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MUFASA
Multidimensional Framework for Advanced SESAR Automation

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MUFASA project

Original project: 2011 - 2013

Original hypothesis: Strategic conformance has an effect on both the acceptance of automated advisories and overall task (CD&R) performance

Definition: Strategic conformance = degree to which automation's problem-solving style matches that of the individual.

Method: 16 controllers playing two HITL simulations. 2x2x2 repeated measures (conformance vs complexity vs LOA)

Result: Conformal advisories benefited both acceptance and performance.

In 25% of cases, controllers rejected their own solution (conformal advisory).
Why did controllers reject their own solution?
Background

1. Decision-making consistency & consensus

2. Source bias
   Positive bias toward automation, unless human is perceived as expert

3. Transparency of interface representation

Measures
- Acceptance
- Performance
- Perceptions
Decision-making consistency & consensus

[Graphs showing performance over time]
Source bias

Positive bias toward automation, unless human is perceived as expert
Transparency of interface representation
Measures

Acceptance → • acceptance rate,
              • agreement rating

Performance → • Response time
              • Workload
              • Interface interactions
              • Control actions

Perceptions → • Questionnaires
MUFASA Simulator

- En-route environment
- Squared sector, 80x80 NM
- One measurement scenario repeated four times
- Designed conflict (stimuli)
**Method**

1. **Prequel sim.**
   - No aid, baseline

2. **Conformance sim.**
   - Decision aid

**Consistency**

- Four different patterns of consistent behavior
  - Solution parameter
  - Number of interactions
  - Solution geometry
  - Control problem

**Source Bias**

- Variables
  - Source type
  - Source difficulty

**Strategic Conformity**

- Variables
  - Strategic behavior
  - Strategic environment

**Transparency**

- Variables
  - Information availability
  - Information quality

**Two Experiments**

- Experienced controllers
- Controller trainees
Strategic conformance

Resolution advisory (orange) plotted in SSD

50% conformal advisories
(based on own conflict solution style)

50% nonconformal
(based on a colleagues different but safe and workable style)

disagreed
• Controllers perceived advice as safer, more efficient, and more effective in solving conflicts.
Method

Prequel sim.
No aid, baseline

Consistency
Four different patterns of consistent behavior
- Solution parameter
- Number of interactions
- Solution geometry
- Control problem

Different conflict solution styles

Controller A
Controller B
Controller C
Controller D

Control problem analysis

Conformance sim.
Decision aid

Two experiments

1. Experienced controllers
2. Controller trainees

Source Bias
Variables
Results
Strategic conformity

Transparency
Variables
Results
Control problem analysis

Was controlled aircraft vectored in front or behind intruder?

Correlated with self-rated consistency (positive)
Source Bias

Variables

"All resolution advisories suggested in this session are made by an air traffic controller"

VS

"All resolution advisories suggested in this session are generated by automation"

Results

- Small sample size - no inferential statistics
- Participants accepted advisories even though they disagreed
- Controllers perceived advice from human source as safer, more efficient, and more similar to their own way of solving conflicts.

Strategic conformance
Transparency

Variables

- Solution space only for current speed
- Investigate solution space by scrolling

VS

- Solution space for entire speed envelope
- Provides more richer information about intruder aircraft's relative position

Results

- Preference for using the triangle representation
- Triangle representation associated with less interface interactions and increased use of speed commands (sim)
- Triangle was perceived as more helpful (quest.)
- Easier to understand why a solution was suggested when using the triangle (quest.)
- Conformal advisories accepted more often (77.8% vs 66.7%)
Conclusions

To what extent can consistency, source, and/or transparency drive acceptance?

1. **Strategic conformance**
   from technology-centered to individually-centered

2. **Defining consistency**

3. **Heterogeneity vs homogeneity**
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