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From: General Aviation Human Factors Program Manager, ATO-P R&D Human Factors
To: General Aviation TCRG

Subj: GENERAL AVIATION HUMAN FACTORS FIRST QUARTER '06 REPORT

Ref: General aviation human factors execution plans (http://www.hf.faa.gov/gafunded.htm)

1) Each project is listed below.

a) Visibility in the Aviation Environment

Significant Milestones: Begun developing further experiments to test models of detection in the PCATD simulator under more realistic flight conditions.

Work in progress:

- continuing to evaluate current detection models for application to the flight environment.
- developed a sample problem sets for our interactive program to instruct pilots on detection and recognition of the altitude direction of motion and distance of targets.
- continuing to develop experiments that will objectively measure performance under simulated flat light conditions.

Best accomplishment. Completion of a sample problem set for an interactive teaching program.

ATO-P R&D HF General Aviation Program Manager requested a six month no cost extension to grant as a result of AFS-800's "Helicopter Pilot Performance: VFR into IMC" pop-up requirement priority. AFS-800 requested researcher to complete the pop-up to meet an urgent need.

b) Migration of HFACS database to a web-based interface

Dr. Hackworth, Cristy Detwiler, and Kali Holcomb met with members of Xyant and the new HFCAS pilot SMEs to review coding reliability. Summary materials outlining disagreements and agreements with existing HFACS codes were developed and supplied. The new pilot SMEs are progressing well. With the assistance from Xyant, the new SMEs have met with a more experienced HFACS pilot SME to discuss discrepancies and to receive additional training regarding HFACS.

The HFACS team conducted several telcons with Dr. Kip Krebs and members of HiTech on the online system. Specifically, we discussed several items that need to be completed before we could commence with the use of the online system. Progress has been made regarding the on-line system. A training test site was created and tested. We are going to begin testing the site and coding online with the pilots and maintenance SMEs in January 06. We have set aside accidents from 2003 that have been previously via paper and pencil to compare with the site's utility and feasibility.

We are working with HiTech on the HFACS production site that will be used by interested parties across the FAA. This site houses all previously coded accidents and allows users to query the database on various human error issues and other variables of interest. At present, CAMI and HiTech are working to make the site available.

At the request of AFS-800, Cristy Detwiler identified all MU-2 accidents that with corresponding HFACS codes. A summary of the human error elements associated with these accidents will be provided in Jan '06.

The HFACS Commercial Tech report "Human Error and Commercial Aviation Accidents: A Comprehensive, Fine-grained Analysis Using HFACS," Shappell SA, Detwiler CA, Holcomb KA, Hackworth CA, Boquet AJ, and Wiegmann DA was approved for publication.

All available information indicates the project is on track On line tool should be operational FY06Q2.

c) Flight Deck Technologies and Procedures, Discriminability Assessment of Proposed Traffic Symbol Set

Significant Milestones:

- Model predictions for the Volpe study were computed using the Matlab symbol discrimination program.
- Model predictions were found to be very good.
- Symbol recognition data collected in the lab at NASA Ames.
- Presented conference paper at the The International Society for Optical Engineering conference.

  Ahumada, A.J., Trujillo San-Martin, M. and Gille, J. (2006). Symbol discriminability models for improved flight displays. SPIE Proceedings Vol. 6057 Paper 30. (available at http://www.hf.faa.gov/docs/508/docs/AhumadaSPIE06.pdf).

Work in Progress:

- Model predictions generated for all pairs of stimuli in the Volpe study having the same color.
- Comparing model predictions with Volpe data and behavioral data collected at NASA Ames.
- NASA Ames behavioral study will replicate Volpe's study (88 in distance) to help refine model.

This effort is cost shared with NASA Ames. All available information indicates the project is on track.

d) FITS - Proficiency Standards for Technically Advanced Aircraft

Researcher met AFS-800 and AFS-600 representatives to discuss the transition of the handbook to an FAA publishable document. FAA representatives were very pleased with the researcher's progress.

Work in Progress: First draft of text is finished and illustrations are being developed. Reviews with TAA pilots will begin in mid- February.

Requirement has been extended. AFS-800 requested the completion of a draft technical reference manual describing the intent, technical approach, and execution of awareness, knowledge, and skill elements for Technically Advanced Aircraft, including illustrative examples with detailed descriptions. Completion date will be September 2006.

e) Unmanned Aircraft Operator Qualification and Training Requirements

Work in Progress: Complete OAM report – Draft final report was completed in September 2005. A partially reviewed report was delivered to ATO-P in January 2006. The report is currently undergoing final review before release as an OAM technical report.

A summary of points from the draft report are as follows:

- The third-class medical certification was judged to be the most acceptable (with the exception that a second class medical might be needed for systems flown by direct visual contact) based on the idea that there were several factors that mitigated the risk of pilot incapacitation relative to manned aircraft. However, legal aspects brought forward by the Office of Aviation Medicine led to a later recommendation for a second-class medical certification.
- The specification of certification requirements for UA pilots should be based on a task analysis of the UA piloting task and a specification of the knowledge, skills, and abilities needed for the task.
- The available research on pilot qualifications show that, while manned-aircraft experience is beneficial for piloting some UA systems (Schreiber et al., 2002), basic stick-and-rudder skills can also be mastered by those without flight experience (Fogel et al., 1973).
- An analysis of the types of applications expected for UA indicated that airspace usage might be neatly divided between applications that use only Class G airspace and those that use other classes.
- Rather than inserting a UAS pilot certification at the level of aircraft classes, as was proposed by the ASTM group, it is recommended that a new certification be created (i.e., at the same level as Private, Commercial, etc.). The reasoning behind this suggestion is that doing so allows the agency more control over specifications of airspace usage, medical certification requirements, and allowed applications. It also clearly separates training for unmanned aircraft from that of manned aircraft.
- Finally, while both training and test standards should be structured similarly to manned aircraft training and testing, they should include areas that are unique to the piloting of unmanned aircraft. Three areas that were identified as unique were data-link issues, detect-sense-and-avoid issues, and control-handoff issues.

The draft final report is being reviewed by AFS-800 and AFS-400 TCRG points of contacts. Sponsors comments will be made available to the researcher by FY06Q2. The goal is to complete the final report by FY06Q4.

f) General Aviation Private Pilot Survey / Initial Certified Flight Instructor – Airplane Survey/ Designated Pilot Examiner Program Assessment

During the first quarter of 2006, over 3,600 GA ASEL surveys and over 840 DPE surveys were distributed. We received approximately 820 GA ASEL surveys resulting in a response rate of 28%. The response rate for the DPE survey was much higher at 61% with over 500 surveys received. We are planning to deliver the DPE survey results in Jan '06 and the GA ASEL results in Feb '06.

The ASEL GA survey distribution will continue past the previously scheduled Jan 31st end date. We will continue collecting data until the end of Sept '06. Dr. Hackworth requested the continued support of the registry to send pilot names and addresses. Xyant Technology will continue to distribute and process surveys received.

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

g) A New Approach to Aviation Accident/Incident Prevention/Mitigation

This is a new start project. On Febraury 2nd, 2005 the GA/VF TCRG identified this requirement as a FY05/FY06 "pop-up" requirement. Project will begin after grant approval.

h) Aviation Safety Inspector Training for Technically Advanced Aircraft

Two groups of ASIs completed TAA training at ERAU during FY '06 Q1. Course feedback surveys were processed by CAMI for the 18803 Technically Advanced Aircraft Prerequisite Study Course and 18830 Qualification for Technically Advanced Aircraft. Reports summarizing course feedback provided by the 11 respondents for the two courses were provided to AFS-500 and AAR-100.

Summary of Prerequisite Course Results
The results indicated that participants believed that the course was both relevant to their ASI job requirements regarding TAA and to the course objectives with 100% selecting agree or strongly agree. Most (91%) of the participants agreed that the lessons were well-organized and logical. In addition, participants believed that they were prepared to identify TAA system failures, and similarly indicated that they were prepared to describe the human factors considerations associated with TAA.

All participants agreed or strongly agreed that they were prepared by this course to explain how basic flight information is displayed on a PFD. Ninety-one percent agreed or strongly agreed that they were prepared to explain the weather features available on MFD, as well as the engine and system display functions. Over half of the respondents agreed that they were prepared to explain the use of both normal and emergency electronic checklists. Seventy-three percent of the participants indicated no prior formal training with TAA; however, 91% indicated prior hands-on experience with TAA.

Summary of Qualifications Course Results
After completing the qualification course, all participants agreed or strongly agreed that the information covered was relevant to their ASI job requirements regarding TAA, the student guide was beneficial during classroom instruction, the classroom exercises were beneficial, the lessons were well-organized and logical, the instructor provided adequate feedback, the training was effective in preparing the participant for TAA surveillance, and the check-ride allowed the participant the opportunity to demonstrate their TAA proficiency.

Following course completion, 91% of the participants agreed or strongly agreed that they were prepared to simulate a failure of each of the major components of TAA and that they understood the human factors considerations associated with TAA. Ninety-one percent of the participants agreed or strongly agreed that they were prepared to perform duties as an ASI regarding TAA.

This is a new start project. On Febraury 2nd, 2005 the GA/VF TCRG identified this requirement as a FY05/FY06 "pop-up" requirement.

i) ASRS Weather Callback

The objective of the project is to investigate the causes of weather related general aviation incidents. The Aviation Safety Reporting System (ASRS) weather incident questionnaire and follows up on actual general aviation weather incidents will investigate hazard themes committed by general aviation pilots.

In FY05, the ASRS began administering questionnaires to pilots who were previously identified as having a weather-related incident. ASRS contractor has not met the expected schedule in delivering the completed questionnaires. As a result, CAMI researchers have not been able to start the analysis.

ATO-P R&D HF General Aviation program manager and CAMI's AAM-510 program manager are working with AFS-800 to clarify project objectives. AFS-800 needs to define specific research questions to address and convey their intentions of how this research will be implemented.

j) How due Pilots Use Weather Ground (internet, FSS dial-up, or other internet services) and/or Aircraft (e.g., data link) Products?

Reports entitled "How general aviation pilots use weather information" and "An analysis of operation voice communications between pilots and automated flight service station specialists who provide preflight weather briefings" were sent to AFS-800 TCRG point of contact for review and comment.

This requirement has been completed

k) Ultra-Fine Grained Analysis of General Aviation Accidents 1990-present

This is a new start project. On Febraury 2nd, 2005 the GA/VF TCRG identified this requirement as a FY05/FY06 "pop-up" requirement. Project will begin after grant approval.

l) Low Visibility and Visual Detection: Design and Development of a Visibility Analysis Tool

The overall objective for this fiscal year is to provide the FAA with two user-friendly software tools that 1) provides quantitative information on the impact of Air Traffic Control Tower (ATCT) height and placement on aircraft visibility (the FAA Vis tool), and 2) provides quantitative information on the available time that a unmanned aerial vehicle (UAV) operator would have to respond to a potential conflict with other manned and unmanned aircraft (the See-And-Avoid tool). The technical approach that ARL Sensors and Electron Devices Directorate (SEDD) will utilize is to team with the U.S. Army's Night Vision and Electronics Sensor Directorate (NVESD) to complete the development and functional testing of the FAA Vis and the See-And-Avoid software tools (developed and enhanced for the FAA by ARL and NVESD in FY04 and FY05), and to calibrate these tools by experimentally determining the field-of-view (FOV) search-time equations, the target (aircraft) *discrimination* difficulty criteria, and *characteristic* target (aircraft) dimensions, through execution of two human perception (HP) experiments/tests. The first HP experiment will be a "time-limited search" experiment designed to yield FOV search time equations as well as aircraft *detection* difficulty criteria (N_{50} for *detection*) and appropriate *characteristic* target (aircraft) dimensions. The general approach will be to collect high-contrast, high-resolution, visible-band digital images of several scale-model aircraft from several perspectives, and high-resolution, visible-band images of real (natural) sky backgrounds, for use in the HP experiment. The HP experiment will measure human response time and *detection* accuracy to displayed images containing variably-*sized* aircraft images synthetically placed into real sky backgrounds at random locations in the FOV. The second experiment will be a classic HP experiment designed to yield both *recognition* and *identification* difficulty criteria (N_{50} for *recognition* and *identification*), and the proper *characteristic* dimensions for *aircraft*. The approach for the second experiment will also utilize high-resolution, visible-band digital images of several scale-model aircraft synthetically placed into either a real (natural) background, e.g., an airport runway scene as viewed from an ATCT, or a homogeneous synthetic background. This second experiment will measure the ability of human observers to *recognize* and *identify* aircraft images synthetically placed into a selected background image with a range of spatial *blurs* applied to the displayed images. The use of scale-model aircraft will significantly reduce both the cost and timelines of these experiments relative to using actual-size aircraft, and should yield more consistent results through better control of experimental conditions. The sets of imagery generated from these experiments will be made available to NASA-Ames researchers for use in an experiment aimed at independently determining task difficulty criteria (N_{50}'s) for *aircraft* using their Standard-Observer-Model-based methodology.

Tasks/Status:

1. Complete the development and functional testing of the enhanced version of FAA Vis and the baseline version of the See-And-Avoid software tools.

   Status: The enhanced desktop version of the FAA Vis tool has been completed and tested. Work on the desktop version of the See-And-Avoid tool is nearing completion. The NVESD SSCAM & NVTherm data import/interface mechanism has now been completed; we are presently in the process of completing and linking together all of the calculation routines. (Expected completion date: Jan '06)

2. Work w/ FAA IT specialists to migrate the current desktop versions of the FAA Vis and the See-And-Avoid software tools to the FAA's Website environment. (This will require negotiations and licensing of the MODTRAN components of these tools with Ontar.)

   Status: The enhanced desktop version of the FAA Vis tool has been migrated to the FAA's Website environment. The desktop version of the See-And-Avoid tool will be migrated to the FAA's Website environment as soon as it has been completed and tested. Negotiations for the licensing of the MODTRAN components of these tools have been initiated. (Expected completion date: Mid-Feb '06)

3. Execute the "time-limited-search" HP experiment for *aircraft* described above.

   Status: Work has no yet started on this task. (Expected completion date: Apr '06)

4. Execute the *recognition* and *identification* HP experiment for *aircraft* described above.

   Status: Work has no yet started on this task. (Expected completion date: Jul '06)

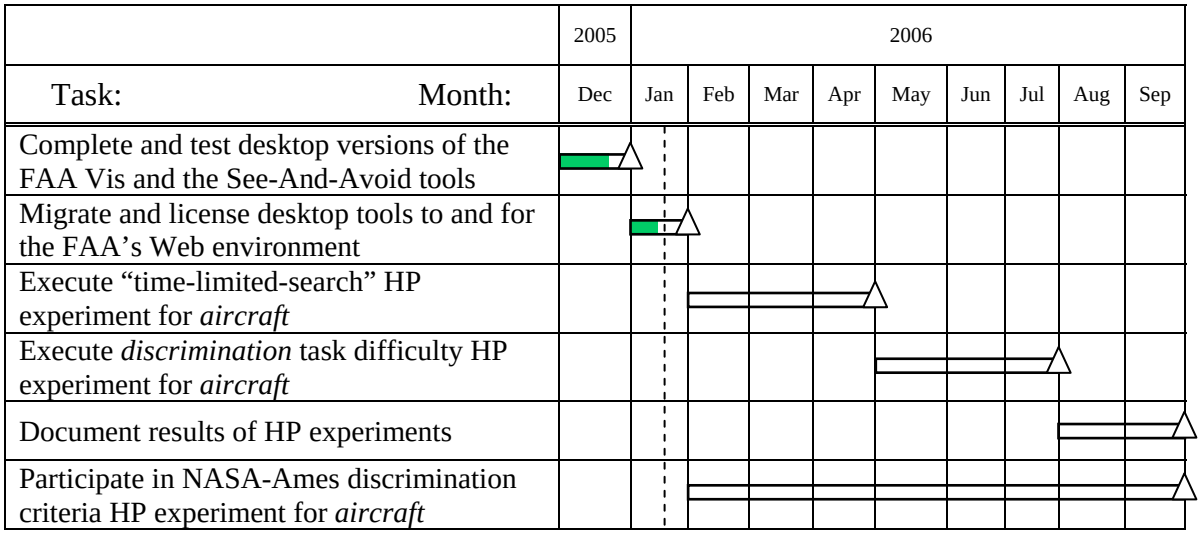
5. Document the results of both HP experiments.

   Status: Work has no yet started on this task. (Expected completion date: Sep '06)

6. Participate with NASA-Ames in the design and execution of a Standard-Observer-based experiment to determine *discrimination* criteria for *aircraft*.

   Status: We have had several conversations with NASA-Ames (Dr. Andrew Watson) regarding their preliminary results from simulating human target *identification* performance using the Spatial Standard Observer (SSO) model on ground vehicle targets, and on plans to perform a similar experiment on *aircraft* target imagery obtained as part of this research. ARL and NVESD researchers plan and look forward to continuing this collaboration with the NASA-Ames and FAA researchers as this research year progresses.

Schedule: Shown below is the schedule for the IAA tasks funded for FY06, along with the estimated progress to date.



This effort is cost shared with Army Research Lab and US Army CECOM NVESD.

m) An Assessment of the Effectiveness of Unmanned Aircraft Control Systems.

The objective of this requirement will be to inventory the current UA control architectures. The inventory will include the type of aircraft being controlled, the types of applications addressed by the aircraft, levels of automation employed under different phases of flight, and a general description of the user control interface.

Summary of findings to date:

- Approximately a dozen separate unmanned aircraft systems were inventoried, representing a wide range of control architectures, sizes, and capabilities.
- A taxonomy of control levels was developed based on human factors research literature on manned aircraft control. These control levels include six levels of horizontal control, five levels of vertical control, and three levels of velocity control. This taxonomy will be used to describe those systems under review and should prove useful for the categorization of any particular UAS on the market.

A draft report will be submitted to the UA TCRG by February 2006.

William K. Krebs, Ph.D.