Attentional Models of Multitask Pilot Performance Using Advanced Display Technology

Presentation by George Sewell

New Features in Aircraft

- Cockpit Display of Traffic Information (CDTI)
  - To enhance a pilot’s awareness of nearby traffic and give visual representation of what they are avoiding
- Digital Air Traffic Control Communication (ATC)
  - To support the audio communication with a digital line of text

Goals

- Determine the ramifications on the pilot and his limited visual attentional resources by adding more visual information to replace audio
- Determine the role, or priority, of audio/visual information to the pilot based on their divided attention
- Develop a method to increase the efficiency of a pilot’s selective attention through optimal visual scanning

Tasks of Importance

- Aviating
  - Maintain stability and keep the aircraft flying
- Navigating
  - Processing visual information to avoid obstacles and achieve a destination
- Side Tasks
  - Reading checklists etc.
  - Listening to the ATC
Attentional Effects

- Instrument Panel (IP)
  - Aviating
- Outside World (OW)
  - Navigating
- CDTI
  - Navigating (Obstacle Avoidance)
- Data Link Display
  - Communication (redundant to ATC audio)

Part 1: Experimental Simulation

Methods

- Participants
  - 12 men, 2 women, ages 21 to 60
  - 200 to 3700 hours of flight experience
- Equipment
  - Flight Simulator
  - Data Displays (with CDTI)
  - Head-Mounted eye and head tracker

Methods (cont’d)

- Task
  - 6 flights, 30 minutes each, 11 legs
  - Communication Legs (6/11)
    - ATC commands given visually/audially/both and pilots need to speak them back
  - Traffic Legs (5/11)
    - Pilots encounter 1 to 4 unpredictable obstacle aircraft and need to act accordingly

Methods (cont’d 2)

- Procedure
  - Pilots were allowed to do all tasks at once, with break, or over 2 days
  - Pilots given a test-flight to familiarize themselves with controls and situation
- Experimental Design
  - Study display format and traffic load during traffic legs
  - Study display format and communication load during communications legs
Example Route

Traffic Leg Results

- Without CDTI, the safest correction was chosen 50% of the time
- With CDTI, the safest correction was chosen 83% of the time

Visual Scanning Analysis

Results of Communication Leg
Discussion of Part 1

- Viewing the CDTI obscured the horizon, increasing navigational variance
- Redundant Display information (A & V) did not provide an advantage to the pilot
- Increasing availability of information did not yield positive results, however with sufficient training it may be possible

Part 2: Computational Model of Attention Allocation

- Goal: To develop a “gold standard” toward which training can be focused to improve accuracy of visual scanning
  - Salience (S): Chance that events might gain attention
  - Effort (E): Requirement for redirecting attention from one location to another
  - Expectancy (E): Probability that a given location will provide useful information
  - Value (V): The benefit of the information to be gathered with respect to task
Basic Graphical Overview (Communications)

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<th>OW</th>
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<th>Com Clip</th>
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Note: Com DL = direct communications, Com clip = clipboard communications

Conclusions

- Part 1 suggests that visual in-cockpit technology should be adopted with caution for single-pilot operations
  - Training should be used to mitigate any detrimental effects due to increased information
- Part 2 suggests that an optimal scanning solution could be developed, but does not actually provide one in lieu of testing
- Pilot Attention is a limited resource and must be rationed wisely in the face of new technology