FEDERAL AVIATION ADMINISTRATION
ATO-P R&D Human Factors (Room 907a)
800 Independence Avenue, S.W.
Washington, D.C. 20591

Tel: 202-267-8758
Fax: 202-267-5797
william.krebs@faa.gov

November 15, 2005

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

Subj: GENERAL AVIATION HUMAN FACTORS FOURTH QUARTER '05 REPORT

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

1) Each project is listed below.

a) Human Error and General Aviation Accidents: A Comprehensive, Fine-Grained Analysis using HFACS

The commercial final report, *Human Error and Commercial Aviation Accidents: A Comprehensive, Fine-grained Analysis using HFACS*, was submitted to AFS-800 to meet the flight plan goal found on page 10 of the AVS Business Plan as part of Flight Plan Performance Target: Airline Fatal Accident Rate; Strategic Initiative: Human Factors; Strategic Activity: Commercial Accidents Analysis.

The Alaska vs. the Rest of US manuscript was submitted to AFS-800 to meet the flight plan goal *Conduct a detailed human factors comparison of general aviation accidents occurring in Alaska with those occurring in the rest of the U.S.* This project can be found on page 11 of the AVS Business Plan as part of Flight Plan Performance Target: GA Fatal Accidents; Strategic Initiative: Human Factors; Strategic Activity: Human Factors Comparisons and Analysis.

Presented below are a list of titles, respective authors, and a summary of what was found.

Human Error Associated with Air Medical Transport Accidents in the United States
Albert Boquet *Embry Riddel Aeronautical University*, Kali Holcomb, Cristy Detwiler, Cristina Bates, Carla Hackworth, *Civil Aerospace Medical University*, Scott Shappell *Clemson University*, Doug Wiegmann *Mayo Clinic*

Helicopter emergency medical services (HEMS) play a vital and growing role in the U.S. healthcare industry. However, since 1998, there has been a troubling increase in the number of accidents associated with this group. Similar to data for other aircraft, the majority of these accidents are human error related. This investigation used the Human Factors Analysis and Classification System to categorize human error in HEMS operations. Like other aviation operations, skill-based errors comprised the majority of the unsafe acts, followed by decision errors, violations and perceptual errors. Also troubling was the number of fatalities associated with weather and night-related accidents, as well as controlled flight into terrain.

Human Error and Commercial Aviation Accidents: A Comprehensive, Fine-Grained Analysis Using HFACS
Scott Shappell, Ph.D. *Clemson University*, Cristy Detwiler, B.A, Kali Holcomb, A.A., Carla Hackworth, Ph.D., Cristina Bates, *Civil Aerospace Medical Institute*, Albert Boquet, Ph.D. *Embry-Riddle Aeronautical University, Daytona Beach,* Douglas Wiegmann, Ph.D., *Mayo Clinic*

The Human Factors Analysis and Classification System (HFACS) is a theoretically based tool for investigating and analyzing human error. The aim of this study was to extend previous examinations of aviation accidents to include specific aircrew, environmental, supervisory, and organizational factors associated with 14 CFR Part 121 (Air Carrier) and 14 CFR Part 135 (Commuter) accidents using HFACS. The majority of causal factors were attributed to the aircrew and the environment with decidedly fewer associated with supervisory and organizational causes. Recommendations were made based on the HFACS findings presented.

A Human Factors Analysis of General Aviation Accidents in Alaska versus the Rest of the United States
Cristy Detwiler, Carla Hackworth, Kali Holcomb, Albert Boquet, Elaine Pfleiderer, Douglas Wiegmann, and Scott Shappell

General aviation (GA) accidents that occurred in Alaska versus the rest of the United States were compared using the Human Factors Analysis and Classification System (HFACS). Overall, categorical differences among unsafe acts (decision errors, skill-based errors, perceptual errors, and violations) committed by pilots involved in accidents in Alaska and those in the rest of the U.S. were minimal. However, a closer inspection of the data revealed notable variations in the specific forms of unsafe acts within the accident record. Specifically, skill-based errors associated with loss of directional control were more likely to occur in Alaska than the rest of the U.S. Likewise, the decision to utilize unsuitable terrain was more likely to occur in Alaska. Additionally, accidents in Alaska were associated with violations concerning VFR into IMC. These data provide valuable information for those government and civilian programs tasked with improving GA safety in Alaska and the rest of the US.

Requirement is complete.

b) Visibility in the Aviation Environment

A significant milestone was achieved this quarter. The researcher submitted a vision chapter for AFS-800's Flight Plan initiative "Pre-Flight Weather Handbook" aimed at reducing weather related GA accidents.

We are developing sample problem sets for our interactive program to instruct pilots on detection and recognition of the altitude direction of motion and distance of targets. We have completed the preliminary detection experiments designed to evaluate the utility of synchronous and asynchronous strobe lights as aids to detection. The results indicate that there is very little advantage of asynchromous strobes over synchronous strobes for detection. However the presence of strobe lights (either synchronous or asynchromous) greatly increases detection of targets on masking backgrounds. We have also been exploring further previous reports of exaggerated motion detection under certain strict stimulus conditions. We are continuing to develop experiments that will objectively measure performance under simulated flat light conditions.

All available information indicates the project is on track.

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

Dr. Hackworth and the HFACS team are working to get the on-line version of HFACS ready for use by the pilot and maintenance SMEs. Dr. Hackworth has been working with Dr. Kip Krebs to complete the needed updates to the HFACs on-line tool. There are several tasks that remain to be completed regarding the site. The HFACS team is compiling a list with need dates of delivery for Dr. Krebs.

All available information indicates the project is on track.

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

Significant Milestones achieved this quarter include:

- Matlab symbol discrimination program allowing for size and position compensation is now available on the web at http://vision.arc.nasa.gov/personnel/al/code/index.htm
- The program takes as input the luminance values for the pixels of two symbol images and the effective viewing distance. It gives as output the discriminability between the two images in just-noticeable-differences (d'), the size reduction of the larger symbol and the horizontal and vertical image offsets in pixels needed to minimize the discriminability.
- Approval obtained from Human Subjects Committee to collect data.
- Experimental control program completed.

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

e) FITS - Proficiency Standards for Technically Advanced Aircraft

Researcher incorporated AFS-800 comments to the first draft. The researcher has completed two new sections with the anticipated first complete draft to be delivered by April 2006.

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.

f) FITS - Enhanced Decision Making (EDM)

This project has temporarily stopped. NASA Ames Research Center matching funds has been withdrawn from this project.

g) Unmanned Aircraft Operator Qualification and Training Requirements

In July, development of the paper to support the specification of UA pilot medical and certification requirements continued. A meeting was held at CAMI regarding the medical and certification requirements of UA pilots. There were eleven attendees at the meeting, representing government, industry, military, and academia. There were representatives from several groups developing guidance for UA. These groups included NASA Access 5, ASTM F38, SAE-G10, and RTCA SC-203. A paper summarizing the minutes of the meeting was released in August. One outcome from the meeting was the development of research requirements for UA human factors research. These requirements included the development of practical test standards for UA pilots and research into control interface architectures for UA.

In August, development of the paper to support the specification of UA pilot medical and certification requirements continued. A summary of the July meeting at CAMI regarding the medical and certification requirements of UA pilots was created and sent out for comment. Several of the attendees responded with additional information and their comments were incorporated into the paper and distributed. A meeting of the SAE-G10 was attended in August. The meeting was held in Washington, DC. A review of the CAMI meeting was presented at the meeting. In addition, a preliminary task analysis of the UA pilot task was completed at the meeting. This work will also be summarized in the technical report. In addition a program review of NASA Access 5 activities was held in Washington, DC. Each of the Access 5 working groups presented a summary of work accomplished during the past year and individual working group meetings were held to discuss where to focus research efforts for the next year.

In September, development of the paper to support the specification of UA pilot medical and certification requirements was completed. The paper, entitled "Unmanned Aircraft Pilot Medical and Certification Requirements", included a summary of the July meeting at CAMI regarding the medical and certification requirements of UA pilots in addition to a summary of several other efforts undertaken during the course of the year in regard to the establishment of those requirements. In addition, initial work was begun on the development of an inventory of UAS pilot control interfaces. Contact by email and/or phone of several companies developing these interfaces produced no responses. Personal contacts were established at a meeting of the NASA Access 5 group. Personal visits of companies developing the interfaces are planned.

The final report will be due to AVR on December 31st, 2005

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

Dr. Hackworth received IRB approval for the DPE task. AFS-800 has taken the action item to get the Registry to provide CAMI with pilot names and addresses. We plan to commence distributing surveys this quarter.

Dr. Hackworth responded to David Karalunas (Alaskan Safety officer) regarding the GA/DPE survey project. He is charged with auditing the DPE/CFI program in Alaska. Dr. Hackworth provided him a copy of the existing requirement, DPE survey, and GA survey. Dr. Krebs advised that this request could be addressed with the existing execution plan. Mr. Karalunas is presenting the surveys to his committee for their approval.

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

i) <u>A New Approach to Aviation Accident/Incident Prevention/Mitigation</u>

The HFIX interim report, *Developing a Methodology for Assessing Safety Programs targeting Human Error in Aviation*, was submitted to AFS-800 and ATO-P R&D.

All available information indicates that this project is on track.

j) <u>Aviation Safety Inspector Training for Technically Advanced Aircraft</u>

Dr. Hackworth worked with Xyant to have the end-of course evaluations teleformed for the ASI TAA prerequisite course and ASI TAA evaluation course. Members of AFS-800, ATO-P, and AFS-500 reviewed the surveys. Copies of each survey were mailed to ERAU for the October course. Dr. Hackworth is scheduled to attend a portion of the October course. Dr. Hackworth received IRB approval for the TAA task.

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

k) <u>ASRS Weather Callback</u>

ASRS began administering questionnaires to pilots previously identified as having weather-related incident. So far, 53 of the planned 100 responses have been collected.

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

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

CAMI researcher failed to meet FY05Q4 milestones and a major milestone to support AFS-800's FAA Flight Plan task. CAMI personnel plan to submit an interim report in FY06Q1 with the final report yet to be determined.

m) <u>Ultra-Fine Grained Analysis of General Aviation Accidents 1990-present</u>

ATO-P R&D requested proposal from grantee.

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

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

The overall objectives for this fiscal year are to: 1) Enhance and validate the Air Traffic Control Tower (ATC) visibility analysis tool (FAA Vis) that was developed for the FAA by ARL in FY04 and, 2) Provide the FAA with a See-and-Avoid analysis tool that provides quantitative information on the available time that a UAV operator would have to respond to a potential conflict with other manned and unmanned aircraft. The technical approach that ARL SEDD will utilize to accomplish the first objective is to team with the U.S. Army's Night Vision and Electronics Sensor Directorate (NVESD) to update the working desktop version of FAA Vis to include: charting routines, new graphical user interface (GUI) elements, the ability to reliably handle a wide range of observation luminance levels, more accurate slant-path calculations, and the ability to account for the effects of atmospheric attenuation by incorporating MODTRAN into FAA Vis. The technical approach that ARL SEDD will utilize to accomplish the second objective is to (again) team with NVESD to develop an interface between NVESD's Solid-State Camera (SSCAM) and Night Vision Thermal Imaging Systems (NVTherm) performance models, and the FAA's See-and-Avoid Detection and Recognition Visibility Analysis tool. The NVESD models will be used to generate all camera- and display-related performance parameters, while the FAA See-and Avoid tool will account for all atmospheric- and target-related performance effects. The FAA See-and-Avoid tool will combine all of the performance parameters to generate overall results. The majority of the algorithms and routines used in the See-and-Avoid tool will be identical to those used in the enhanced version of the ATC analysis tool FAA Vis. Overall validation of the subject analysis tools will require establishment of the proper detection and recognition discrimination criteria. Toward this end, ARL will team with NVESD and participate in a NASA-led *aircraft*-human perception experiment/study.

Tasks/Status:

1. Validate the Probability of Discrimination vs. Range predictions of the visibility analysis tool(s) through participation in a NASA-led *aircraft*-human perception experiment/study.

   Status: In early February, NVESD received a request from Andrew Watson (NASA – Ames) for a target set (complete w/ experimentally-determined N50's) for use in their *aircraft*-human perception experiment/study. Since the initial request, NVESD has delivered a *ground vehicle* target set to NASA-Ames, and Dr. Watson et al have proceeded to analyze the imagery using one of their standard observer model metrics. Recent results show a *feasibility* of simulating human target *identification* performance using the *image-based* Spatial Standard Observer (SSO) model for both visible and infrared imagery. Performance of this model is controlled by a single "neural noise" parameter which, at this point, is not known a priori; additional work to develop a process to estimate the value of this parameter is thus required. Another challenge (discussed at a site meeting @ NASA-Ames in June), is the formulation of an appropriate approach to effectively apply *image-based* observer model metric(s) to intra-image, *object-based* discrimination. Future research in this area should also include attempts to simulate human target *detection* and *recognition* performance on existing (*ground-vehicle*-based) human perception experiment imagery, and on *aircraft* human perception experiment imagery (when available). ARL and NVESD researchers look forward to continuing this collaboration with the NASA-Ames and FAA researchers in the coming year.

2. Update ARL's working desktop version of FAA Vis by adding charting routines and new GUI elements.

   Status: Work on this task is complete.

3. Enhance FAA Vis to reliably handle a wide range of observation luminance level inputs and implement more accurate slant-path calculations.

   Status: Work on this task is complete. In addition to enhancing FAA Vis to more reliably handle a wide range of observation luminance levels and to allow for slant-path calculations between arbitrarily-defined target and observation heights, we have added a feature that accounts for the reduced target-to-background contrast that arises from various (user selectable) levels of atmospheric scattering (path radiance).

4. Modify FAA Vis to account for the effects of atmospheric attenuation by first, incorporating Moderate Resolution Transmittance (MODTRAN) code into FAA Vis, and second, by incorporating MODTRAN-generated attenuation data into FAA Vis calculations.

   Status: Work on this task is essentially complete. NVESD has developed the Atmospheric Attenuation GUI and incorporated the new ONTAR Corp. NVESD-model-to-MODTRAN interface that allows for the arbitrary target-to-observer slant-path calculations required for the See-And-Avoid analysis tool. The MODTRAN functionality is now resident in FAA Vis; we are presently in the process of correcting a range resolution limitation in the ONTAR Corp. NVESD-model-to-MODTRAN interface for low-visibility (short range) weather conditions. (Expected completion date: December '05)

5. Develop an interface/mechanism to import relevant camera- and display-related performance parameters from NVESD's SSCAM and NVTherm performance models into the FAA's See-and-Avoid Detection and Recognition Visibility Analysis tool.

   Status: Work on this task is complete.

6. Incorporate the camera- and display-related performance parameters into the See-and-Avoid tool performance calculations.

   Status: Work on this task was started last quarter, but is not yet complete. (Expected completion date: Dec '05)

7. Develop GUI elements and calculation routines into the See-and-Avoid tool for additional scenario inputs and outputs.

   Status: Work on this task is essentially complete. All GUI elements have been developed; the calculation routines will be completed in parallel with task 6 (above). (Expected completion date: Dec '05)

8. Integrate all improvements into the Web version of FAA Vis, as available. This task will require time and resources from both ARL and from an FAA-designated information technology (IT) organization (e.g. CSSI, Inc.).

Status: Work has no yet started on this task. (Expected completion date: Dec '05)

Schedule: Shown below is the original schedule for the tasks funded for FY05, along with the estimated progress to date. Note that while we are somewhat behind original estimates at this point, we anticipate completion of FY05 tasks in December.

	2004	2005								
Task: Month:	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Participate in NASA-led *aircraft*-human perception experiment/study										
Update working version of FAA Vis										
Incorporate enhancements into FAA Vis										
Incorporate atmospheric attenuation into FAA Vis										
Develop NVESD SSCAM & NVTherm interface for See-and-Avoid tool										
Incorporate NVESD SSCAM & NVTherm output into the See-and-Avoid tool calculations										
Develop GUI & routines for See-and-Avoid tool										
Integrate all improvements into the Web version of FAA Vis										

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

William K. Krebs, Ph.D.