

Find out more @ <http://www.delftecologicaldesign.nl>

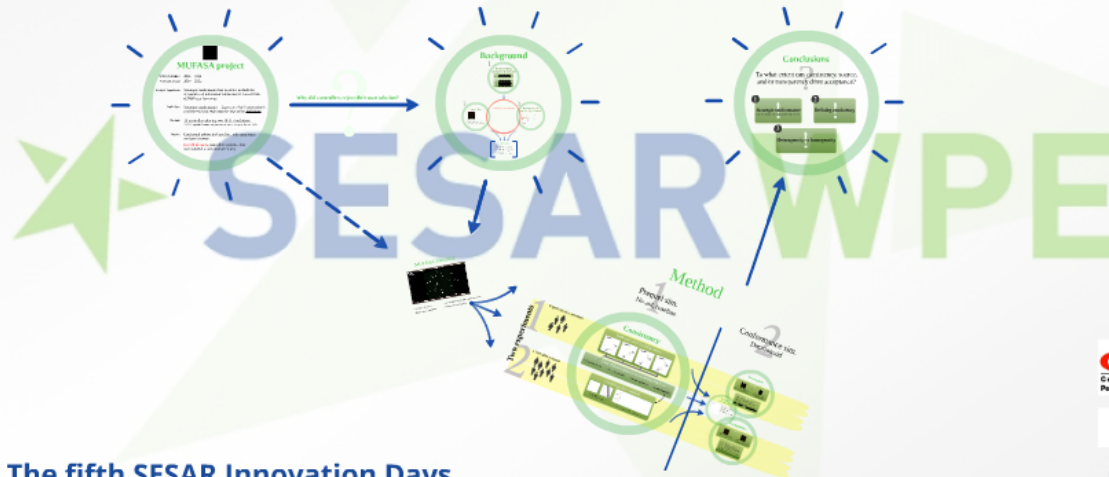
# MUFASA

Multidimensional Framework for Advanced SESAR Automation

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**The fifth SESAR Innovation Days**  
Bologna, Italy. 1st – 3rd December 2015



The main message to take away: Automation was initially designed after a technology centered principle. The human (or in this case the cat) had to adapt to the automation (in this case the glass bowl). Wrong in so many ways. In ATC, aviation, space and other domains, extensive researches have been devoted in finding "the right stuff" - people with the right qualities. While it can be expected that the filtering process has resulted in a more homogeneous workforce, it does not make it ok to develop automation for the masses. With human-centered automation more consideration was given to the human operator and his/her abilities, limitations and needs. Still not enough. The final step lies in making automation fully adapt to the individual. That is turning the equation. The automation should acknowledge each individual and adapt in that individuals abilities, needs, requirements, knowledge, decision-making style etc.





# MUFASA project

**Original project:** 2011 - 2013

**Extension phase:** 2014 - 2015

**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)

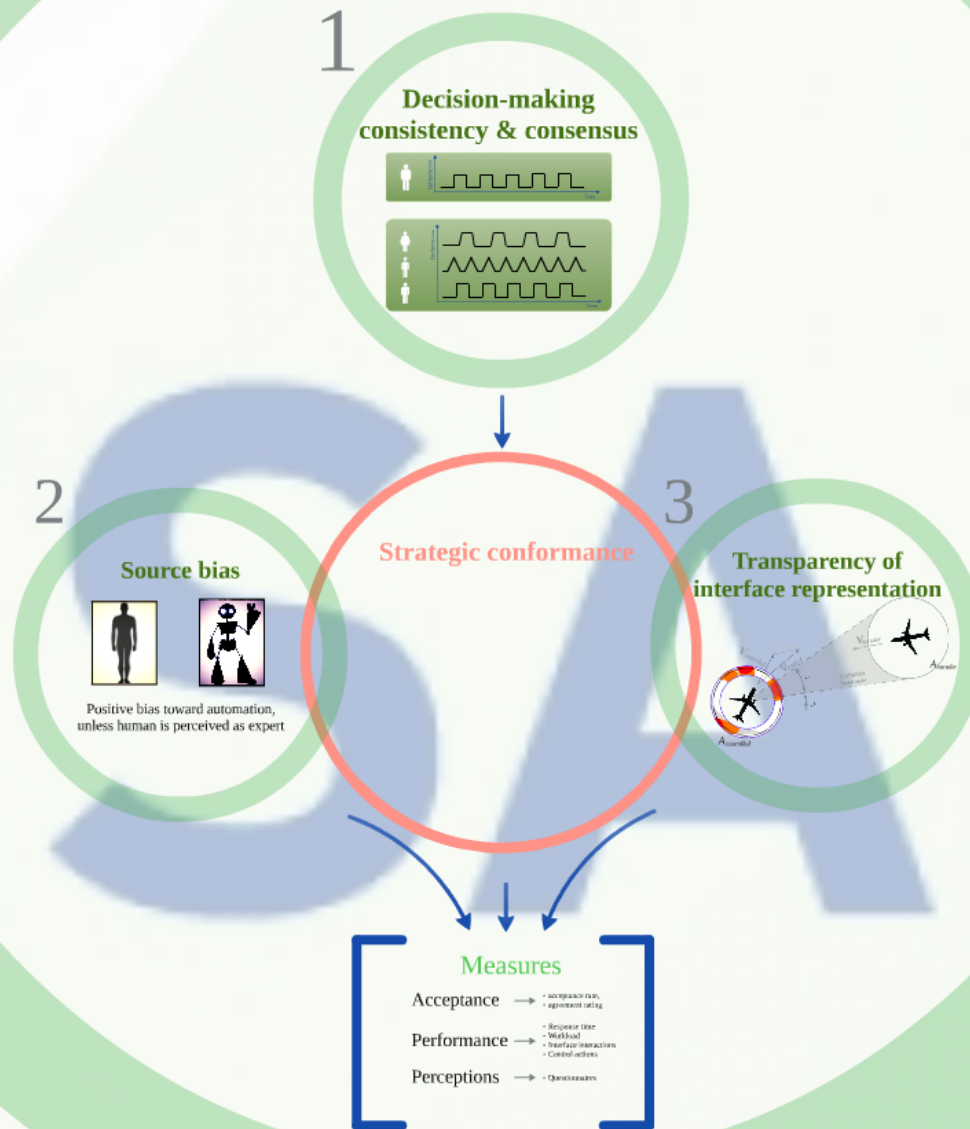
**Result:** Conformal advisories benefited both acceptance and performance.

**In 25% of cases**, controllers rejected their *own solution* (conformal advisory).

**Why did controllers reject their own solution?**

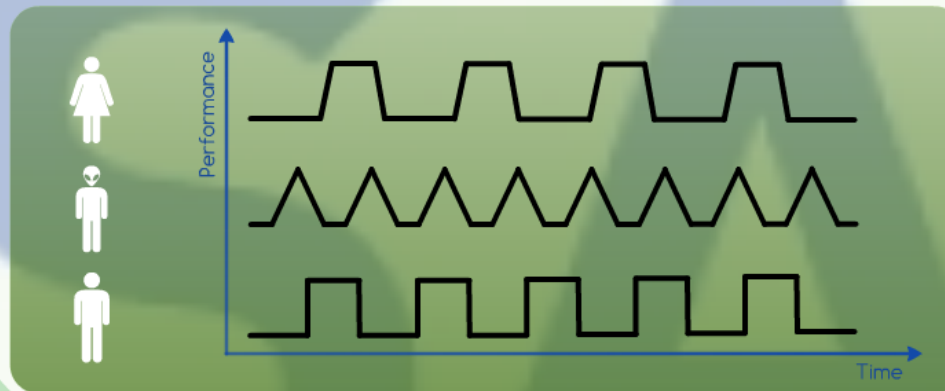
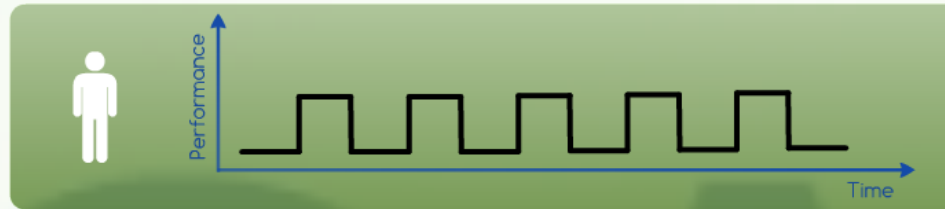


# Background



# 1

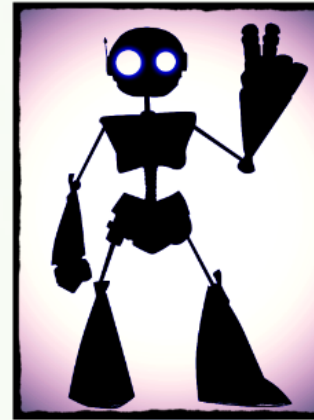
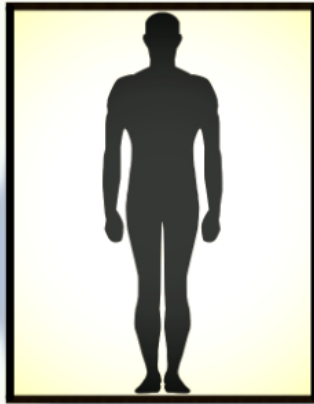
## Decision-making consistency & consensus



2

St

## Source bias

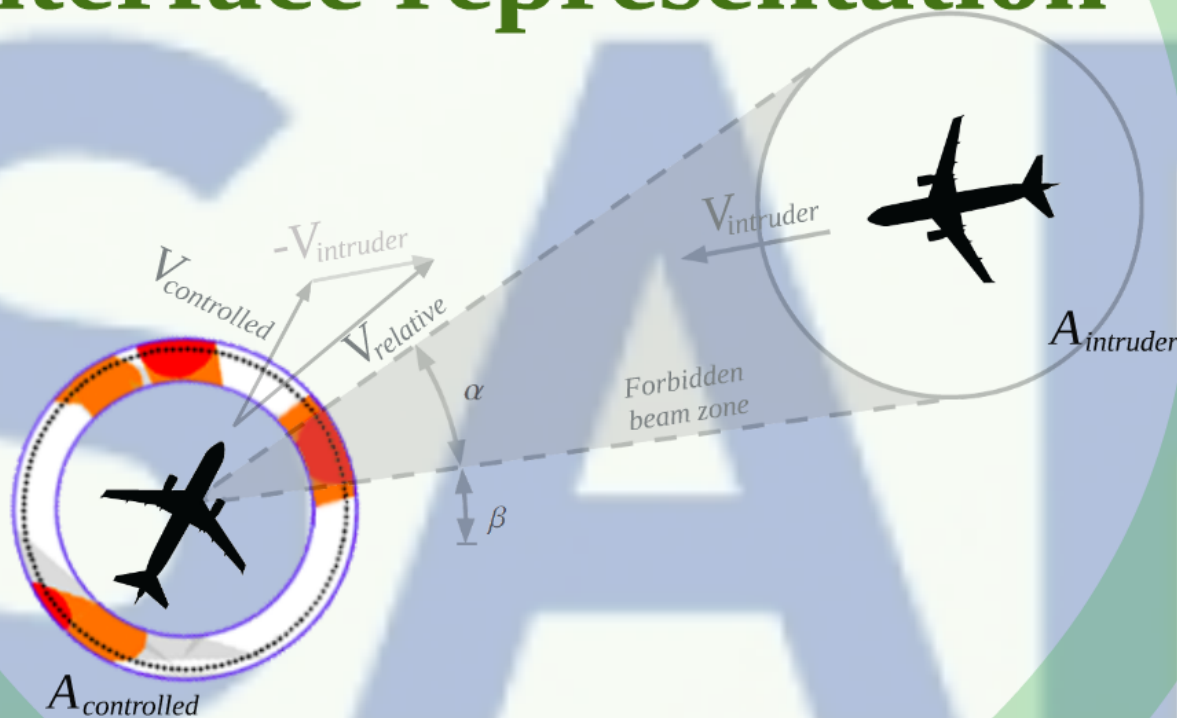


Positive bias toward automation,  
unless human is perceived as expert

3

nce

# Transparency of interface representation





# Measures

Acceptance →

- acceptance rate,
- agreement rating

Performance →

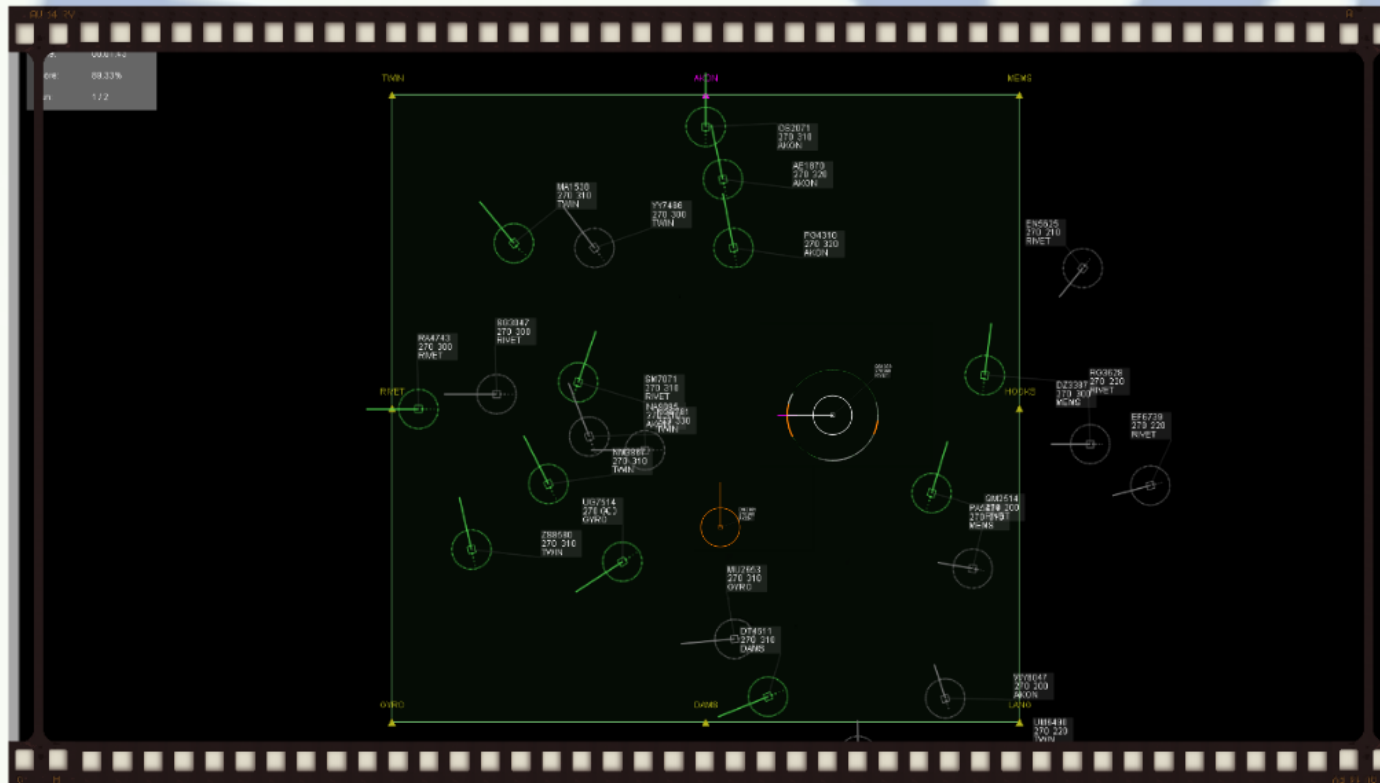
- Response time
- Workload
- Interface interactions
- Control actions

Perceptions →

- Questionnaires



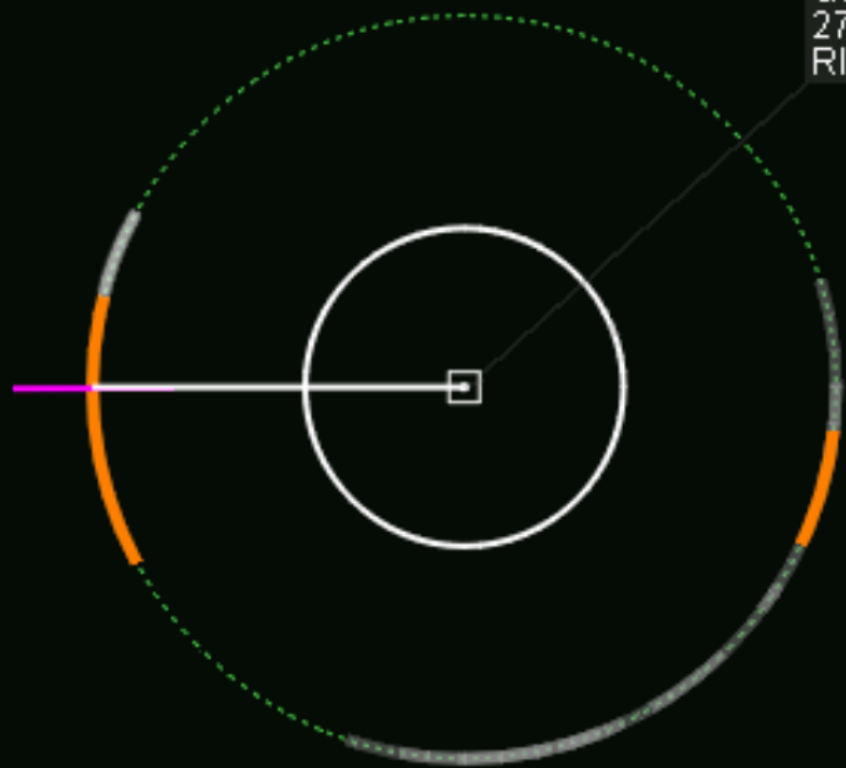
# MUFASA Simulator



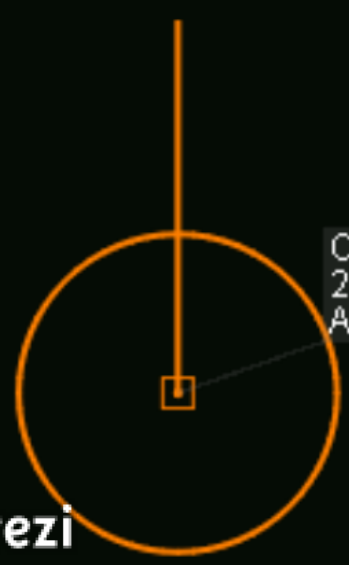
- En-route environment
- Squared sector, 80x80 NM
- One measurement scenario repeated four times
- Designed conflict (stimuli)

0  
281  
330  
J

QS1338  
270260  
RIVET



OM3185  
270260  
AKON

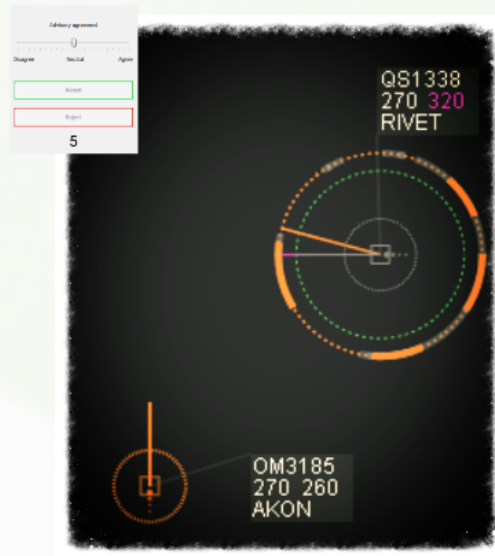




# Strategic conformance

disagreed

- Controllers perceived advice safer, more efficient, and more effective of solving conflicts.



Resolution advisory (**orange**) plotted in SSD

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

50% nonconformal  
*(based on a colleague's different but safe and workable style)*

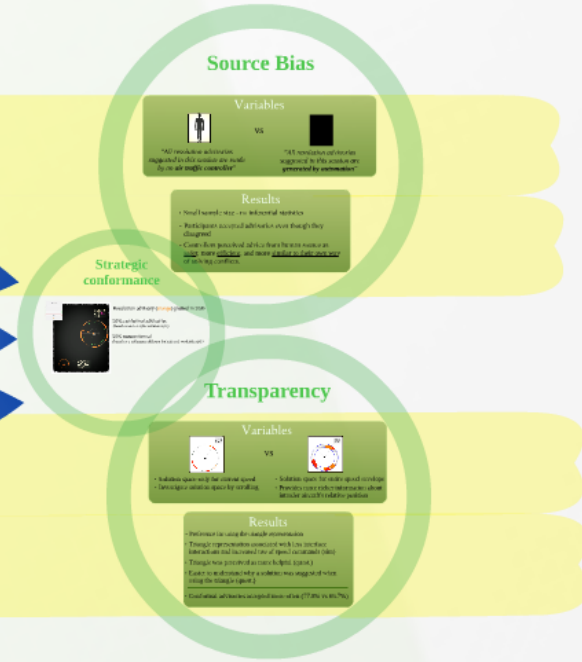
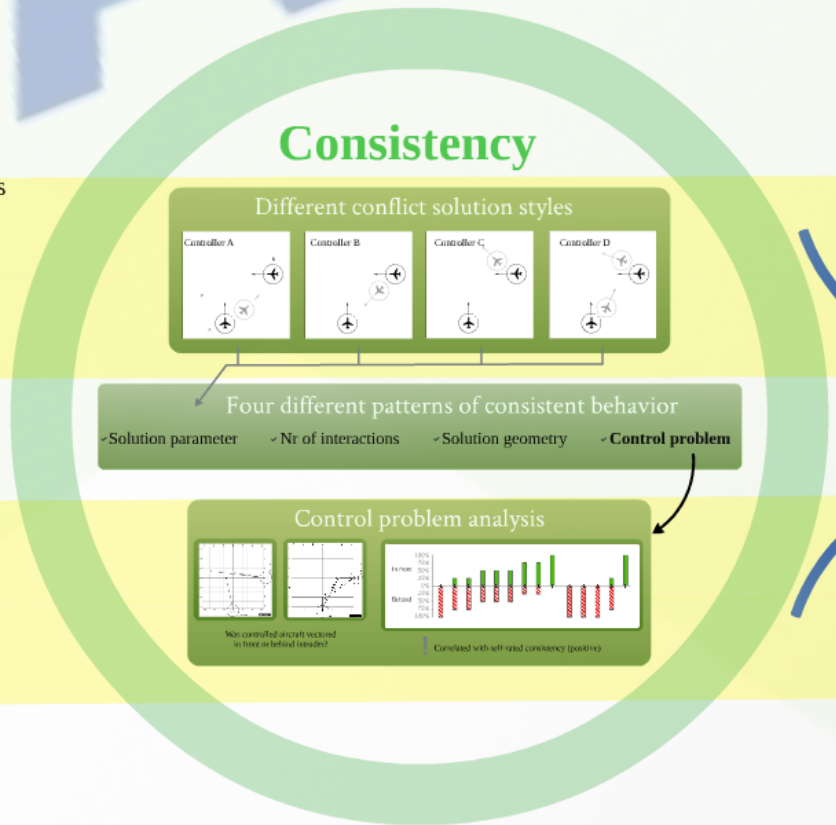
# Transp

# Method

1  
Prequel sim.  
No aid, baseline

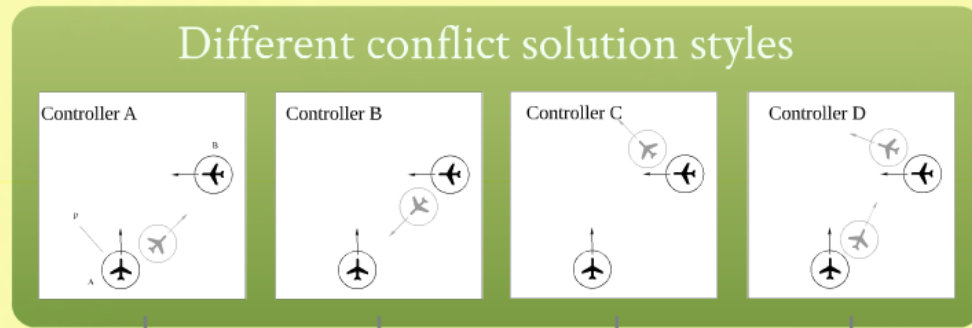
2  
Conformance sim.  
Decision aid

1  
Two experiments  
2  
Experienced controllers  
Controller trainees



# Consistency

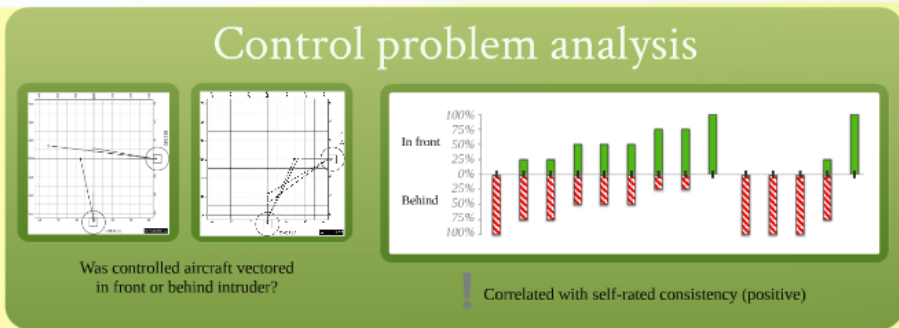
ed controllers



Four different patterns of consistent behavior

- ✓ Solution parameter
- ✓ Nr of interactions
- ✓ Solution geometry
- ✓ **Control problem**

r trainees



# Four different patterns of consistent behavior

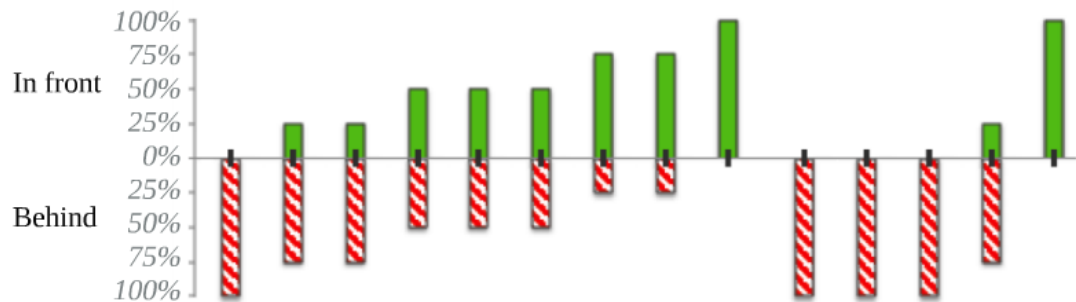
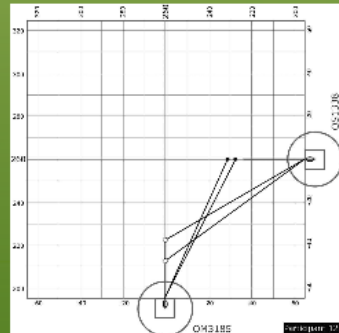
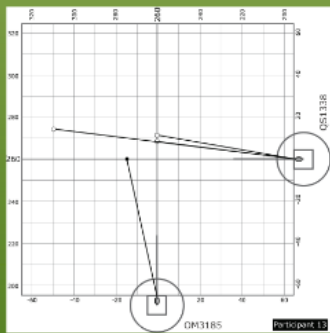
parameter

✓ Nr of interactions

✓ Solution geometry

✓ Control

## Control problem analysis



Was controlled aircraft vectored in front or behind intruder?

! Correlated with self-rated consistency (positive)

# Source Bias

## Variables



VS



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

*"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**



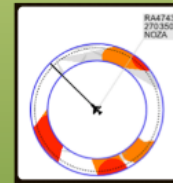


# Transparency

## Variables



VS



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

- 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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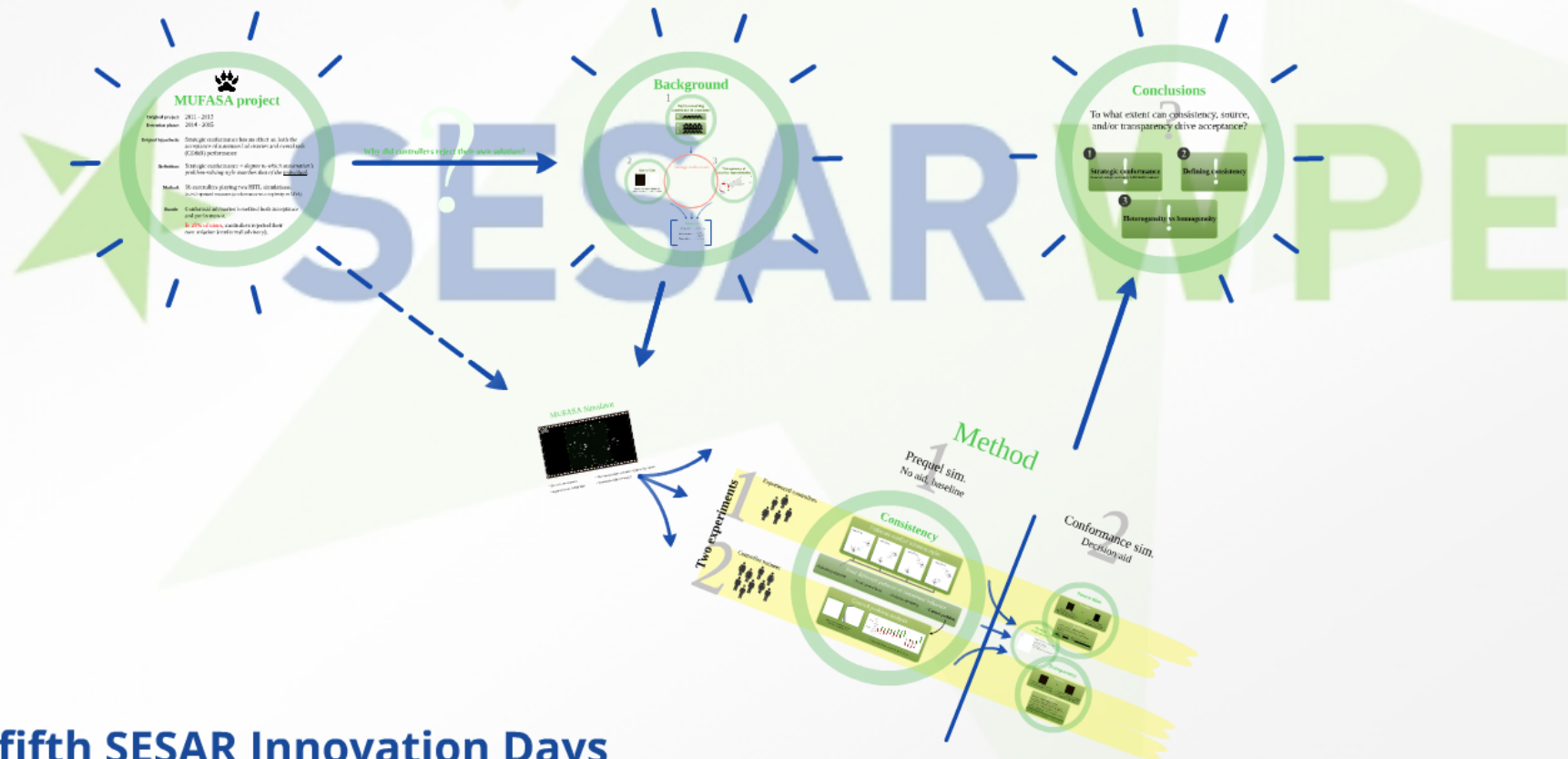
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