

Interval Management Speed Annunciation & Conformance Experiment (IMSACE)

Interval Management Surveillance Broadcast
System/Industry Ad Hoc Group

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Outline

- Research Problem
- Stakeholders – Who's Interested?
- Avionics Conditions
- Apparatus
- Subjects
- Independent Variables
- Dependent Variables
- Experimental Design
- Scenarios

Research Problem

Must IM-supportive information be displayed in the forward field of view?

Assess variations of avionics implementations

- Retrofit v. Fully Integrated

for their efficacy of supporting

- Detection of speed target onset/changes
- Adherence to speed profile

in conjunction with annunciation conditions (visual or aural attention directing, and speed profile aiding)

- Does providing an attention prompt affect presentation position requirements?
- Does providing conformance aiding affect presentation position requirements ?

Stakeholders - Who's Interested?

NASA Programs

- Airspace Systems
 - SAIE/ATD: Input on FIM avionics for ATD-1 HITL & flight test (\$\$)
 - CDT/SDO: FIM Operational Concept development (\$\$)
- System-wide Safety Assurance Technologies: Attention & Human performance modeling

FAA

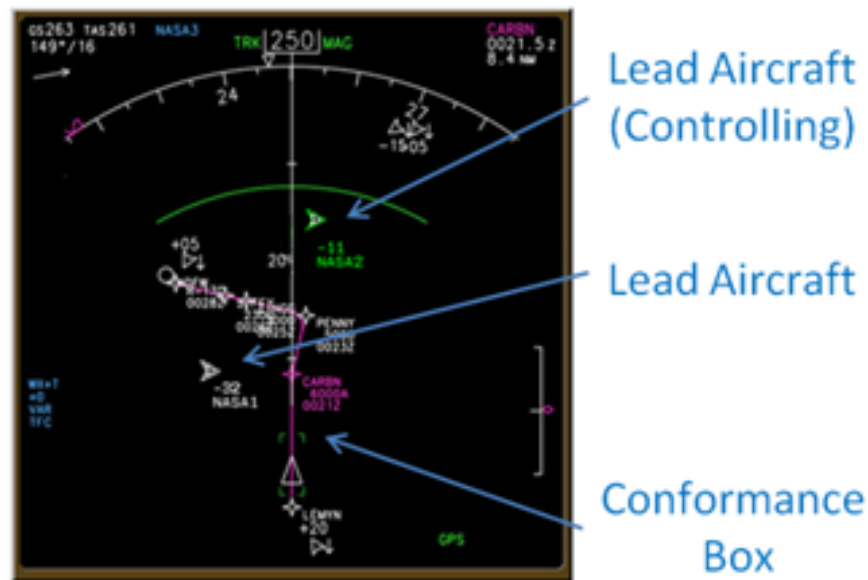
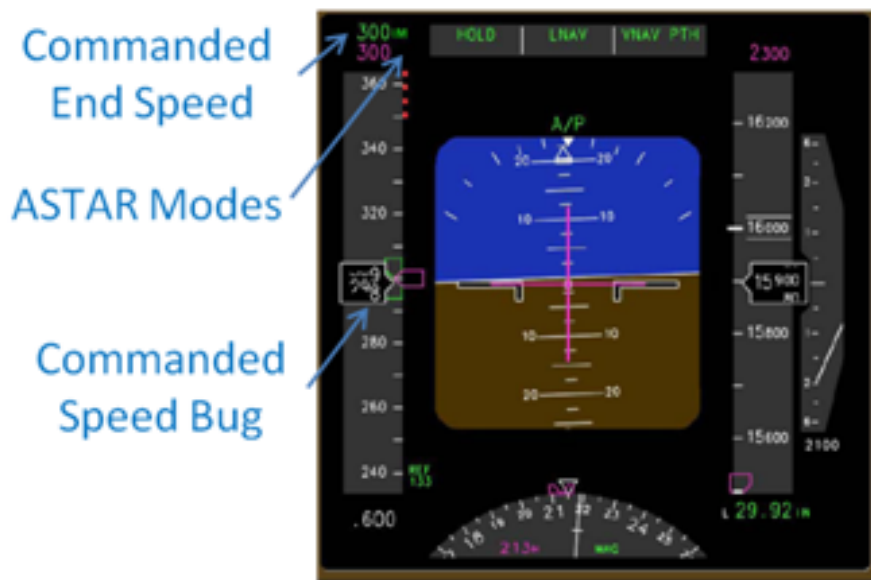
- SBS Office request to address forward-fit v. retro-fit
- FAA Human Factors Research Office
 - high priority research item in 2010 Review of HF Issues in FIM
 - Follow on reimbursible agreement to investigate alerting (\$\$)

Industry groups

- Aviation Rule Making Committee & MOPS Development for IM

Avionics Implementation Conditions

- **Electronic Flight Bag (EFB) only**
(*fast/slow indicator: +/- kts*)
- **EFB+ADS-B Guidance Display (AGD)**
(*fast/slow indicator: +/- kts*)
- **Primary Flight Display+Nav Display**
(*bug for speed profile*)



Annunciations

Two types of annunciation

- Type1: When the crew has not dialed in a speed after a new speed target has been provided.
- Type2: When the aircraft is not in conformance with the speed profile required to reach the target speed.

Forms of annunciation

- Visual: flashing speed target, speed deviation
- Aural+Visual
- None

Apparatus

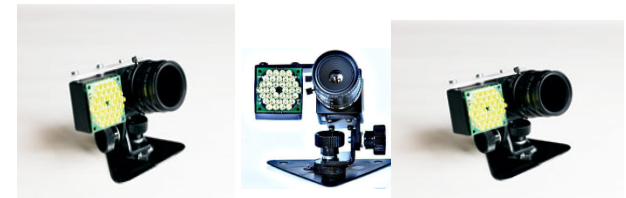
IFD: Integration Flight Deck

- ***High fidelity duplicate of B757-200 cockpit***
- *Mostly aircraft hardware*
- *High fidelity 6-DOF airframe model (B757-200)*
- *Panoramic 2000 horizontal and 400 field-of-view*
- *Control column with wheel, rudder pedals*
- ***Honeywell PEGASUS Flight Management Computer***
 - IM treated as external system
 - No change to normal 757 FMS behavior
- ***Fixed base or motion base capable***
- ***Communication, Navigation, and Surveillance***
 - GPS, INS Sensor models
 - Automatic Dependent Surveillance – Broadcast (ADS-B)
 - TCAS not yet implemented
- ***Class III Electronic Flight Bag available***



Smarteye Oculometer

10 cameras & 6 IR flasher remote system



Subjects

2 internal pretest pilots

2 external pre-test + 12 data subjects

- Unfamiliar with FIM research
- Current B-757 pilots
- Captains
- Desirable to minimize variability of airlines

Independent Variables

Avionics (*where is speed and traffic information*):

- Electronic Flight Bag (EFB) only,
- EFB+ADS-B Guidance Display (AGD)
- Primary Flight Display (PFD)+Nav Display (ND)

Attention Directing Indications

- None, Visual Alerting, Visual Alerting + Aural

Conformance aiding (available/not)

- Speed profile aiding (speed bug on PFD, fast/slow on AGD/EFB)
- Speed profile deviation alerts (modality consistent with above ADI)

Distraction / operational tempo

high (upper altitude), low (lower altitude) in a descent scenario

Research Questions & Dependent Variables

How do configurations affect performance?

Simulation Data:

Speed entered correctly

Speed conformance – initiation time

Speed conformance – quality (aircraft data, fte)

ATC communications / queries

Attention Allocation Data (oculometry):

Allocation of attention v. baseline (head up/down; deviations from normal scan)

Referencing of traffic information in responding to clearance

Noticing time for speed target onset/changes

Questionnaire Data:

Situation Awareness (SAGATesque queries by confederate Pilot Monitoring) (SART)

How do configurations affect pilot acceptance?

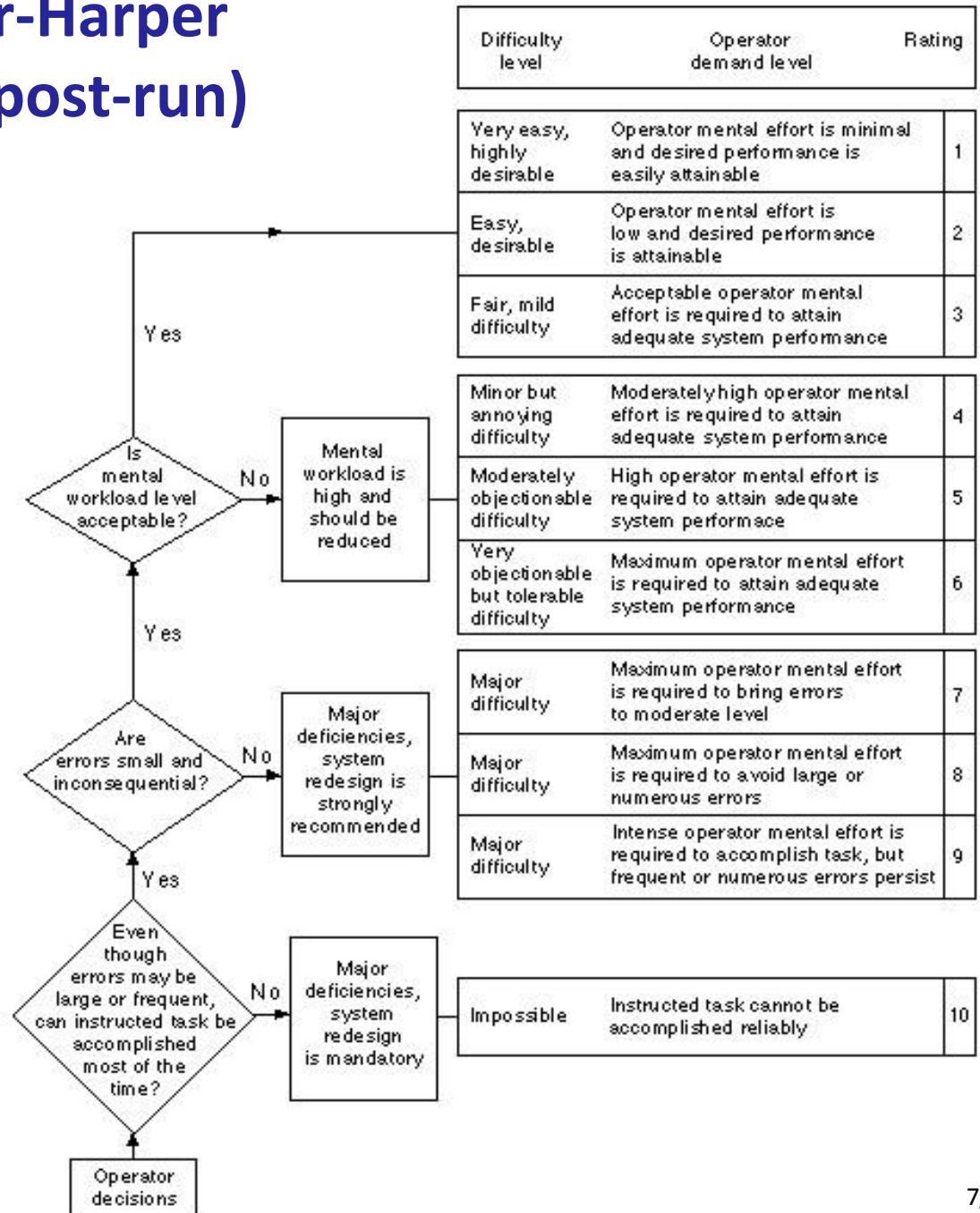
Subjective Data:

Self assessment of responsiveness to speed changes

Perceived reliability of, and trust in, information

Post run workload (Modified Cooper Harper scale)

Modified Cooper-Harper Workload Scale (post-run)



Boff, D. R., & Lincoln, J. E.
Engineering Data Compendium: Human Perception and Performance. AAMRL, Wright-Patterson AFB, OH, 1988.

Online reference:

<http://www.dtic.mil/dticasd/edc/EDCSec07/e07-0707.html>

SAGATesque Queries

SAGAT: SA Global Assessment Technique

- Simulation frozen, questions asked of information elements
- Three levels of Situation Awareness
 - level 1 (perception of data),
 - level 2 (comprehension of meaning)
 - level 3 (projection of the near future) components.

SAGATesque approach here:

- Confederate pilot in right seat asks questions
 - event trigger when asked and answered
 - oculometer data to see if item referenced before answering

SART – Situation Awareness Rating Technique

Demands on attention

- instability of the situation
- complexity of the situation
- variability of the situation

Supply of attention

- situation arousal
- concentration of the situation
- division of attention
- spare mental capacity

Understanding of the situation

- information quantity
- information quality
- familiarity

Experimental Design

IM Conditions (18 runs/subject) v. Baseline non-IM (6 runs/subject)

Avionics (*within subject variable*) – 3 Levels

- Electronic Flight Bag (EFB) only,
- EFB+ADS-B Guidance Display (AGD)
- Primary Flight Display (PFD)+Nav Display (ND)

Attention Directing Indications (*within subject variable*) – 3 Levels

- Visual, Visual+Aural, None

Conformance aiding (*between subject variable*) – 2 Levels

- Unavailable, Available

Level of distraction (*within subject variable*) – 2 Levels

- High (late), Low (early) in a descent scenario

**** Runs Blocked on Avionics Condition;**

2 Baseline conditions within each Avionics Block

Experiment Design Matrix

Avionics (within)

EFB Alone

EFB+AGD

PFD+ND

Conformance
Aiding
(between)

Attention Indicator (within)

Distraction
(within)

Aural Visual None None

High

Low

IM OPERATIONS (within)

-----Yes----- No

Yes

No

Attention Indicator (within) Distraction (within) High Low <table><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr></table> IM OPERATIONS (within) -----Yes-----No										...	...
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Each of 12 subjects experiences 24 data runs + 3 training runs

Scenarios

Descents to DFW

~ 20 minutes in descent to landing

Pilot will implement speed on MCP

ASTAR Algorithm

Update 11 – spacing behind single aircraft

Clearances are voice delivered (not CPDLC)

Subjects are Pilot Flying

Confederate acts as Pilot Monitoring (*aka PNF*)

- Asks SAGATesque situation awareness probes

Questions?