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

Subj: AVIATION MAINTENANCE HUMAN FACTORS FIRST 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

NASA Ames has assumed responsibility CAMI's broadband/computer technology survey project being done at Goodrich Aerospace. We have begun looking at how broadband and computer technology is and can be used to archive and distribute case-history information. Such an application would minimally include Service Bulletins and Airworthiness Directives, but we are mainly interested in capturing timely and informal case information that will provide troubleshooting assistance in cases where existing documentation [such as a fault isolation manual (FIM)] cannot provide further guidance. The current method of sharing case information among technicians, aside from slow-moving ADs and SBs, is word-of-mouth. Our goal is to determine if computer and broadband applications can play a successful role here. We have interviewed one maintenance manager at a major air carrier, and one expert on text data mining. We anticipate spending the second quarter of FY04 talking to more technicians and managers about what kind of applications might be useful, how technicians would contribute information to, and access information from such an application.

All indications indicate that this project is on track.

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

NASA Ames: Researcher is near completion of the software for the simulations. Dr. Good (Ohio State University) stated that crack detection is an optimal task to

explore and has provided appropriate working distances to examine. Currently, the researcher is almost complete of the experimental design and writing the software to begin visual psychophysical data collection.

Ohio State University and CAMI: After a preliminary analysis of task-related data performed at five maintenance facilities, the researchers reported an adequate amount of data has been collected. Additional detailed visual task analysis at other maintenance facilities will not be performed. The researchers completed a vision-related "Essential Tasks List" for the three NDI/NDT procedures (borescope, fluorescent penetrant, and visual inspection), based on a preliminary analysis of task-related data obtained during visits to several maintenance facilities. The visual task information for these procedures was forwarded to Dr. Tina Beard at NASA-Ames. Disseminated personnel and facility surveys from maintenance facilities have been collected and collated. Analysis of personnel and facility survey data to establish an NDI/NDT and visual inspection industry and personnel profile is ongoing.

All indications indicate that this project is on track to complete Phase II milestones as planned; however there may be problems accessing military and civilian maintenance facilities which will impact the Phase II deliverables.

c) Language Barriers Result in Maintenance Deficiencies

The researcher completed the experimental design for the data collection on the frequency of Language errors and the effectiveness of coping strategies. All of our documentation for the coping tests has been translated into Chinese (Mandarin), and a Mandarin / English glossary prepared to cover two of the possible coping strategies. We have contacted four sites in Taiwan and three in China to begin data collection, but have still not been able to confirm travel dates.

To collect data on the frequency of Language errors and the effectiveness of coping strategies, we must visit foreign maintenance and inspection worksites. We are still finding this difficult in the current climate in aviation post 9/11.

The researcher is currently addressing (1) better quantify the incidence of each type of language error identified in the taxonomy from Phase I, and (2) quantify the effectiveness of representative intervention strategies to reduce language-related errors.

From the execution plan, the 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. The researcher will provide a report on the activities in Year 2 on time by 31 Jan 2004, but it will not contain the expected data from foreign 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.

d) General Aviation Alaska Maintenance Accidents

The researcher has almost completed the data analysis and is writing the final report. The final draft report is due to AAR-100 February 28th, 2004. After AAR-100's endorsement, the report will be forwarded to the TCRG.

All indications indicate that this project is on track. This project will be completed this fiscal year.

e) Using Technology to Support Inspector Training

Redefined the performance objectives of the training program with input from industry partners. Developed detailed functional and technical specifications. Developed story board for organizing material for inspection training. Developed and evaluated alternate prototypes. Obtained feedback from potential users on various interface prototypes. Selected potential prototypes for implementation. Currently evaluating alternate methods for training. Sought feedback on the material developed from subject matter experts. Conducted repeated visits with subject matter experts to evaluate the developed material. Disseminated research through the following sources:

Jacob, R. and Gramopadhye, A.K. (2004). Customized Computer Based Training to meet GA aircraft inspection needs. Full paper submitted to *IERC (Industrial Engineering Research Conference)*, Houston.

Raina, S. and Gramopadhye, A.K. (2004). Development and evaluation of a CBT to support decision making. Full paper submitted to *IERC (Industrial Engineering Research Conference)*, Houston.

Regunath, S. and Gramopadhye, A.K. (2004). Use of HTA in designing computer based simulator. Full paper submitted to *IERC (Industrial Engineering Research Conference)*, Houston.

Subramanian, R. and Gramopadhye, A.K. (2004). An error taxonomic approach to support inspection training. Full paper submitted to *IERC (Industrial Engineering Research Conference)*, Houston.

All indications indicate that this project is on track.

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

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. As of December 31, 2003, there were twenty-eight airlines that operated ASAPs for pilots, but there were only six ASAP MOUs for aircraft maintenance mechanics. Of the six maintenance ASAPs, most are considered by all stake-holders to be highly effective. Because of the potential benefits to safety, a major interest of the FAA is to determine whether the failure of ASAPs to expand to multiple operators as rapidly for aircraft maintenance as it has for pilots is attributable to FAA's ASAP policy, or to other factors beyond the control of the FAA.

The first year of this project will focus on data collection. It consisted of two steps: (a) focus-group discussions to identify the most important issues concerning maintenance ASAPs and (b) survey questionnaire development.

As of December 31, 2003, focus group discussions have been completed at six partner airlines. Three of these airlines have an active maintenance ASAP agreement and three do not. The FAA representatives from the Certificate Management Offices of airlines with active maintenance ASAP agreements also participated in the discussions. Additionally, the researchers interviewed a noted expert in disciplinary policies in aviation organizations for his perspective on the role of corporate disciplinary policies in relation to voluntary disclosure programs such as ASAP as well as legal interpretation of terms related to reckless or at-risk behaviors. The data from all the interviews were analyzed to develop the Maintenance ASAP Questionnaire (MAQ). A preliminary compilation of best practices that include strategies to elicit support for ASAP programs and strategies to communicate the results of ASAP programs to all concerned parties has been developed and will be included in the full First Year Report; this compilation will be refined as additional data become available during the second year of this project. The First Year Report will be submitted by February 28, 2004.

All indications indicate that this project is on track to complete year 1 milestones as planned.

f) Auditing and Surveillance Maintenance Error Tool

Researchers conducted two visits to FedEx facility in Memphis, TN and scheduled observation sessions at Mobile, AL maintenance site. They conducted interviews with key members in the Quality Assurance and Audits departments. Refer to attachments for trip reports. Researchers used task analysis to identify needs to support surveillance and inspection performance. Analyzed the procedures of the Quality Assurance Department of FedEx and studied the processes of Surveillance, Auditing and Airworthiness Directives groups in detail. Conducted a comprehensive literature review of user-centered design methodologies, aviation maintenance literature. Developed a database of literature. Identified customer statements and translated customer statements to

need statements. Begun outlining the impact variables to be considered for WebSAT. Sought Institutional Review Board approval for conducting interviews and observation sessions.

Researchers are identifying impact variables using the need-metrics matrix. They will conduct a web based impact variables validation survey with other airlines to ascertain the accuracy of the selected impact variables. They will complete an analysis report documenting the results of the web based impact variables validation survey with other airlines. Disseminated research through the following sources:

Dharwada, P., Iyengar, N., Kapoor, K., Gramopadhye, A. K., and. Greenstein, J. S., Web-Based Surveillance And Auditing Tool (WebSAT): A Proactive System To Capture Maintenance Errors, *Proceedings of Safety Across High-Consequence Industries*, St. Louis, Missouri, 2004.

Kapoor, K., Dharwada, P., Iyengar, N., Greenstein, J. S., and Gramopadhye, A. K., Standardized Auditing and Surveillance of the Aircraft Maintenance Operations, *Proceedings of the Industrial Engineering Research Conference*, Houston, 2004.

Iyengar, N., Kapoor, K., Greenstein, J. S., Dharwada, P., and Gramopadhye, A. K., Data Gathering Methodologies to Identify Impact Variables in Aviation Maintenance, *Proceedings of the Industrial Engineering Research Conference*, Houston, 2004.

All indications indicate that this project is on track to complete year 1 milestones as planned.

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

At the 2003 Human Factors and Ergonomics Society meeting, we discussed possible software for FPI image inspection with Dr. Anand Gramopadhye, Clemson University. This led to a copy of the latest ASSIST software being obtained and tested by our team. In fact it was not suitable for the inspection simulation we propose so we have written our own software specifically to allow participants to perform simulated FPI tasks on detailed images of JT-9 fan blades. In December 2003, Dr. C. G. Drury visited AANC at Sandia National Labs in Albuquerque to obtain images of the six faces of each of a set of 63 engine blades. These are now being incorporated into the program. The pre-test of the experiment is currently being designed.

Also at 2003 Human Factors and Ergonomics Society meeting, contacts have been made with noted vigilance researchers, Joel Warm and Raja Parasuraman, where we discussed the latest vigilance literature. From Dr. Warm we obtained some interesting data that the vigilance decrement may be a result of response

complexity factors. We are currently following up this lead based on Dr. Warm's paper in *Human Factors* in November 2003.

We have visited one aviation hangar to meet with a corporate jet fleet team (Rich Products) to familiarize the new graduate students with the relationship between flight operations and maintenance / inspection. This meeting is expected to lead to a visit to a maintenance / inspection base in Florida where this corporate flight department does its maintenance. We are also traveling to Delta Airlines (Jan 13 – 15, 2004) and USAirways (Jan 27-29, 2004) to collect data on hours of work, environmental conditions and strategies to combat fatigue.

Our contacts with CAMI (Thomas Nesthus) for cooperation on vigilance and fatigue measurement and using the Actiwatches have not progressed, but we plan to contact CAMI again in January 2004. The report from Galaxy Scientific on hours of work has been reviewed with the author, William Johnson (now at Lufthansa Technical Training). There was never any data collected on inspectors specifically, so we cannot fruitfully re-analyze that data.

At present we are writing the final report on the 5 months of year 1.

First year deliverables will be as follows: (1) report on comprehensive literature reviews on Vigilance, Inspection, Fatigue and hours of work. Status Green, will be completed by 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 will be completed by Jan 31 2004.

All indications indicate that deliverables one and three are on track while deliverable two will be slightly delayed due to the lack of existing data that was previously assumed to exist.

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