CORA
COORDn
COnflict Resolution Assistant

Human Factors Lab experiments

NEXTOR-FAA Conference
June 3, 2003
Aims of the CORA HF Experiments

Evaluate different ‘design philosophies’ for CORA:

- User-driven (psychological - comparison)
- Automatic (technological - left-over)
- Collaborative (cybernetic - complementary)

Evaluate different conflict detection (resolution) timelines:

- 5 minutes prior to conflict
- 10 minutes prior to conflict
- 15 minutes prior to conflict

Determine whether resolutions should be presented in a:

- Fixed order (by type)
- Ranked order (by quality-index)
Conflict detection

Calculates and ranks resolutions

Display best-ranked resolution

View related conflict?

yes

Display conflict

Reject resolution?

yes

Find own resolution

No

(Automatic on implementation time reached)

Implement resolution
Conflict detection

Calculates and ranks resolutions

Display indication of Conflict (+ first conflict to act on)
Display indication of resolution availability

View resolutions?

yes → Display ranked resolutions
no → Find own resolution

no → Accept one resolution?

yes → Implement resolution
no → Find own resolution
## Summary of the philosophies

<table>
<thead>
<tr>
<th>CORA system</th>
<th>CORA philosophies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>User-driven</td>
</tr>
<tr>
<td>Calculation</td>
<td>On request</td>
</tr>
<tr>
<td>Resolution display</td>
<td>On request</td>
</tr>
<tr>
<td>Number of resolutions</td>
<td>Several (5 best-ranked by type)</td>
</tr>
<tr>
<td>Conflict Indication</td>
<td>Automatic</td>
</tr>
<tr>
<td>Conflict data</td>
<td>On request</td>
</tr>
</tbody>
</table>
User-driven
HMI
Automatic HMI
Collaborative HMI
Schedule

25 to 29 November 2002
10 Controllers (6 active), male, mean age 42.2, mean experience 18.7 yrs.
2 Austria, 1 Finland, 3 Great Britain, 1 Germany, 1 Hungary, 1 Italy,
1 Maastricht (Experience: All ACC and one Departure/Approach)

08.30 - 09.30   Welcome and Overview
                 Presentation of the simulation environment
                 and the goals of the experiments
Training
09.30 - 10.15   Runs**
10.15 - 10.30   Coffee Break
10.30 - 12:00   Runs
12.00 - 13.00   Lunch
13.00 - 14.30   Runs
14.30 - 14.45   Coffee Break
14.45 - 15.30   Runs
15.30 - 16.30   Questionnaire + Debriefing
16.30           Departure
Two Factorial Designs

Philosophy
- User-driven
- Collaborative
- Automatic

Time horizon
- 5 Minutes
- 10 Minutes
- 15 Minutes

Order
- Fixed order
- Ranked

Exercises
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Evaluation

Questionnaires

- **Post-exercise questionnaire** (21 questions)
  - Human-Automation Co-operation (Halden Co-operation scale)
  - Mental workload (NASA TXL revised)
  - Situation Awareness (SAHSA_Q revised)

- **End-of day questionnaire**
  - Design philosophy
  - Resolution timeline
  - Sorting
  - General questions

Debriefing:

- **End-of-day debriefing**
  - Based on observations and open questions
  - After the end-of-day questionnaire
Experimental Design

- **Route Structure:**
  - based on sectors from Reims FIR, France and Maastricht UAC.

- **Traffic:**
  - based on 2 x 2.5 hour periods from 10 July 1998 (baseline).
  - Air traffic scenarios prearranged (Controllers unable to interact).
  - Each scenario presented one conflict.

- **Factorial Designs (two partly overlapping):**
  - 3 x 2 x 2 (time/design/sorting) within subject.
  - 3 x 3 (time/design) within subject.

- **Incomplete counterbalancing:**
  - Randomised - Controllers tested simultaneously experienced different scenarios and treatment levels.
Experimental Design

• Power analysis:
  - probability that the experimental design could produce statistically
    significant results (ok for large and typical effects).

• Dependent variables:
  - checked to ensure no extreme violations about the assumptions about normal
    distribution and measurement level occurred.

• Questionnaires:
  - Reliability and validity of subjective rating scales evaluated:
    • inter-item reliability testing (Cronbach’s Alpha) (All)
    • factor analysis (SA)

• Hypotheses:
  - Non-directional
  - P-value approach for significance.
Timeline

Human-Automation Co-operation

Main effect of Treatment A (Timeline)
$F(2, 18)=8.2445, p=0.0287$
Timeline
Mental Workload

Main effect of Treatment A (Timeline)
F(2, 18)=2.9411, p=.07848
Design Philosophy

No statistical evidence to suggest that the different design philosophies did not have an equal effect on Human-Automation Co-operation

- Observational nature of the task

- Controllers not able to tell the difference

- Controllers' preferences politically motivated

- Experimenter bias
Timeline & Design Philosophy

Mental Workload

Interaction between Treatment A and B
Current effect: $F(4, 36)=2.6085$, $p=0.05167$

Timeline

- Automatic
- Collaborative
- User-driven
Design Philosophy & Sorting

Human-Automation Co-operation

Interaction between Treatment B and C

F(1, 9) = 5.3315, p = .04631

- Sorted by Type
- Sorted by Ranking
Interaction between Treatment A and C

\[ F(2, 18) = 4.6003, p = .02434 \]

Timeline & Sorting Principle
Situation Awareness

Interaction between Treatment A and C

Timeline

- Sorting by Type
- Sorting by Ranking
Timeline preference
- forced & free choice -
Timeline preference
- by Design Philosophy -
Results - End of Day Questionnaire / Debriefing

‘Design Philosophies’ for CORA:

- User-driven 3/10
- Collaborative 7/10
- Automatic 0

(LOA/HMI - Controller bias - Researcher bias - Design)

Situation Awareness - very difficult to measure

Timeline:

- 10 & 15 minutes - more support at Planning stage
- (7 - 20 minutes free choice)

Sorting:

- By type for User-driven
- By quality-index for Collaborative