



INFORMATION CUES AND THE CONFLICT LIFE CYCLE: VALIDATING A RETROSPECTIVE-THINK-ALLOUD TECHNIQUE USING EYE TRACKING

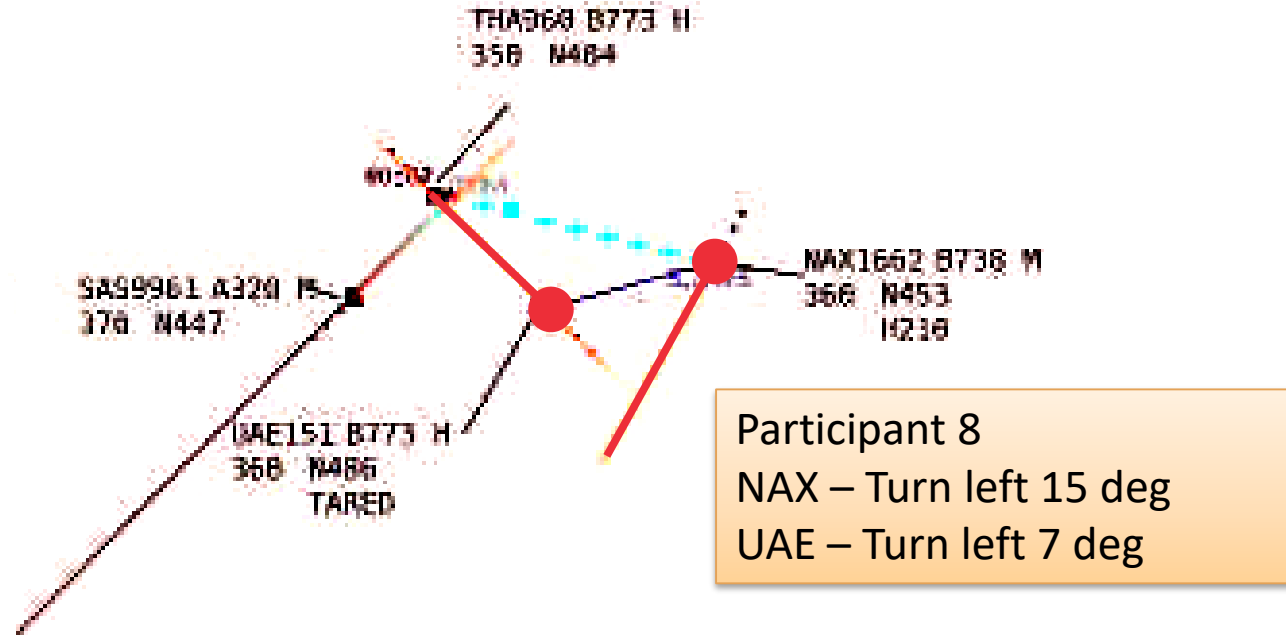
Lothar Meyer, Katerina Vrotsou, Karl Johan Klang, Supathida Boonsong, Carl Westin, Aida Nordman, Jonas Lundberg and Billy Josefsson

Automation in ATC

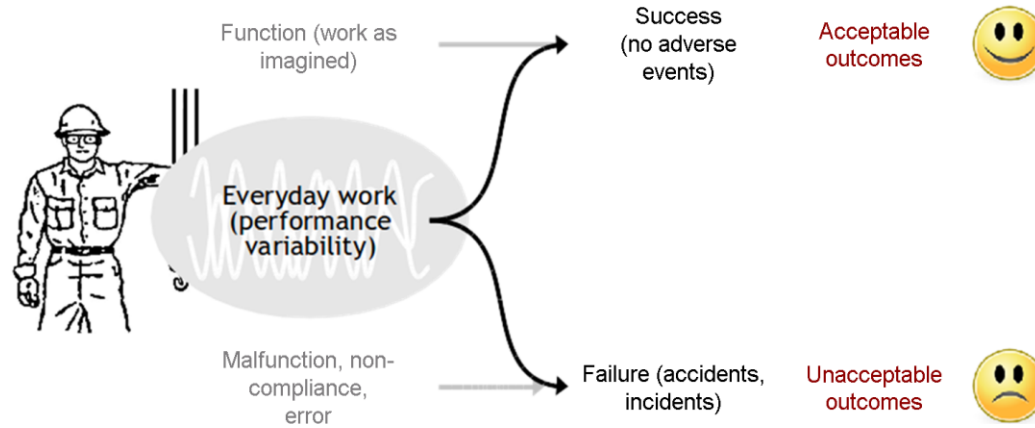
- ✓ Remote Tower
- ✓ Visual Tracking
- ✓ Radar Tracking
- ✓ Departure Management
- ✓ Digital Tower Assistant (DITA)
- ✓ AI-supported Decision Making



Performance Variability



Performance Variability



The Safety-II view of failures and successes

We cannot make things go right simply by preventing them from going wrong. We can only make things go right by understanding the nature of everyday performance and by learning how to perceive those things which we otherwise do not see.

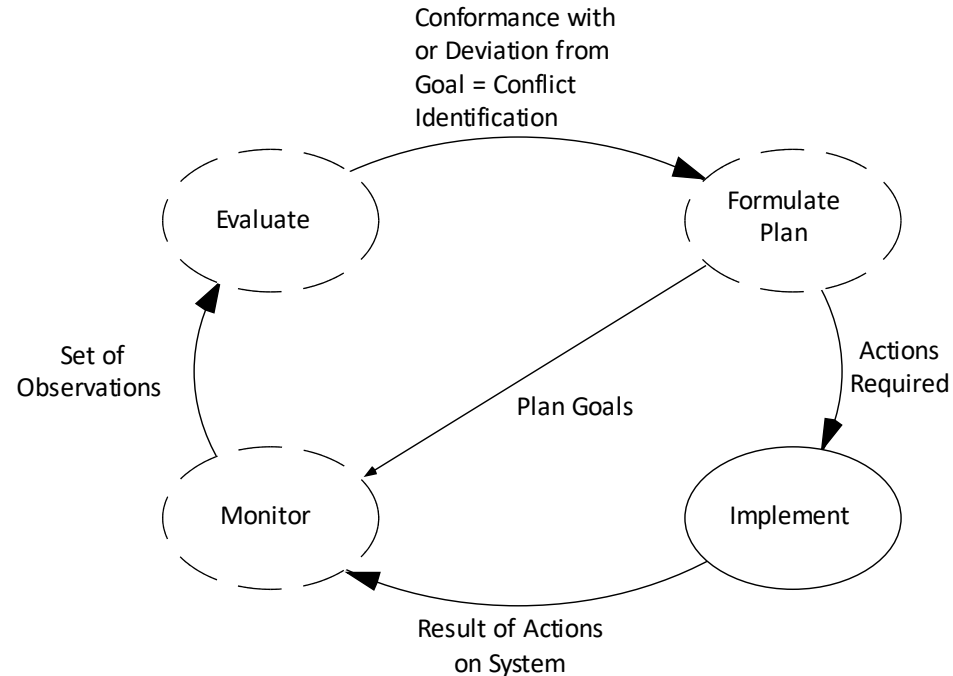
Hollnagel, Resilience Engineering: A New Understanding of Safety, 2016

Decision Making of Controllers



Objective of the Qualitative Study

- ✓ Identify information, timing and other cues (decision cues)
- ✓ Relate decision cues to the work steps of the CD&R-task, the related purpose, and the intention of the ATCO (based on pre-work by Pawlak 1996¹)
- ✓ Variances between ATCOs
- ✓ Solutions and the preferences between ATCOs

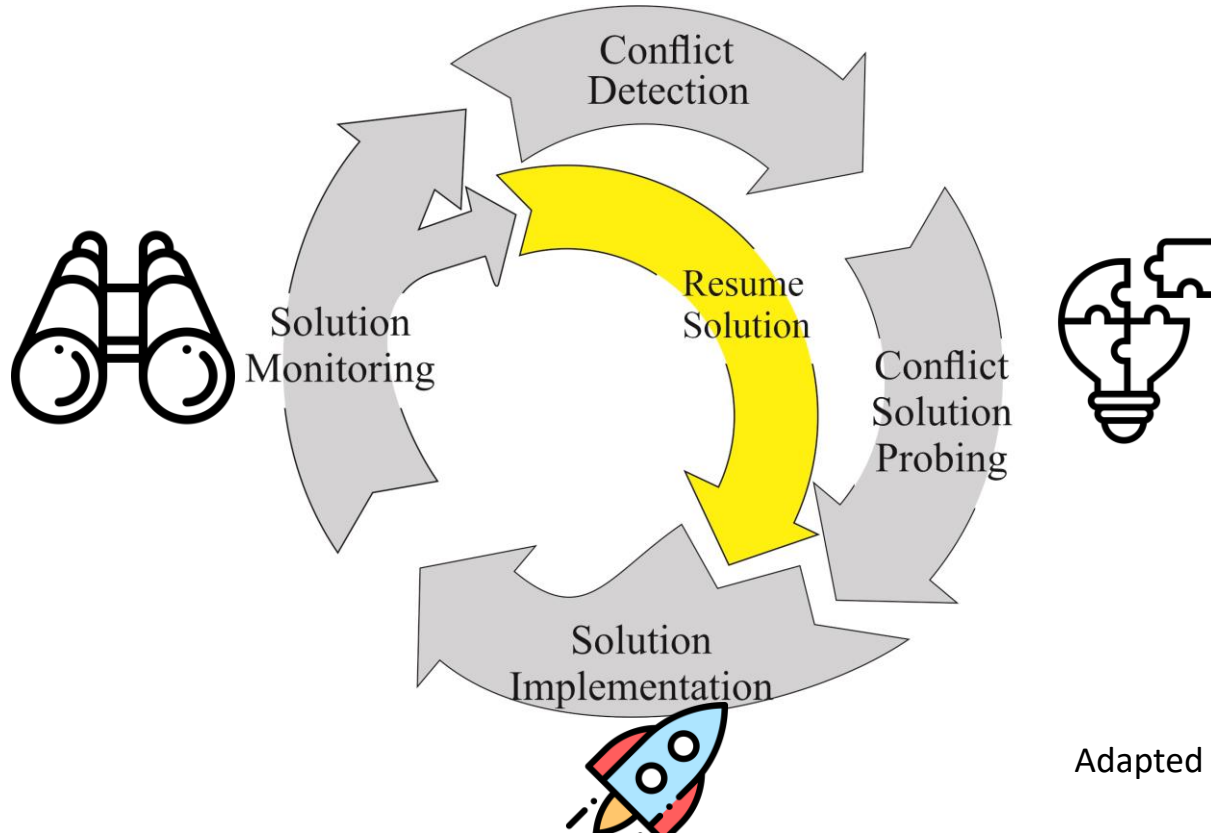


¹W. Pawlak, C. Brinton, K. Crouch, and K. Lancaster, "A framework for the evaluation of air traffic control complexity," in Proc. AIAA GNF Conf., San Diego, CA, 1996.

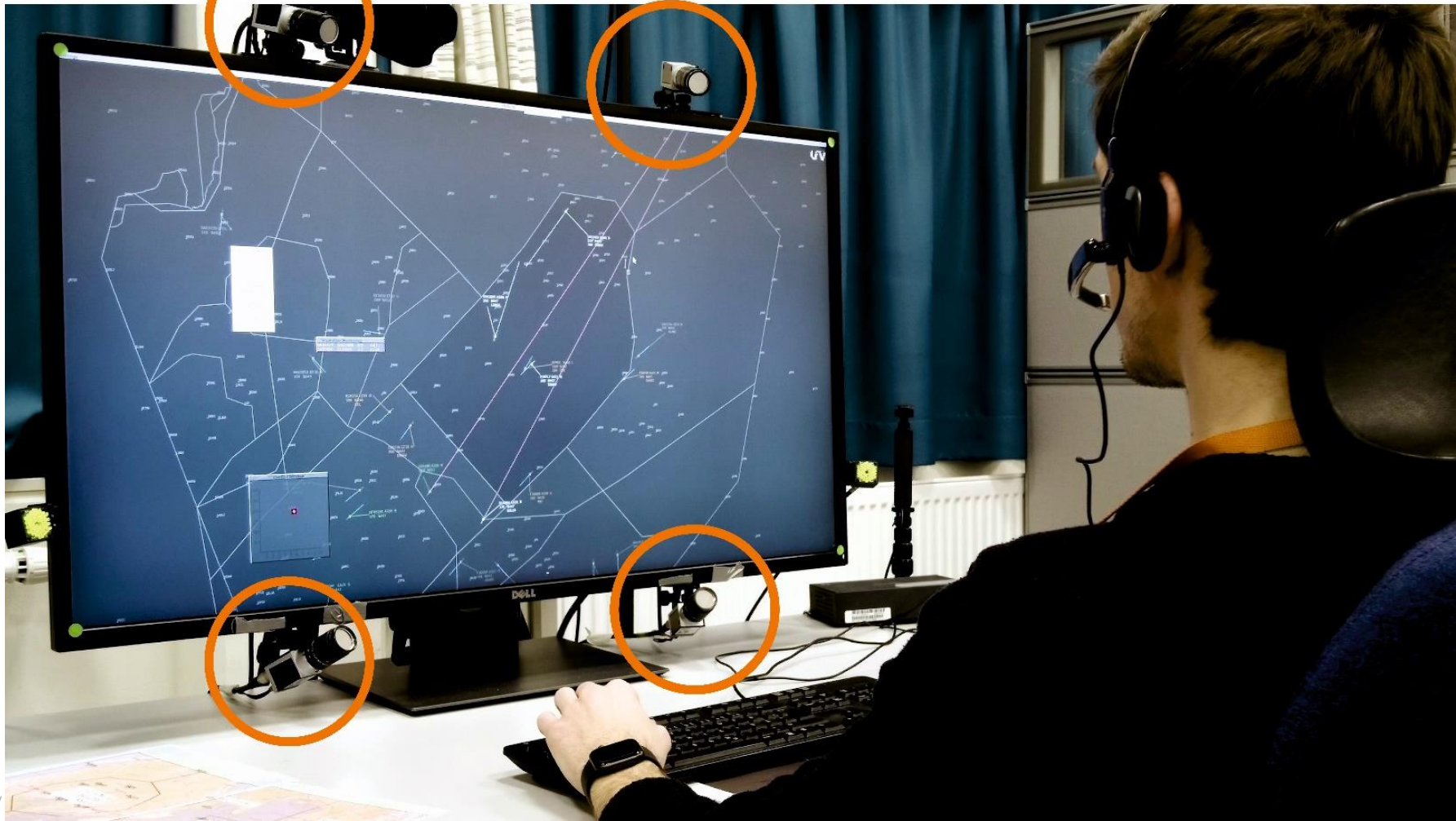
Method

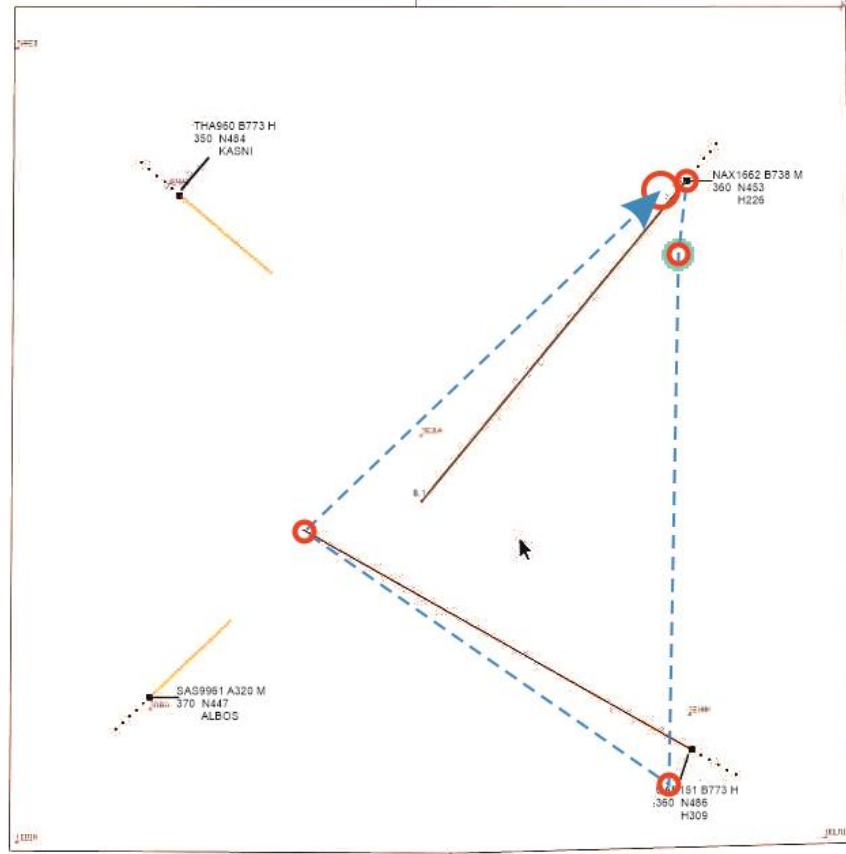
- ✓ 13 Air Traffic Controllers from En-Route
- ✓ Simple Conflict Scenario
- ✓ Four movements in a generic airspace lasting 5 minutes
- ✓ Training 20 min
- ✓ Eye Tracking with SmartEye in 4 IR-Cameras
- ✓ Retrospectiv Think Aloud (RTA)-Technique

Conflict Life Cycle



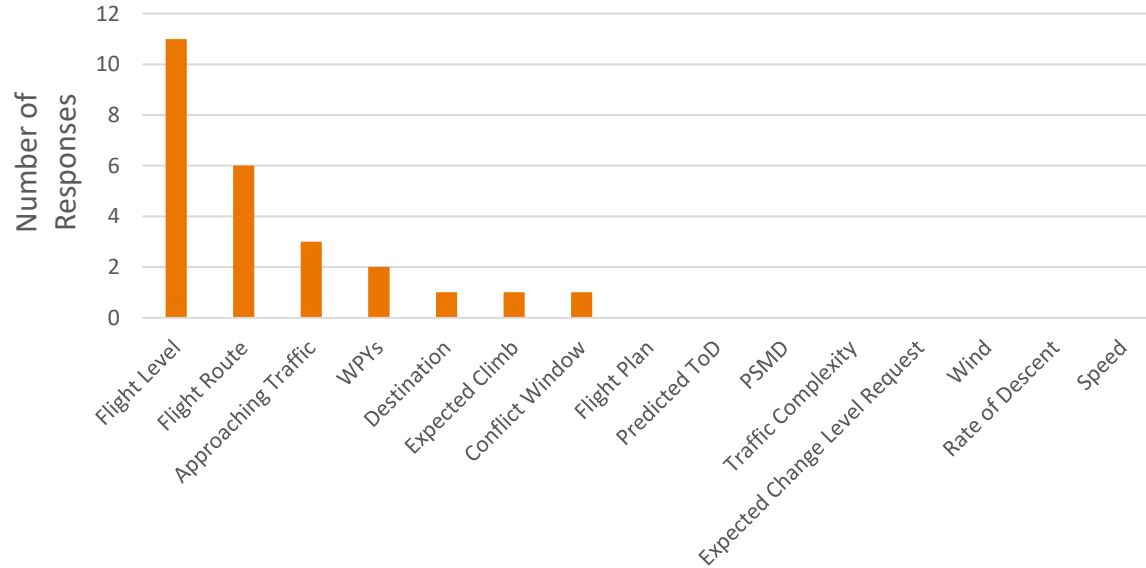
Adapted from Pawlak 1996 to our scenario case³



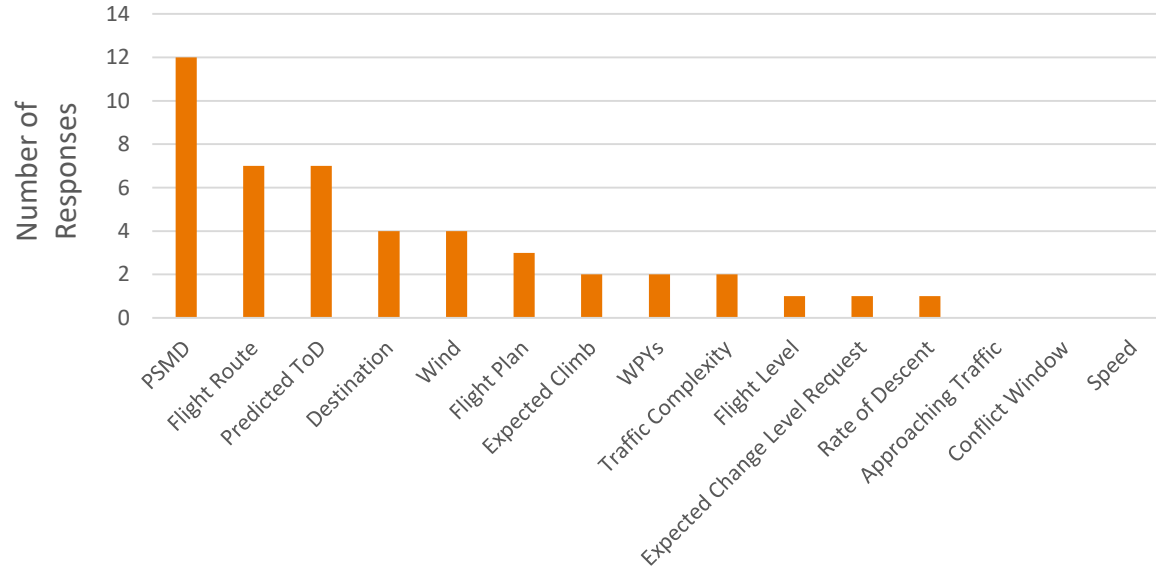




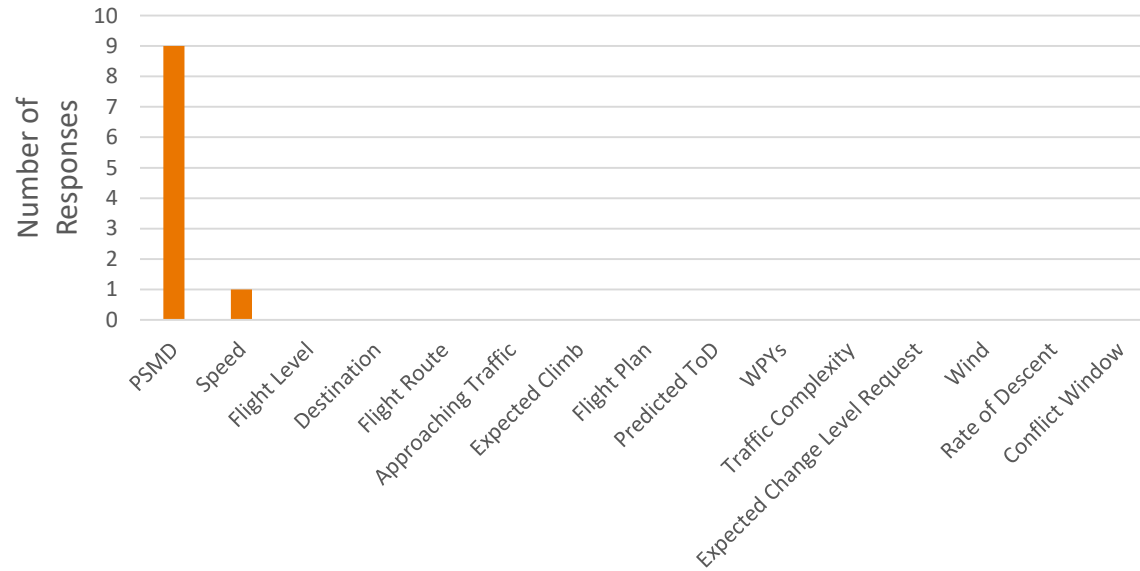
Conflict Detection



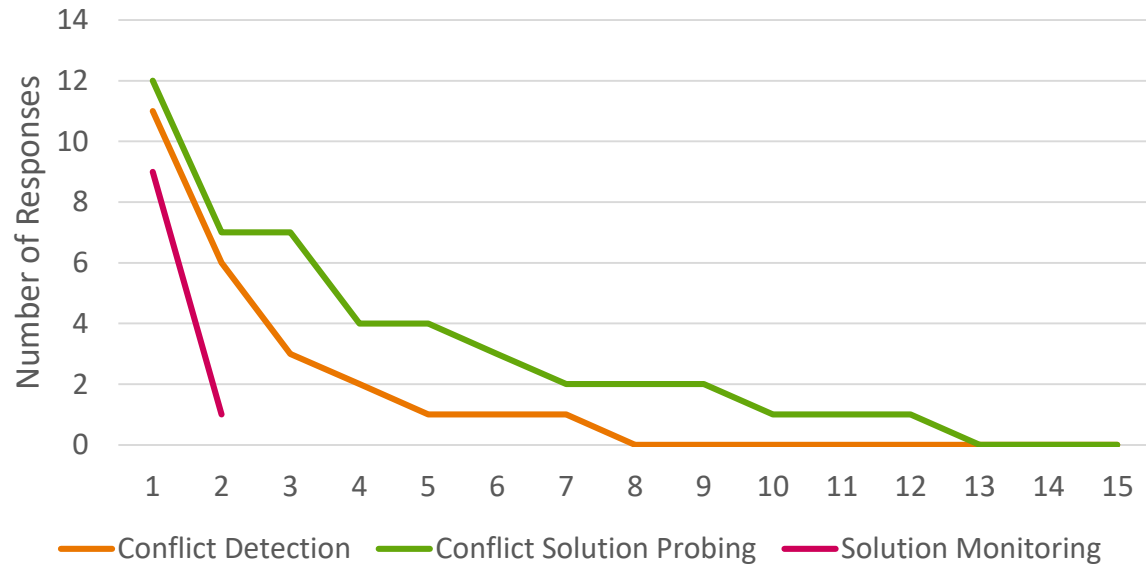
Conflict Solution Probing



Solution Monitoring

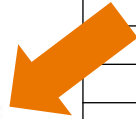
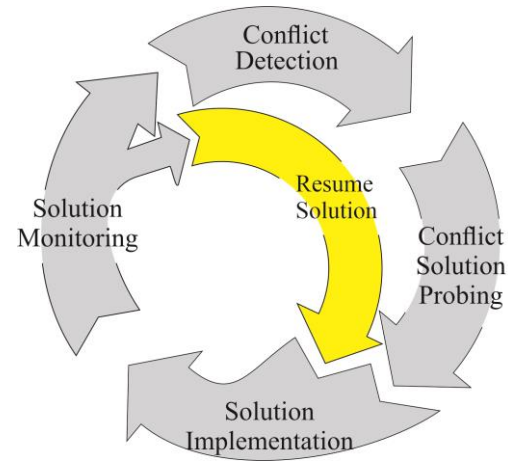


Comparison of All Work Steps



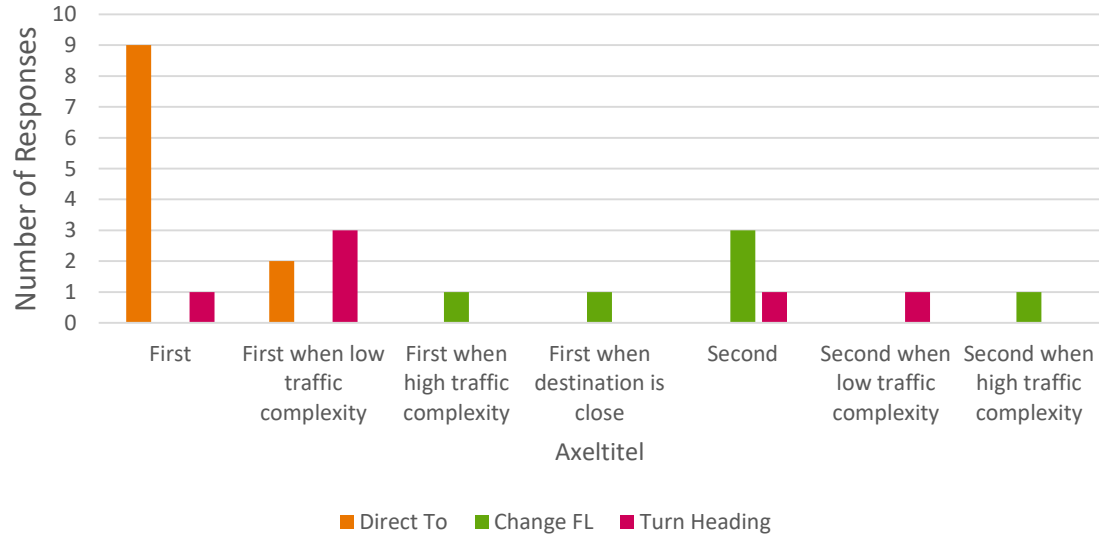
”Conflict Solution Probing”

Comparison of Individuals



	1	2	3	4	5	6	7	8	9	10	11	12	13
PSMD	1	1	1	1	1	1	1	1	1	1	0	1	1
Flight Route	1	1	0	0	0	1	1	0	1	0	0	1	1
Predicted ToD	1	1	1	0	0	1	0	0	0	0	1	1	1
Destination	0	0	1	0	0	1	1	0	1	0	0	0	0
Wind	0	0	1	0	0	1	0	0	1	1	0	0	0
Flight Plan	1	0	0	0	0	0	0	0	0	0	1	0	1
WPYs	1	0	0	0	0	0	0	0	0	0	0	0	1
Expected Climb	1	1	0	0	0	0	0	0	0	0	0	0	0
Traffic Complexity	0	0	0	1	0	0	0	0	1	0	0	0	0
Flight Level	1	0	0	0	0	0	0	0	0	0	0	0	0
Expected Change Level Request	0	0	0	0	0	1	0	0	0	0	0	0	0
Rate of Descent	0	0	0	0	0	0	0	0	1	0	0	0	0
Approaching Traffic	0	0	0	0	0	0	0	0	0	0	0	0	0
Conflict Window	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed	0	0	0	0	0	0	0	0	0	0	0	0	0

Variance of Solution Preference



Discussion

- ✓ **Most used Information Cue** – Predicted Minimum Separation Distance mentioned most (21/39)
- ✓ **Frequency of Cues** - Conflict solution probing appears to be the most demanding task among the work steps, measured in terms of the decision cues included for this purpose
- ✓ **Individual Variance** - Controllers experience a highly individualized development of decision-making competence, especially Solution Probing
- ✓ **Solution Preference** – Controllers mention the “direct to” as preferred solution
- ✓ **Limitations** - The open-ended RTA questioning method used may lead participants to mention only the cues they consider most important

Conclusion

- ✓ 16 decision cues were found of which 13 were information cues
- ✓ “conflict resolution probing” step is the most challenging task because it contains the most decision cues

- ✓ The qualitative results show a diverse distribution of decision cues
 - Variance along work steps
 - Information Cues are work step specific (referring to Conflict Life Cycle)
 - Inter-Individual Variance

Outlook

- ✓ The classification of intention by means of empirically measured work pattern might become possible.
- ✓ Interview with closed set of decision cues
- ✓ Involvement of multiple conflict scenarios (more realistic)
- ✓ Quantification of variance
 - explained by the CLC,
 - explained by the inter-individual variance

THANKS

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