulus was being presented and to provide feedback when the response was incorrect. Images were clipped and rotated so that they would display properly. Code was implemented so that the program would not become unstable after big images were displayed. Calibration methods were established, and measurements were taken. 'Level of blur,' an independent variable of the experiment, was also implemented, (4) changes were also made to the data collection section of the experiment. New calculations were included, and output files were updated to include important data.

Ohio State University and CAMI: Researchers accomplished the following:

1. Specific visual processing requirements for essential tasks in NDI/NDT and visual inspections, which will extend Dr. Drury's NDI/NDT task analyses for the Borescope, Fluorescent Penetrant, and Visual Inspections.

Site visits to 5 maintenance facilities were conducted. Inspectors were observed and documentation of working distances, fixation directions, and descriptions of defects were made. The information was compiled and shared with Tina Beard of NASA-Ames (November 2003). (Preliminary data from these observations were presented at Reno (September 2003) and AAO-International (April 2004).) Action Complete.

2. Establish an NDI/NDT and visual inspection industry and personnel profile.

Personnel information was collected via surveys disseminated to volunteer inspection personnel at 5 maintenance facilities. Information on age, race, refractive corrections, and ocular health was collected. Preliminary data from these surveys were presented at Reno (September 2003). Action Complete.

3. Determine time interval for the administration of vision exams.

The time interval between vision examinations for inspection personnel has yet to be determined. While some information needed to determine this interval has been obtained through personnel surveys, additional information remains outstanding. Research results from testing at NASA-Ames and collating data from site visits of selected maintenance facilities are required before this milestone can be completed. At the present time, no delay in the meeting this milestone is expected (September 2004).

4. Develop written guidance material for organizations to establish programs (testing equipment & procedures) for the administration of vision standards.

While some background information regarding this milestone has been obtained through interaction with medical personnel during site surveys, development of specific testing equipment and procedures can not be completed until a draft vision standard for inspection personnel is completed. At the present time, no delay in the meeting this milestone is expected (September 2004).

5. Develop a vision standard amendment to the FAR, if needed.

While some information needed to determine the vision requirements for inspector personnel has been obtained, pertinent information remains outstanding. Research results from testing at NASA-Ames and inspector vision screening information (milestone vi.) are required before a vision standard based upon the essential visual tasks of the occupation can be made. At the present time, no delay in the meeting this milestone is expected (September 2004).

6. Determine the potential impact of recommended vision standards on the current employee population. Vision screening shall be performed on a representative sample of NDI/NDT and visual inspection personnel, if needed.

Vision screening will be performed at 2 maintenance facilities on a total of 150 NDI/NDT and visual inspectors. The vision measures for these inspectors will be compared to the proposed vision standard to determine the potential impact upon the present workforce of a change in the present vision standard. In order to be completed by September 2004, however, planning for the screenings should take place as soon as possible. Any delay may result in not meeting this milestone, especially if unforeseen scheduling problems are encountered. Presently, however, screening forms have been developed and IRB approval of testing has been granted through The Ohio State University.

In summary, researchers are on schedule to complete the milestones as previously indicated. They are awaiting testing results from NASA-Ames to complete Milestones 3, 4, 5, and 6. Additionally, scheduling of the vision screenings should proceed without delay.

*Visual Demands Associated With Aviation Maintenance Inspection*, presented at the American Academy of Optometry's Academy '04 Global - Pacific Rim Meeting in Honolulu, Hawaii (April 2-4, 2004.) - <http://www.hf.faa.gov/docs/508/docs/maintVisionOSU2004.pdf>.

*All available information indicates the project is on track.*

c) Language Barriers Result in Maintenance Deficiencies

Researchers have contacted three sites in Taiwan and five in China to begin data collection, and have confirmed travel dates to both. They traveled to China, including Hong Kong during March and April 2004 and collected data on 200 participants from a variety of maintenance bases. At present they are entering the data into their analysis programs and will prepare a report on this analysis in Summer 2004. Colin Drury is traveling to Taiwan from 22-29 May to collect data there.

They completed the Year 2 annual report on 31 January 2004, and have had a paper accepted for the HFES Annual Conference in New Orleans in September 2004. A report on Asian data collection and findings on the questions originally posed will be prepared in Summer 2004.

Their final report will provide refined estimates of error frequency, patterns of error types, effectiveness of intervention strategies and recommendations for FAA action to mitigate language related errors. They will report on the activities in Year 3 on time and include all Asian sites.

*Indications are that there are minor risks to the activity being completed as planned. Due to the researcher's inability to access maintenance facilities (current climate in aviation post 9/11), the researcher has not been able to collect the proposed data that was stated in the grant proposal. The researcher will receive a no cost extension to complete the grant by December 2004.*

d) General Aviation Alaska Maintenance Accidents

An initial HFACS analysis of all general aviation maintenance-related accidents was completed in January and submitted to AAR-100. After discussions with Dr. William Krebs, it was determined that the analysis of maintenance-related accidents should have been conducted with A&P mechanics as subject matter experts, not pilots as has been the practice with other GA accident data. Consequently, it was agreed that CAMI would re-analyze the GA maintenance

data set with A and P experts with the goal of delivering the final data April, 30, 2004.

Since that time Dr. Bert Boquet was assigned the lead on the project and several (six) certified A&P mechanics were identified as SMEs on the project. After a slight delay in the hiring process (several modifications had to be made to the existing project support contract with OMNI) the training of the SMEs on the HFACS framework was conducted at the end of the 2<sup>nd</sup> quarter. We expect at the current pace that the accidents will be coded and entered into the database by 4/31. At that time analysis of the data will begin followed by briefing of AAR-100 and AFS-300 and generation of the technical report. Unfortunately, our target date of April 30<sup>th</sup> for delivery of the final briefing and generation of the report will slip a few weeks, but should still be completed within the 3<sup>rd</sup> quarter of FY04.

In addition to the post hoc accident analysis with HFACS, a survey of selected Alaskan Maintenance Facilities will be conducted to get a sense of issues specific to maintenance in Alaska. Ms. Cristy Detwiler is working with Ms. Angela Elgee (AAL-240) and Mr. Jerry Dennis (Director of the Medallion Foundation) to identify several facilities to survey. Meetings will be held with Ms. Elgee and Mr. Dennis when Ms. Detwiler presents a series of briefings in Alaska in May. The target for the survey distribution is 3<sup>rd</sup> quarter with an early 4<sup>th</sup> quarter delivery of results. Dr. Douglas Wiegmann (University of Illinois) has agreed to conduct the survey as part of another funded (AAR-400) FAA research initiative.

*Project has experienced a slight delay; however the final report should be completed this fiscal year.*

e) Using Technology to Support Inspector Training

Researcher accomplished the following: (1) Sought feedback on methods for training, (2) Integrated training material and methods, (3) Collected multimedia data [text information, images of structures/defects, videos, and voice over support] for specific inspection activities, (4) Developed videos on FOD (Foreign Object Damage), Work Interruption and Body Posture for FY05 Congressional Hearings – point to <http://www.hf.faa.gov/maintfunded.htm> then select between three videos in the *General Aviation Maintenance Inspector Training Reports/Products* cell, (5) Developed alternate prototype interfaces.

Future milestones include: (1) Seek feedback from users (industrial partners) on the prototype interfaces, (2) Incorporate feedback into the prototype interfaces, (3) Select Interface – Find the power point presentation containing few screens of the interface at the following website - point to <http://www.hf.faa.gov/docs/508/docs/GAITS2004.ppt> to view interface examples.

Jacob, R., Raina, S., Regunath, S., and Gramopadhye, A.K. (2004). Improving Inspector's performance and reducing errors - The General Aviation Inspection Training Systems (GAITS). Poster submitted to HFES (Human Factors and Ergonomics Society) 48<sup>th</sup> Annual Meeting, New Orleans, Louisiana, September 20-24, 2004. - <http://www.hf.faa.gov/docs/508/docs/maintGAHFES2004.pdf>

*All available information indicates the project is on track.*

f) An Assessment of Barriers to Implementation of Aviation Safety Programs (ASAP) in Maintenance Organizations

As of March 31, 2004 the following tasks have been accomplished: (a) Dissemination of the preliminary results of Maintenance ASAP programs in the United States through a paper presentation at the Safety Across High-Consequence Industries Conference (actual paper [#2004-01-20] is attached) and (b) Distribution of the Maintenance ASAP Questionnaire (MAQ), developed in the first quarter, to a nationwide sample of randomly selected Airman Certificate (Aircraft Mechanics) holders.

First, the researchers did not want the MAQ survey to be perceived as a "Union Program," "Company Program," or an "FAA Program." Therefore, instead of requesting specific people or organizations to champion the distribution of the questionnaires, the most neutral dataset—the Airman Certificate Database—was selected as the master database from which a randomly selected sample could be targeted for the survey. Second, it was acknowledged that the Airman Certificate Database contained Aircraft Mechanic Certificate holders who may not be actively working in the field at this time, may not be working in civilian aviation, or simply may not be exercising the privileges of their Mechanic Certificate. Therefore, it was necessary to over-sample the population.

Considering the above factors, approximately 83,000 individuals were randomly selected from a population of about 130,000. Assuming that at least about 50% of the recipients are actively involved in aviation maintenance, about 40,000 individuals are likely to be realistic candidates for the survey. The typical response rate for mail-in surveys is 30% and the typical response rate for aircraft mechanics is about 10%. Therefore, it is likely that between 4,000 and 12,000 surveys will be returned. As of April 9, 2004, just over 4,000 responses have been received. There are many individuals as well as organizations that are promoting this survey and encouraging their respective associates/constituencies to respond to this survey. The researchers are getting about 2-3 phone calls and 2-3 e-mail messages per day regarding the survey. Therefore, it is clear that the sample population is taking this survey very seriously.

The Maintenance ASAP Questionnaire has been distributed to a national sample of 83,000 aircraft mechanics. This is the largest and most comprehensive survey of its kind. The response to this survey has been very positive. This project

continues to progress satisfactorily to meet the target milestones; therefore, the status is Green.

Patankar, M., & Driscoll, D. (2004). Preliminary analysis of Aviation Safety Action Programs in aviation maintenance. In Patankar, M. (Ed.) *Proceedings of the First Safety Across High-Consequence Industries Conference*. St. Louis, Missouri: Parks College of Engineering and Aviation - <http://www.hf.faa.gov/docs/508/docs/MaintASAPpaper2004.pdf>.

*All available information indicates the project is on track.*

g) Auditing and Surveillance Maintenance Error Tool

Researchers accomplished the following: (1) Conducted interview sessions with key members in the Quality Assurance and Audit departments at the FedEx facility in Memphis, TN, (2) Conducted observation session at Mobile, Alabama, (3) Completed a trip report, documenting the information gathered from the interview sessions at Memphis, TN, and the observation session at Mobile, AL, (4) Used task analysis to identify needs to support surveillance and inspection performance, (5) Defining the impact variables to be considered for WebSAT, in association with key members in the Quality Assurance and Audit departments, at the FedEx facility at Memphis, TN.

Future milestones include: (1) Completing the second Quarterly report. (April 9, 2004), (2) Present a poster related to the WebSAT research at the Clemson University research forum. (April 12, 2004), (3) Schedule a trip to Mobile, AL maintenance site. (April 16, 2004), (4) Make a seminar presentation at the Clemson University Industrial Engineering doctoral colloquium. (April 23, 2004), (5) Present two papers related to the WebSAT research at the Industrial Engineering Regional Conference. (May 15-16, 2004), (6) Develop the survey tool to validate the defined impact variables with other airlines. (May 15, 2004), (7) Complete an analysis report documenting the results of the web based impact variables validation survey with other airlines. (May 15, 2004), (8) Design a framework of the WebSAT tool which would include the goals and the functions that would be accomplished by WebSAT (May 15, 2004), (9) Conduct a web based impact variables validation survey with other airlines to ascertain the accuracy of the selected impact variables (May 30, 2004), (10) Identify impact variables using the need-metrics matrix (June 30, 2004), (11) Identify the modules that will be incorporated in WebSAT (June 30, 2004), (12) Develop the goals and functions to be included in each module (July 15, 2004), (13) Develop objectives for each module and sub – objectives for modules. (July 15, 2004), (14) Schedule a trip to a participating airline company to validate the selected impact variables (August 31, 2004), (15) Present paper/poster in the proceedings of Human Factors and Ergonomics Society Conference. (September 20-24, 2004), (16) Schedule a trip to the FedEx Greensboro maintenance base. (September 30, 2004), (7) Started

preliminary work on designing the iteration prototype for each module using the conceptual design methodology. (October 31, 2004)

Kapoor, K., Dharwada, P., Iyengar, N., Greenstein, J.S., and Gramopadhye, A.K., A Strategy for the Development of a Web-based Tool to Reduce Aviation Maintenance Errors, Proceedings of the 48th Annual Conference of Human Factors and Ergonomics Society, New Orleans, Louisiana, 2004.

*All available information indicates the project is on track.*

h) Effects of Fatigue, Vigilance, Environment on Inspectors Performing Fluorescent Penetrant and/or Magnetic Particle Inspections

Our Final Report of the first (shortened) year of the project was completed and submitted on time at the end of January 2004. We have also had a paper accepted for the HFES Annual Conference in New Orleans in September 2004 based on the first year's final report.

We have now visited two aviation hangars familiarize the new graduate students with the relationship between flight operations and maintenance / inspection and to collect data on hours of work, environmental conditions and strategies to combat fatigue. We also documented the FPI and Magnetic Particle Inspection processes. With this data we have designed suitable conditions for our experiments.

Our contact with CAMI (Thomas Nesthus) for cooperation on vigilance and fatigue measurement have led to one meeting in March to collect the Actiwatches for data collection. Colin Drury is also visiting CAMI on 19 May to discuss potential cooperation in vigilance and fatigue studies.

Our computer program for simulating FPI inspection has now been written and some of the photographs of engine blades needed as stimulus material for this program have been manipulated into the correct format. Colin Drury would like to visit FAA HQ in May to show the program to our grant monitor and others with knowledge of NDI techniques.

We have designed the experiment for data collection and obtained Institutional Review Board approval for its conduct.

Future milestones include: (1) report on comprehensive literature reviews on Vigilance, Inspection, Fatigue and hours of work (Jan 31 2004), (2) report on findings for distribution of working times, fatigue strategies, inspection environments. Not possible just from existing data. Are collecting data during Jan 2004, and will collect additional data from our contacts in Year 2, (3) report on design of experiment and result of pre-tests (May 2004), (4) design and programming completed (May 2004).

*All available information indicates the project is on track.*

William K. Krebs