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From: Aviation Maintenance Human Factors Program Manager, ATO-P R&D Human Factors

To: Aviation Maintenance TCRG

Subj: AVIATION MAINTENANCE HUMAN FACTORS SECOND QUARTER '05 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

The researcher created five models of the line maintenance process at the SFO facility. These models include: (1) a *communications* model that shows what information is passed between all maintenance personnel; (2) a *sequential* model that enumerates the steps in the line maintenance process; (3) an *artifact* model that shows all of the tools (including information-processing tools) used by maintenance personnel; (4) a *physical* model that diagrams the physical layout of the facility; and (5) a *cultural* model that makes explicit the cultural landscape of the facility (e.g., relationship between flight crew and maintenance personnel, or between maintenance personnel and company management).

The researcher shadowed line maintenance crews at San Francisco International airport during six 10-hour workshifts. The purpose of these visits was to refine the accuracy of the five models. Measurements were made of distances between all key locations at the facility (maintenance office, tools and parts inventories, and each of the gates). Measurements were taken of the average time required to access needed maintenance documents in the companies various electronic documentation systems. An inventory was made of all artifacts used by the maintenance crew. Detailed notes were made of all arriving aircraft, their maintenance issues, and all actions of the line maintenance crews.

We have implemented a computer simulation of the line maintenance process, using the models described above. The program accepts a list of scheduled

aircraft and their assigned gates. Probability functions determine whether or not each airplane has maintenance issues. The program enumerates all of the actions required on the part of the maintenance crew to defer or resolve each issue, including: gathering documents, parts, tools, communicating with the flight crew or other technicians, and traveling around the facility. The program keeps a running total of the distances traveled and the total time spent accessing information. The program and models will allow us to better understand where maintenance crews spend the majority of their work time, which steps offer the greatest chance for errors to be made, and which steps in the maintenance process would best be suited for the use of computer and broadband technology.

All available information indicates the project is on track.

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

NASA Ames: researcher added an additional section to the final draft document that discusses recent changes to vision model to predict crack detection performance. Researcher will submit final report before May 2005.

OSU/CAMI: completed a summary of recommendations based on findings from the NDI/NDT Vision Standards Program research that was submitted to sponsor POC.

Project is complete. OSU/CAMI submitted recommendations to sponsor POC and NASA Ames will submit final report next quarter.

c) Language Barriers Result in Maintenance Deficiencies

New data was collected from Puerto Rico (26 participants at one site) and Colombia (86 participants at one site). This data is currently being entered for analysis. Data collection for Chile and Argentina has been agreed to but no date yet fixed. Data for one large site in Spain will be collected 5-12 July 2005. We have asked three sites in the USA for cooperation in collecting a better baseline data set. Two have refused due to work pressure and outsourcing. The third has agreed to a date "later this summer."

Analysis of the 250 participants from Mexico has begun. At this stage it appears that translation is beneficial, somewhat in contrast to Asian findings.

Original objectives for Phase II were to:

1. Better quantify the incidence of each type of language error identified in the taxonomy from Phase I.
2. Quantify the effectiveness of representative intervention strategies to reduce language-related errors.

Our 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. We will provide a report on the activities in Year 3 on time by the end of the project period, to include the current report on all Asian sites. Status Yellow, due to report from a single region to date. A second region (Latin America) has been the site for collection of over 350 participants and a site in Europe has been agreed on.

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 August 2005.

d) Using Technology to Support Inspector Training

Significant Milestones (e.g., completion of a research goal):

- Completed Beta- interfaces and coding for the following modules – Simulator, Design and Analysis - Simulator
- Incorporated multimedia for wing inspection to support simulator module
- Revised and modified draft of accompanying audio for the various modules
- Set meetings with industry partners to demonstrate and seek feedback on the simulator and design and analysis modules
- Made changes based on feedback obtained on multimedia data [text information, images of structures/defects, videos, and voice over support] into the training system based on data collected from previous quarter
- Developed the first prototype of scenario generator to organize image database
- Debriefed REDAC on the progress of the research – Power point presentation can be downloaded from the following link -- <http://people.clemson.edu/~astagi/>

Work in Progress (describe in brief bullet format):

- Continued image editing work for simulator following feedback from inspectors
- Started work on voice over to support demonstrations for the simulator module
- Analyzed usability evaluations introduction, training and design and analysis modules
- Started work on developing a journal paper for submission to one of the following journals: International Journal of Applied Aviation Sciences/Computers and Industrial Engineering

All available information indicates the project is on track.

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

Purpose and Rationale:

The primary purpose of an Aviation Safety Action Program (ASAP) is to identify and correct adverse safety events that would otherwise not be likely to come to the attention of the Federal Aviation Administration (FAA) or company management. Prior to the start of this study, there were twenty-eight air carriers with flight ASAP programs and only six organizations with maintenance ASAP programs. Since then, however, the number of flight ASAP programs has risen to forty-one and the number of maintenance ASAP programs has risen to ten. Although both ASAP programs have increased during the past year, the ratio of flight-to-maintenance programs remains steady at about four-to-one.

The second year of this project is focusing on survey data collection and analysis of sample ASAP reports. In the first quarter of FY05, emphasis was placed on scanning and archiving the 5,022 survey responses that were analyzed during the fourth quarter of FY04. Additionally, LexiQuest Mine, a text mining software, was acquired to begin text analysis of narrative safety reports, such as those obtained from an ASAP report or an ASRS report. The results of this analysis will assist in the development of the Web-based ASAP Safety-information and Program-tracking (WASP) tool, whose development process will start in the next quarter.

Status of Work in Progress:

LexiQuest Mine, a text mining/analysis software, is being tested for its usability and applicability as a “back-end” tool that could be used to conduct dynamic and objective analysis of a large volume of narrative safety reports. If this software is promising, it will be incorporated in the development of the WASP tool. Initial experiments show that LexiQuest could be used to map key concepts in textual data and the relative importance of these concepts as well as the interrelationships among several concepts could be analyzed.

A complete Maintenance ASAP database has been obtained from a partner airline. This database is currently being “cleaned-up” and prepared for use with the LexiQuest tool for text analysis. Preparation of the database for text analysis is quite a laborious process because it involves standardization of terminology, acronyms, and overall language across all the reports (n>1500)

Most Significant Achievement

Obtaining access to the entire maintenance ASAP database is clearly the most significant achievement. It is a testimony to the trust between the researchers and the airline partners as well as to the value of this project to the industry.

All available information indicates the project is on track.

f) Auditing and Surveillance Maintenance Error Tool

Significant Milestones achieved as of March 15th, 2005:

- Conducted interview sessions with key members in the Quality Assurance and Audit departments at the FedEx facility in Memphis, TN.
- The research team made a presentation of the on-going research at the FedEx headquarters in Memphis, TN.
- Used task analysis to identify needs for support of surveillance and inspection performance.
- Made a doctoral colloquium presentation on WebSAT in the Department of Industrial Engineering, Clemson University.
- Designed a framework for the WebSAT tool which would include the goals to be met and the functions that would be accomplished by WebSAT.
- Completed the quarterly report in March 2005.
- Conducted a web-based process measures validation survey with other airlines to ascertain the support for the selected process measures.
- Developed the goals to be met and functions to be included in each module.
- Developed objectives for each module and sub – objectives for modules.
- Developed user needs based on customer statements for the four work functions WebSAT is involved with.
- Developed metrics for the product.
- Developed a need-metrics matrix.
- Began product map iterations.
- Developed paper based prototypes for each module using a conceptual design methodology.
- Began screen design iterations.
- Developing a working prototype for the technical audits module prototype.
- Developed the data base schemata for the technical audits module prototype.
- Awaiting review of paper submitted to the Proceedings of Industrial Engineering Research Conference, 2005 and review of journal paper submitted to IJAAS (International Journal of Applied Aviation Studies), 2005.

Work in Progress from March 15th – June, 2005 (The dates in parentheses indicate the deliverable date):

- Make a trip to participating airline company (Northwest Airlines, Minneapolis) to validate the selected process measures. (March 28th, 2005)
- Make a trip to Oklahoma City to present a paper on “*Strategy for Evaluation of Aircraft Maintenance Operations Using Process Measures*”

in the International Symposium on Aviation Psychology, 2005. (April 20th, 2005)

- Make a trip to FedEx to conduct testing. (May 1st, 2005)
- Test the first set of product map iterations with FedEx. (May 1st, 2005)
- Test the first set of screen design iterations with FedEx. (May 1st, 2005)

All available information indicates the project is on track.

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

Data collection continues, with 32 out of the 80 participants in the screening experiment completed to date. It will probably be early June before data collection is completed.

Status of deliverables is as follows:

- i. Report on comprehensive literature reviews on Vigilance, Inspection, Fatigue and hours of work. Status Green: completed by Jan 31 2004.
- ii. Report on findings for distribution of working times, fatigue strategies, inspection environments. Have collected data from approximately 30 inspectors, and will collect additional data from our contacts in Year 2. Status Yellow
- iii. Report on design of experiment and result of pre-tests. Status Green, FPI simulation tested on two groups of pilot subjects, and 32 actual participants.

All available information indicates the project is on track; however the report on findings for distribution of working times, fatigue strategies, inspection environments will be delayed.

h) Creation and Maintenance of AAR-100's Human Factors in Aviation Maintenance Knowledge Portal

Significant Milestones achieved as of March 15th, 2005:

Web-site Development

- Tested and evaluated DotNetNuke skins for most categories
- Sought feedback from program manager on developed skins
- Made modifications to the DotNetNuke skins following feedback
- Continued work on developing search function in DotNetNuke environment

Content Development

- Started work on converting files from hfskway location to pdf format

- Continued work on collecting additional technical reports based on initial outline provided.
- Keyed information on professional societies and organization

Work in Progress (describe in brief bullet format):

- Prototype website being modified based on FAA guidelines and feedback forthcoming from Program Manager
- Populating web-site with appropriate content will continue during the upcoming months.

All available information indicates the project is on track

i) Human Factors Maintenance Considerations of Unmanned Aircraft

The research requirement can be found at <http://www.hf.faa.gov/docs/508/docs/maintUAVreq.pdf>. The execution plan can be found at <http://www.hf.faa.gov/docs/508/docs/maintUAVexplan.pdf>.

A review of technical and research documents is progressing. Preliminary discussions have been held with key personnel within the FAA and industry.

In the next quarter, the literature review will be completed, a series of visits will be made to industry centers, and preparations will be made for interviews with UAV maintenance personnel.

New start. NASA Ames will cost share this research requirement with the Federal Aviation Administration. All available information indicates the project is on track

William K. Krebs