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April 15th, 2003

From: Vertical Flight Human Factors Program Manager, AAR-100
To: Vertical Flight TCRG

Subj: VERTICAL FLIGHT HUMAN FACTORS SECOND QUARTER '03 REPORT

1) Second quarter report for each project is listed below.

a) NVG lighting requirement. The researchers have completed review of alternative visual acuity chart irradiance sources. Data collection is approximately 50% complete for methodology determining acceptability of darkness level of NVIS lighting evaluation facility. Data collection is approximately 80% complete for verifying alternative visual acuity chart. Data collection for pilot study of objective NVIS compatibility assessment is complete. So far, alterative charts and irradiance sources have been used in a field evaluation of NVIS lighting compatibility of an F-15 aircraft at St. Louis with positive results supporting validity of methodology.

The researchers are currently working on the following:

- Completing final report section on alternative irradiance sources
- Writing final report section on verifying darkness sufficiency
- Completing data analysis and final report section on visual acuity assessment methodology
- Send Ann Godfrey, ASW, "visual acuity assessment kit" including the illuminator, an illuminance meter, charts, and draft appendix sections that relate to the visual acuity procedure.

Indications are the activity has been delayed because of radiometric measurement equipment breakdown (needed to verify final NVIS radiance interference levels) delaying final report until June 2003.

b) NVG resolution requirement. The researcher completed literature review to interpret NVG tube MTF's in visual units. Researcher is adapting Ahumada's luminance model Matlab code to the NVG model. The NVG model will incorporate models of camera and display nonlinearity and tube MTFs. The researcher is working on the best method for making the code last (due to Matlab version changes) and designing the interface for new capabilities. The plan is to complete all or most of this work in the next quarter. Next quarter, review the

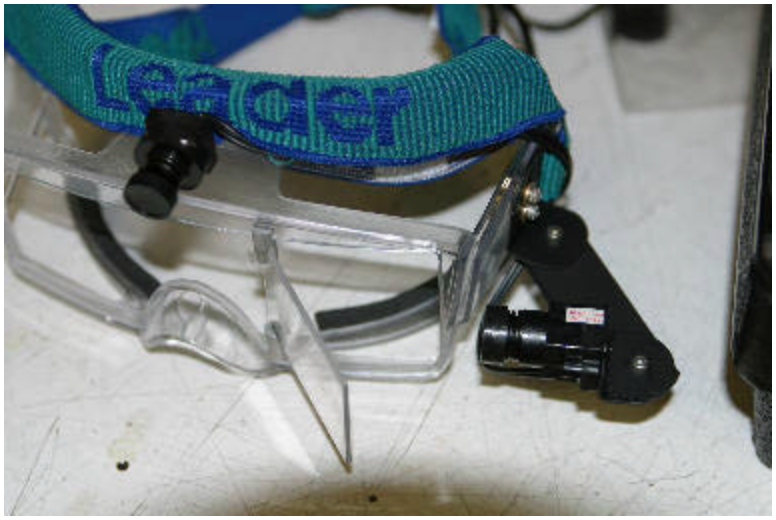
literature on noise characterization of NVG tubes and incorporation of noise models in the software (Poisson noise and otherwise) that reflect models of NVG tube image rendering.

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

c) Simultaneous Non-interfering Operations - Quantify VFR Navigation Performance.

Naval Postgraduate School: Researchers have restructured simulation software to make it easier to swap helicopter dynamics models and terrains. We felt this was important because there is still some uncertainty about aircraft and venue. This will put us in a safe zone for the simulator. We also have the basic helo simulator hardware plan finalized and partly built. It's much smaller than what we have now. Should be an advantage for when we insert into the CAVE for display.

NASA Ames: The picture below shows the prototype headset, built on a racquetball eye shield. There are two cameras, a small forward-looking color camera (mounted center-top), and a slightly larger monochrome eye camera (seen in the right of the image, slightly difficult to distinguish from the black mounting strut). The eye camera views the subject's eye through the "hot mirror," the clear rectangle protruding from the goggles at approximately 45 degrees. (In this picture, a piece of acrylic plastic is taking the place of the hot mirror, which will be cut from glass stock when the dimensions are finalized.) The configuration shown has the hot mirror entirely forward of the front of the goggle, to accomodate a subject wearing eyeglasses; the "hinges" which are used to attach the mirror to the goggle frame may be slid side-to-side, to allow the mirror to be positioned closer to the subject's eye if clearance for eyeglasses does not have to be maintained.



The researcher is currently working on the following:

- Complete fabrication of eye illuminator mount

- Cutting/shaping/finishing of hot mirror
- Add mounting for monochrome scene camera/scene illuminators for night recordings?

This image below shows the major components of the electronics package, on the workbench of our division's electronics shop.

Three components may be seen at the left, sitting on the suitcase foam: the nearest box is the "quad processor," which combines signals from four cameras into a single video signal. Behind the quad processor are two time code units: the time code generator connects to a GPS receiver, and outputs linear time code (LTC) which may be recorded on an audio track; the second unit is a translator which takes LTC and embeds the information in the unused portion of the video signal, called vertical-interval time code (VITC). (Use of VITC instead of LTC allows both audio channels to be used for audio recording.) To the right of the suitcase on the workbench is the 8mm digital VCR, which will be used to record audio, video, timecode and GPS data. Not pictured is a miniature display monitor which will be used for making adjustments to the headset, and verification of correct operation. The foam will be removed from the suitcase, and the components will be rigidly mounted to the sides of the case. Holes will be cut to permit observation of the monitor and operation of the VCR without opening the case. The case will additionally contain a small amount of circuitry for power supply regulation.

The portable power supply, which is a unit sold as an automobile jump-starter. The unit is approximately half the volume and weight of a typical car battery. On the sides may be seen the jumper cables and clips, which are clamped on pegs underneath the black plastic covers. These seem reasonably secure, but care must be taken when the unit is secured in the aircraft that the cables cannot be jostled loose from the secured positions: accidental contact of

battery voltage with the aircraft frame could pose a safety/fire hazard. If it is deemed that this poses a significant risk, it may be necessary to remove the cables.

When fully charged, a voltage of approximately 13.5 volts is produced (significantly above the nominal 12 volts), while the voltage drops as low as 9 volts when the battery is completely discharged. It will therefore be necessary to add some additional regulation circuitry. Typical voltage regulation circuits assume that the input voltage is either well above or well below the desired output voltage. Because both situations may occur during normal operation, we are designing a switching regulator with simultaneous step-up and step-down capability. Some experimentation will be required to determine whether or not this can be accomplished using a pair of off-the-shelf monolithic switching regulator circuits having unsynchronized oscillators. (The desired regulator would have a single oscillator controlling both the step-up and step-down switches, but this circuit is not available as a monolithic integrated circuit, and would have to be constructed using discrete components.)

Remaining tasks:

- Design and construction of regulation circuitry

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

d) Rotocraft Precision Visual Flight Rules Simultaneous Non-Interfering Human Factors Project. Mr. Hickok, STI Manager/PVFR Project Supervisor, and Mr. McConkey, STI Engineer/PVFR Program Manager, prepared for and participated in the PVFR meeting on February 28, 2003, in regards to continued efforts for final coordination of the Draft Flight Test Plan. Discussions, tasks, and action plans were reported in separate minutes. Action items remain as deliverables for a telecom scheduled for April 3rd, 2003, however the critical item of site and aircraft were resolved: the test site was finalized for the University of Tennessee Space Institute (UTSI) in Tullahoma, Tennessee, and the test aircraft finalized to be one of the two UTSI OH-58A helicopters.

During the week of March 24th Mr. Hickok traveled to Tullahoma, Tennessee, for coordination meetings with Dr. Ralph Kimberlan, Department Head, UTSI's Aviation Systems & Flight Research Center. Mr. Hickok also met with Mr. Mike Leigh, Research Specialist, who will be completing the aircraft installations of a TSO C-129 A-1 GPS receiver, and data collection system. Final coordination was completed with Dr. Kimberlan for contracting of UTSI by STI, and Mr. Hickok reviewed GPS receiver location selection, and primary location for the Ashtech TSPI aircraft antenna on the aircraft. Other avionics/test aircraft issues were also

resolved. Mr. Hickok toured UTSI's facility for available space to be used by the PVFR test-team, and initiated coordination's for logistics such as housing in the city of Tullahoma. Of critical importance, Mr. Hickok developed preliminary test routes for the test, and flew the preliminary routes in UTSI's test aircraft. The flights were archived, and are currently being used to finalize proposed routes for discussions by the PVFR team during the April 3rd meeting.

During this quarter STI has continued to coordinate with Navy Postgraduate School (NPS) and NASA AMES to support the simulation requirements and head-and-eye tracker development. During the Tullahoma trip, Mr. Hickok took digital photos of certain features in the preliminary routes and of the test aircraft cockpit/layout necessary for NPS development of both the cockpit and route simulation efforts. Mr. Hickok also took digital photos to be used by NASA AMES in determining installation options for cameras and other related components of the head-and-eye tracker.

STI completed and submitted to FAA a Draft PVFR/SNI Flight Test Plan during this quarter. The Draft Flight Test Plan was the primary discussion topic during the February meeting. There does not appear to be any insurmountable problems that will delay the submission of a final Draft Flight Test Plan for coordination and acceptance within the time period scheduled (to be finalized by June 30th, 2003).

There is a new item for coordination, which Mr. Hickok identified with Dr. Kimberlan during the recent Tullahoma trip that involves data collection parameters that will have to be resolved by the FAA PVFR team. According to STI's original draft test plan, Table 1, Airborne Digital Data Parameters, STI had listed that barometric altitude would be collected as derived by the aircraft systems and recorded at +/- 1 foot. During a review with Dr. Kimberlan of the data collections system and requirements it became apparent that recording Barometric altitude to this accuracy is not possible by any means and the parameter will have to be removed from the test plan. Using a direct recording method from the barometric altimeter will only provide Mode-C accuracy (+/- 100 feet). Mr. Hickok explored the use of a Pressure Transducer, which UTSI could manufacture for the test and has used for other tests, however, the altitude error of a 0-15 psia pressure transducer has a stated accuracy of +/- 0.1 % over the 0-15 psia range. Mr. Hickok, Mr. Kimberlan, and Mr. Leigh worked out the total accuracy using this highly accurate transducer, and found that the pressure transducer solution will only provide altitude accuracy of +/- 20 feet. Discussions with FAA PVFR team will be initiated at the April meeting.

Status of Specific Tasks for Phase One (the current Phase of the project):

- *Task 3.1.1 through 3.1.2 (Flight Test Plan):* On schedule
- *Task 3.1.3 (Site Selection/Test Routes):* UTSI in Tullahoma, Tennessee has been selected as the test site. Preliminary test routes have been developed,

and flown. Data collected during the recent Tullahoma trip and flights are currently being used to finalize proposed test routes. This task is on schedule/complete for Site Selection, and approximately 1 week behind schedule for final route development.

- *Task 3.1.5 (Data Collection/System Evaluations):* Mr. McConkey, STI's Program Manager/Engineer, is continuing his work on this task. In addition, Mr. Hickok initiated coordination efforts with UTSI's Research Specialist, and Mr. McConkey is coordinating with UTSI, FAATC, and Ashtech on this task. This task is on schedule.
- *Task 3.1.6 (Test Aircraft/Subject Pilots/Equipment):* The test aircraft has been selected and evaluated during the recent Tullahoma trip (complete). STI is awaiting FAA action item from the 28 February 2003 meeting in regards to the minimum number/percentage of VFR-Only subject pilots prior to initiating subject pilot efforts. Test equipment has been finalized, and UTSI has already received the TSO-C129 receiver for installation (complete). There are no anticipated delays in meeting the 31 May, 2003, scheduled complete time for the remaining test equipment and subject pilot selections.
- *Task 3.1.9 (Coordination with NPS and NASA):* There are no delays anticipated and coordination efforts are ongoing.

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

William K. Krebs