



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

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

November 10, 2004

From: General Aviation Human Factors Program Manager, AAR-100

To: General Aviation Human Factors TCRG, (POC: Bill Kaliardos, AIR-130)

Subj: Flight Deck Technologies and Procedures, Discriminability Assessment of  
Proposed Traffic Symbol Set

Ref: (a) GA/VF TCRG 09/02/04 meeting minutes

1. Requirement Background: Recent technological advances (e.g., ADS-B, TIS-B) afford the capacity to display traffic in the cockpit. More information is now available on traffic than in previous systems (e.g., TCAS), some of which could be coded in the traffic symbols on the display (e.g., by varying shape and color of the symbols). There is no consensus among manufacturers for the traffic display symbol set, prompting FAA Certification to propose an acceptable set in an appendix to their draft Advisory Circular, "Aircraft Surveillance Systems and Applications." Given that manufacturers may choose to implement the proposed symbol set, it is important that the proposed symbols be at least minimally evaluated for human factors considerations.

The Federal Aviation Administration draft Advisory Circular (AC) (to be released in FY05), "Aircraft Surveillance Systems and Applications" identified a limited number of airborne and airport surface traffic symbols for a low-end traffic cockpit display. The AC specified the minimum symbol size to achieve satisfactory discriminability. Additional studies need to be conducted to evaluate other airborne and airport surface traffic symbols and how these symbols affect pilot discriminability on various types of traffic cockpit displays. Ideally, the Federal Aviation Administration needs a simple method to evaluate whether an applicant's proposed text and symbols on a given display. The applicant would retrieve a library of airborne and airport surface traffic symbols from the Federal Aviation Administration then run a vision discriminability model to assess a display's performance for those symbols. The output of the model would indicate whether the symbol has enough discriminability to be accepted by the Federal Aviation Administration certification.

2. Project's Objective: Can the luminance image discrimination model be modified to include color and extended to a multiple image classification model be used to predict text or symbol discriminability? The model input parameters will include: (1) CIE

Yxy images of the actual images computed from display characteristics (number of pixels, CIE values, gamma, spatial size, etc), and (2) 'ideal' text or symbols (obtained from a look-up-table of accepted AVR symbols). The model will be tested on text and symbol data and if successful it will allow the user to predict users' text or symbol discriminability for a given display using accepted AVR text and symbols.

3. Technical Approach: The study's approach will the study will be divided into two phases: (1) create symbol library and (2) develop discriminability model to predict observers' ability to detect symbols on a given display.

*Symbol Library* task will primarily consist of psychophysical experiments and image processing. The Federal Aviation Administration will submit a proposed list of symbols to NASA Ames for evaluation. NASA Ames will characterize each symbol's CIE Yxy value of the actual images computed from display characteristics (number of pixels, CIE values, gamma, spatial size, etc). For each symbol in the library, CIE Yxy minimum and maximum values will be specified as well as the minimum spatial dimensions.

*Discriminability model* task will modify Ahumada's luminance model (Ahumada, 1996) to include color and extended to a multiple image classification model be used to predict text or symbol discriminability. The web based model will allow applicants to evaluate a given monitor's performance. The applicant will run the model by selecting symbols from the Symbol Library then entering the monitor's performance characteristics. The model output will state whether a selected symbol will be discriminated for that display. If the symbol is outside the desired performance, the model will recommend changes to increase symbol discriminability.

4. Deliverables and Delivery Schedule:
  - i. Library of CDTI symbols to be used as the standard set of symbols to assess displays (June 2005)
  - ii. Web application color vision model to predict users' text readability and symbol discriminability for a given display using accepted AVR text and symbols (December '05)
  - iii. Quarterly (December, March, June, September) research progress status reports: Informal e-mail reports from the program manager aviation maintenance human factors to General Aviation Human Factors TCRG.
  - iv. Annual five page report
  - v. Program Review: Grantee will participate in the annual program review.
5. AIR-130 Responsibility
  - Make available personnel and resources to investigator