Displays

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Lecture 7
Overview

• Taxonomy of displays
• Classic display issues
• Design and evaluation of flight deck displays
  – EFB discussion
• Display examples from different domains
• EVS/HUD video
Basic Taxonomy

• Displays can be visual, auditory, haptic etc.
  – Any way to transmit information
  – Focus on visual displays for this lecture

• Static displays
  – Symbols (e.g., road signs)
  – Good for spatial information (e.g., paper maps)

• Dynamic displays
  – Present temporal information such as current status, trends, predictions
Some Classic Display Issues

• Inside-out vs. Outside-in
• Display arrangement
• Moving pointer vs. moving scale display
• Information integration on glass displays
Moving Aircraft
Exocentric moving aircraft outside-in

Moving Outside World
Egocentric moving horizon inside-out

Image by MIT OpenCourseWare.
Display Design

Slides covering the following topics have been removed due to copyright restrictions:
• Early Display Design: Enabling T Scan
• Primary Flight Displays
• Visual Displays: Old vs. New
• Integral Boeing Displays
The Rise of Glass Cockpits

Image by MIT OpenCourseWare.
Boeing 787 Flight Deck

Image courtesy of Jetstar Airways on Flickr.
Display Taxonomy Continued

• Round-dial vs. glass displays
  – A.k.a. electro-mechanical vs. electronic
  – Round-dials are often separated while glass displays are typically integrated

• Analog vs. digital
  – e.g., car speedometers show either a needle & dial or numbers

• Shared displays
  – Glass displays with multiple functions that are either overlaid (e.g., traffic & weather) or switched between (display modes)
Visual Display Design Considerations

- Display size
- Density
- Screen Resolution
- Clutter
- Color
- Luminance
- Brightness
- Font Size
- Field of View
- Highlighting
- Grouping
- Vibrations
- Dark adaptation
- Analog vs. Digital
- Dual Coding
- Graphical vs. Textual representation of data
General Display Implementation Issues

• Design
  – Display size
  – Presentation of information
  – Interaction
  – Location relative to operator

• Evaluation
  – By regulators, users, purchasers...

• Standardization
Electronic Flight Bag

- Combination of hardware and software
  - Some general purpose devices (iPad), some aviation-specific (Astronautics)
  - Portable or installed or mounted in flight deck
- Report on EFB human factors considerations (2003) used by FAA and other authorities to evaluate EFBs
Display Design and Evaluation

• General issues
  – Legibility of fonts and labels, training, ease of use, “intuitiveness”
• Hardware
  – Screen size
  – Physical controls and interaction
  – Screen technology (e.g., CRT, LCD, HUD)
    • Resolution, refresh rate, viewing angle, brightness (daylight readability)
    • Input devices, e.g., touch screen, cursor control device
• Software
  – Software controls (e.g., buttons, icons)
  – Color
  – Multi-tasking and interaction
    • Data entry, configuration
  – Information time lag (e.g., traffic)
• Design standards
  – RTCA DO-160 Environmental Testing
  – RTCA DO 178-B software assurance
Examples

• Aeronautical chart samples
• Flight deck traffic displays
• Boeing 787 flight deck slides
• Air Traffic Control Displays
• Weather Displays
• Automobiles
• Locomotives
• Enhanced Vision Systems and Head-up Displays
Traffic Alert and Collision Avoidance System (TCAS) Traffic Display

Standard TCAS symbology

- TCAS traffic display shows
  - Traffic Alerts (TAs)
  - Resolution Advisories (RAs)
  - Proximate traffic as either or
  - Relative altitude and climb/descent information
Newer Traffic Displays

- New symbols can present more information e.g., data quality, directionality
- How much information can be encoded visually in a traffic symbol without confusing the pilot?

Image of Garmin G1000 CDTI Display removed due to copyright restrictions.
Air Traffic Control

• Issues include
  – Information integration, time lag, ambient lighting
Integrated Terminal Weather System

• Issues include
  – Information integration, both spatial and temporal

Image of ITWS interface removed due to copyright restrictions.
Locomotive Displays

• Beginning to convert to glass displays
  – Standardization
  – Display arrangement
  – Information integration
Human Factors in Display Advertisements…

- Garmin multi-function displays for general aviation