Cooperation under guidelines

How guidelines for cooperation affect interaction behavior of airport experts

Anne Papenfuss, Anna Biasotto

Institute of Flight Guidance, German Aerospace Center, Germany
University of Heidelberg
Overview

1. Motivation & Background
   Why guidelines for cooperation?

2. Method
   How to assess the effect of guidelines on interaction behavior?

3. Results
   What is the effect?

4. Discussion
   What did we learn?
The usefulness of collaboration in airport decision making is widely accepted.
Motivation & Background
Learning from the Cockpit – Prescriptive Models for Decision Making

F
- Facts

O
- Options

R
- Risk & Benefits
  - Transition from Situation Analysis to Decision Making

D
- Decision

E
- Execution

C
- Check

Phases

1) Awareness of event that might cause conflicts
   Roles: AP / GH

2) Analysis of conflicts
   Roles: AP / GH

3) Generation of individual solution
   Roles: AP / GH

4) Detection of secondary conflicts
   Roles: AL / GH / AP

5) Refinement of solution
   Roles: AL / GH / AP

6) Decision about final solution
   Roles: AL / GH / AP

source: Hörmann, 1995

AL = Airline, AP = Airport, GH = Groundhandler
Guidelines for Cooperation

Information, Actions & Decisions

Roles

Phases

Phase 1: Information about event
Phase 2: Conflict detection
Phase 3: First solution
Phase 4: Induced secondary conflicts
Phase 5: Elaboration of final solution
Phase 6: Conversion of the solution to operations
Guidelines for Cooperation
Motivation & Background

Research Question

To what extent do expert teams behaved in conformance with the proposed guideless or did they came up with ad-hoc adaptions of the prescriptive decision process?

1. Do teams follow the proposed transition of phases and the proposed activity patterns?

2. Are there distinctive features that can be observed when teams apply the guidelines for cooperation compared to an unstructured decision making process?

Team effectiveness rated significantly higher with guidelines $F(1,12) = 9.35, p = .01, \eta^2 = 0.44$
source: Papenfuss et al. 2017
Method
Set-Up and Roles

• 3 different scenarios with impact on departures
  • thunderstorm
  • construction work at apron
  • radar center software failure

• 45 minutes time to adapt TOBT for departures

• pre-tactical time frame, i.e. two hours in advance
## Method

Joint Planning of Airport Operations disturbed by Events

<table>
<thead>
<tr>
<th>Airline</th>
<th>Airport</th>
<th>Ground handler</th>
</tr>
</thead>
</table>
| • Two punctual priority flights  
• Minimize delay  
• Set TOBTs | • Maximum a/c handled at gate  
• Allocate stand & gates | • Fulfil contract with airlines  
(2 quick)  
• Minimize staff cost  
• Allocate ground handling teams |

conflict free & feasible plan,  
fulfil overall performance goal (PBAM in place)
Method
Data Preparation

- Each interaction event defined by:
  - Start time
  - Speaker
  - Receiver
  - Content
  - Code (Phase of Guideline, Priority Flight, System, Other)

- Reliability of Coding – Krippendorff’s α
  - Stability (intra-rater) α = .91 (almost perfect)
  - Objectivity (inter-rater) α = .57 (moderate)
Results

Qualitative Analysis of Interaction Behavior – Team 1

Chart 11

free guidelines

Speaker

Airport GH PEA TGA


00:30 10:04 16:29 18:21 21:17 26:33 31:07 34:23 38:44
Results
Qualitative Analysis of Interaction Behavior – Team 3

free guidelines
Results
Qualitative Analysis of Interaction Behavior – Team 2

Weekend
Phase

- a
- b
- c
- d
- e

Speaker

- Airport
- GH
- PEA
- TGA

Weekend conditions
Phase

- a
- b
- c
- d
- e

Speaker

- Airport
- GH
- PEA
- TGA
Results

Qualitative Analysis of Interaction Behavior – Team 2

free guidelines
Results
Qualitative Analysis of Interaction Behavior – Team 2

5 TGA, min 01:18 Das heißt du staffelst deine Flüge grad noch nicht?
5 (...) (...)
5 TGA, min 01:36 Ok. Also ich habe vier Flüge verschoben.
5 (...) (...)
5 PEA, min 03:44 So, ich schau grad. Die Betroffenen haben wir jetzt alle.
Results
Qualitative Analysis of Interaction Behavior – Team 2

4 TGA, min 05:59 Ich hab einen neuen Konflikt bekommen, das ist die Lima November.
3 Airport, min 06:05 Ich bin noch ganz kurz an dem –
5  PEA, min 13:46  Ich weiß nicht ganz – Ich könnt jetzt schon noch
durch die Adaptierung von Targetzeiten, den ein oder anderen wieder auf grün
bringen. Da müsstest du, [Name GH] gar nichts machen.

(...)

O  TGA, min 14:15  Die Frage ist nur, wenn wir ihm jetzt – Nachdem
er jetzt durch ihn schon alles rot bekommen hat. Wenn wir ihm jetzt mit
diversen Anpassungen dazwischen pfsuchen –
Results

Qualitative Analysis of Interaction Behavior – Team 2

[Graph showing interaction behavior phases and speakers]
## Results
Quantitative Analysis of Interaction Behavior

<table>
<thead>
<tr>
<th></th>
<th>team 1</th>
<th>team 2</th>
<th>team 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>free</td>
<td>guide</td>
<td>free</td>
</tr>
<tr>
<td>n events</td>
<td>229</td>
<td>265</td>
<td>226</td>
</tr>
<tr>
<td>n events phase 2-4</td>
<td>65</td>
<td>74</td>
<td>70</td>
</tr>
<tr>
<td>n events in phase optimization (5)</td>
<td>164</td>
<td>191</td>
<td>156</td>
</tr>
<tr>
<td>% of compliant transitions</td>
<td>90.8</td>
<td>96.1</td>
<td>93.3</td>
</tr>
<tr>
<td>perc. events in phase optimization</td>
<td>71.6</td>
<td>72.1</td>
<td>73.0</td>
</tr>
</tbody>
</table>

Chi-Square Test for distribution of events

<table>
<thead>
<tr>
<th></th>
<th>team 1</th>
<th>team 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of compliant transitions increased?</td>
<td>*</td>
<td>(*)</td>
</tr>
<tr>
<td>Situation Analysis more in focus than Optimization?</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>
Discussion & Outlook

Data Level

• Content analysis revealed that teams were aware of the guidelines but analysis of phase progression revealed they did not follow them consequently

• Quantitative measures do not show an overall impact
  • Phases could also be identified in runs with free structure, esp. phase 3 - 5
  • Deviations from proposed structure, esp. early input from airlines
  • Strong inter-team differences, more factors influence interaction behavior, e.g. extraversion

• Metrics proposed to quantify impact of guidelines on interaction behavior
  • compliant transitions (n, %)
  • Odds ratio
  • Can be used for statistical analysis, e.g. Chi-square tests

• Small sample size of this study prevents statistical analysis of this data
• Time span of decision making process was fixed (45 min)
Outlook
Advancing the Guidelines & Planned Work

• communicate „affordances“ of the situation early → adapt/add phase where airlines can communicate priorities

• develop „easy-to-remember“ structure
• highlight necessity of situation assessment
  • In collaborative environment no single stakeholder has access to all information relevant for situation assessment

• Collaborative decision making
  • in situations with higher risk and time pressure
  • where several teams contribute to decisions (teams-of-teams)
  • Inter-Team-Collaboration (ITC) as DLR-projekt, planned start 04/2018
Contact

Anne Papenfuß
Institute of Flight Guidance
Lilienthalplatz 7
38108 Braunschweig / Germany

anne.papenfuss@dlr.de

COCO
Collaborative Operations in COntrol Rooms