Appropriate monitoring behavior as a predictor of manual control of a simplified air traffic flow simulation

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Disclosure Information

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Dietrich Grasshoff

I have no financial relationships to disclose.

I will not discuss off-label use

and/or investigational use in my presentation.

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- Aviator 2030 (Eißfeldt et al., 2010):
  - There will be a future need of operators, able to resume manual control after a phase of automation.
  - Appropriate monitoring behavior will become crucial in future operational systems

- What defines an “appropriate” monitoring behavior?
- And: is it possible to predict manual control on the basis of appropriate monitoring behavior?

A normative model of monitoring behavior

1. O.M.A. allocate attention to demands of the ***overall-situation***

- Experienced drivers adjust scanning strategy to the overall situation
  e.g. Underwood & Crundall, 2003

  → O.M.A. keep an overview of system operations.

2. O.M.A. allocate attention to ***phase-specific*** demands

- Experienced air traffic controllers show characteristic monitoring phases
  Niessen & Eyferth, 2001

  → O.M.A. orient, anticipate, detect and recheck in time.

A normative model of monitoring behavior

Hypotheses to test for an “appropriate” monitoring behavior:

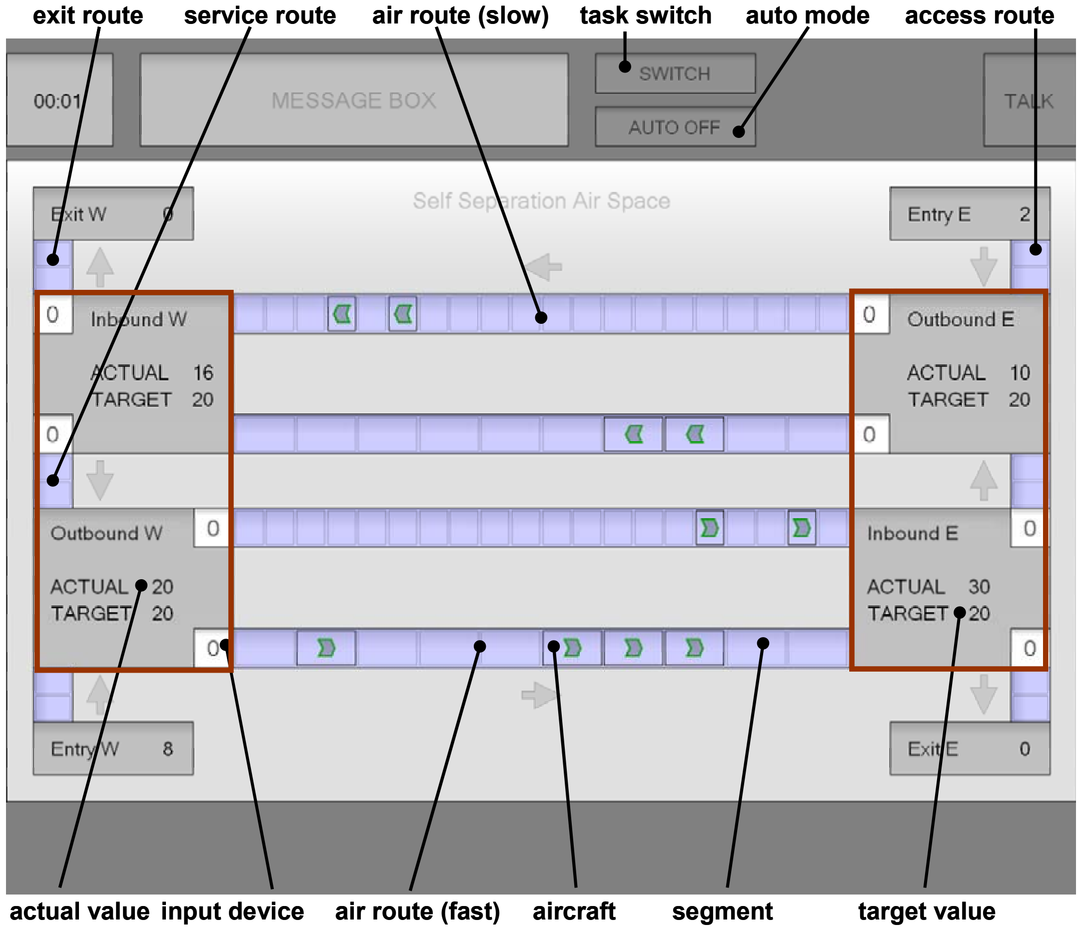
1. Attention allocation to the demands of the ***overall-situation*** is related to *the ability to resume control.*

2. Attention allocation to ***phase-specific*** demands (reflects orientation - anticipation - detection - recheck of system operations) is related to *the ability to resume control.*

We assume, that individual differences in monitoring behavior lead to differences in learning the underlying principles of an automatic system and finally in controlling the system manually.

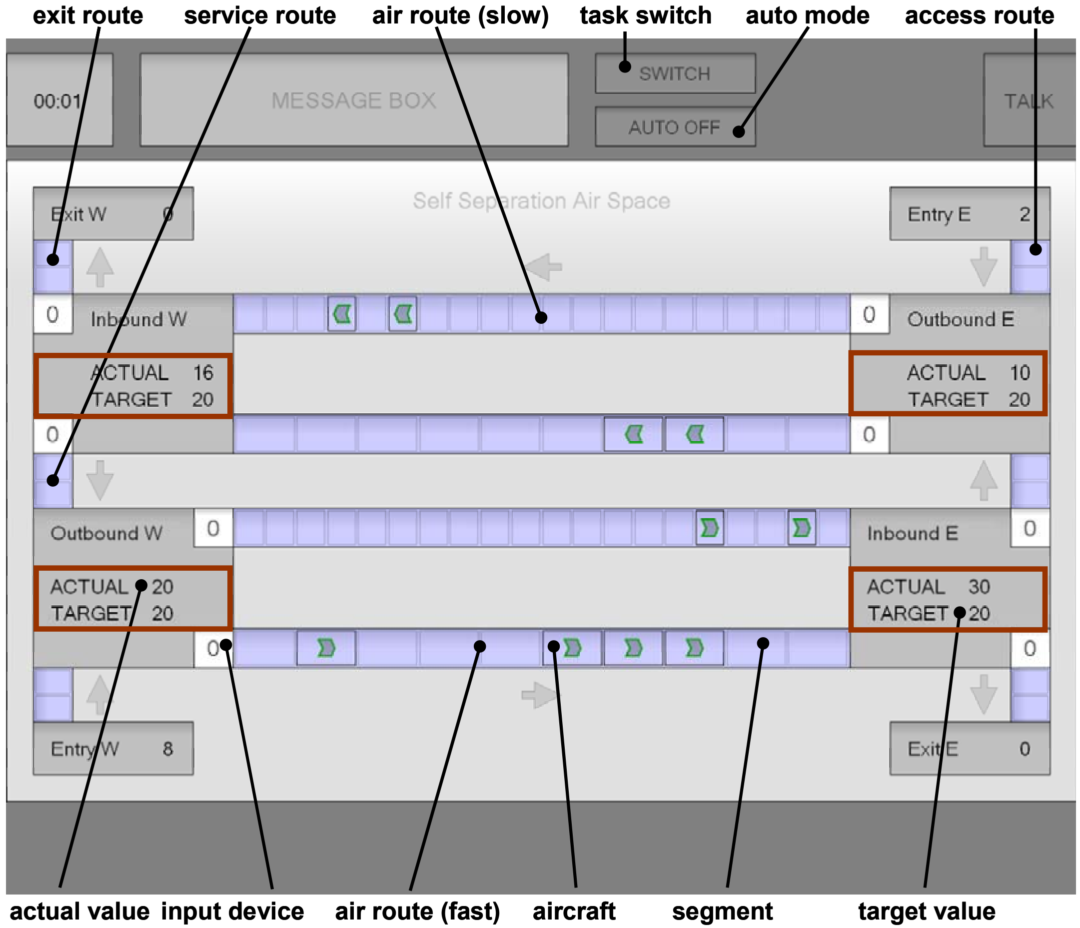
Method Simulation tool SSAS

Traffic flow management task



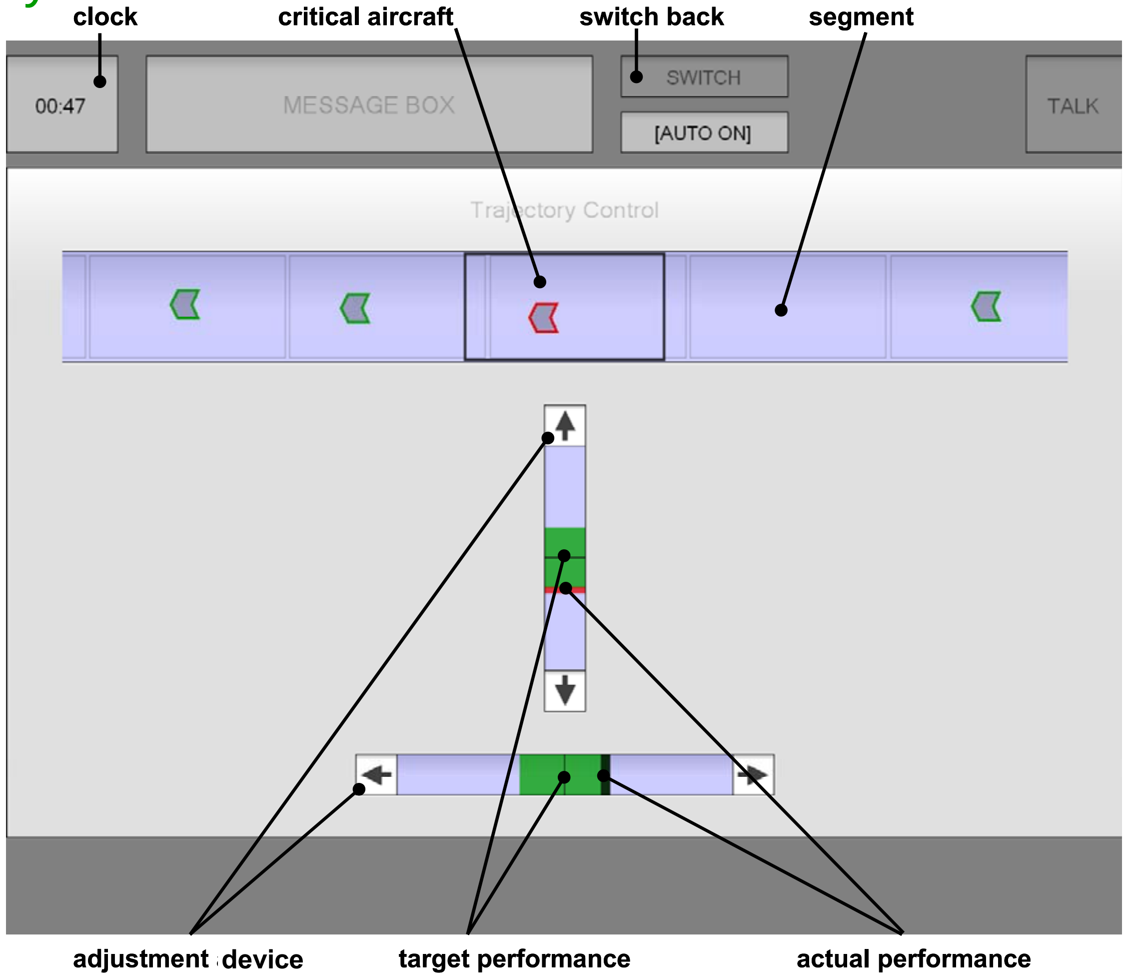
Method Simulation tool SSAS

Traffic flow management task



Method **Simulation tool SSAS**

Trajectory control task



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Method Eye movement tracking system

Method Experimental Procedure

- Test Subjects:
  - 90 Applicants for DFS (Deutsche Flugsicherung GmbH) and DLH (Deutsche Lufthansa AG)
- Procedure
  - Instruction
  - Training (Baseline manual system control)
  - Calibration
  - Scenarios (1-4), 2 modes:
    - Automatic control mode:
      - subject is monitoring automated system control
      - objective of understanding the rules and dynamics
    - Manual control mode:
      - manual system control (by the subject)
    - Subjective evaluation of scenario`s difficulty

Method **Experimental Procedure**

Automatic Mode

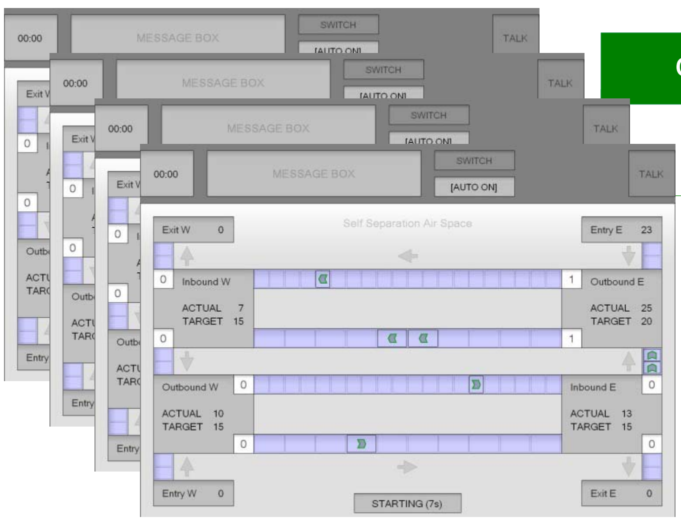
Monitoring

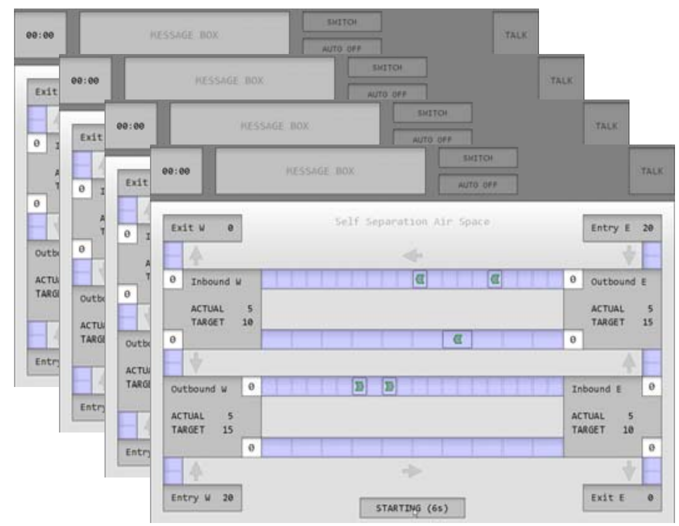
Manual Mode

Active Control

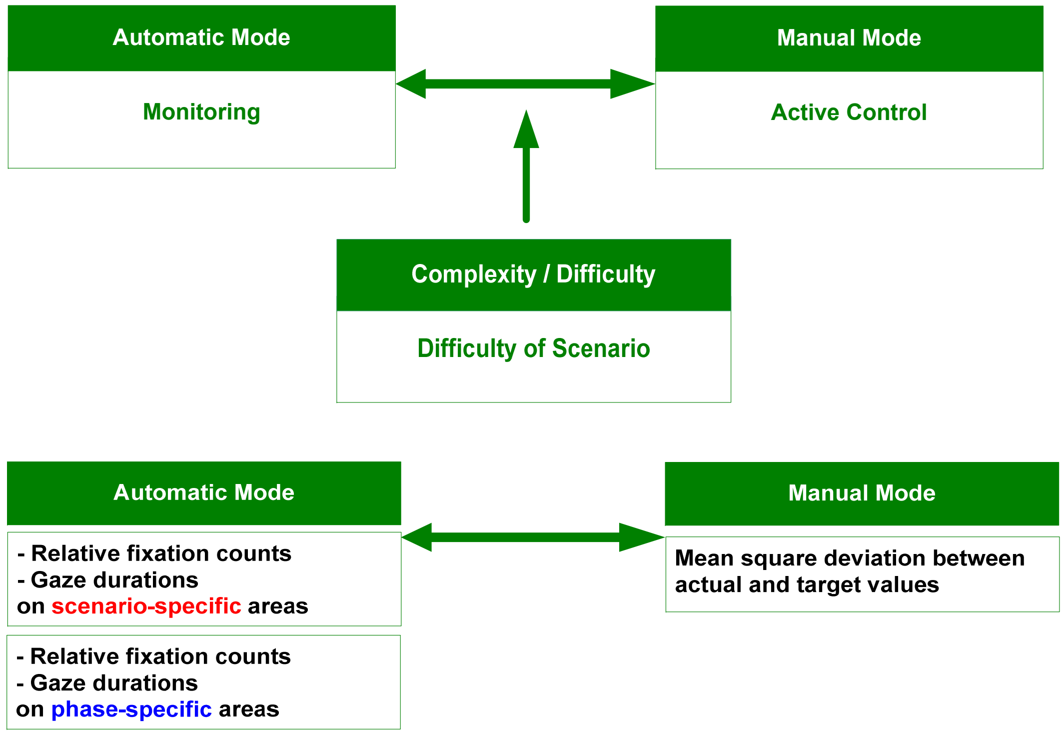
Complexity / Difficulty

Difficulty of Scenario





Method **Measurements**



Method **Measurements**

- **Relative fixation counts**
- **Gaze durations**

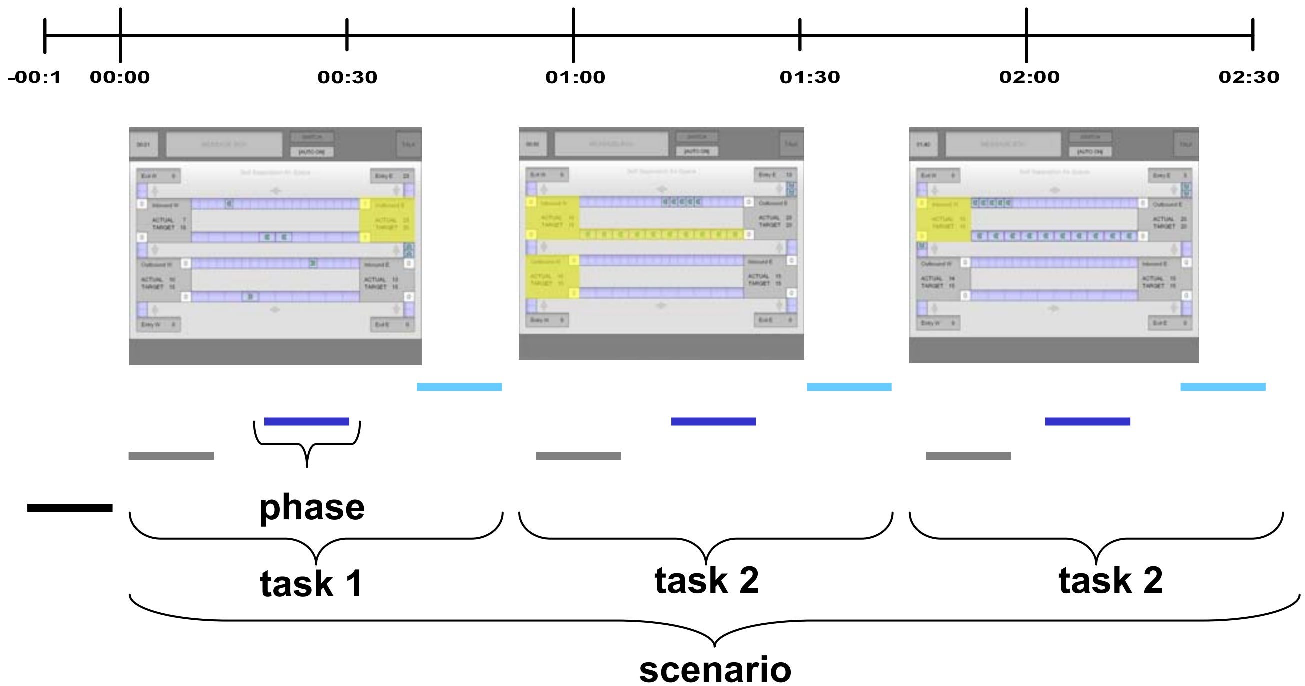
on phase-specific areas

Orientation

Anticipation

Detection

Recheck



Results Overview

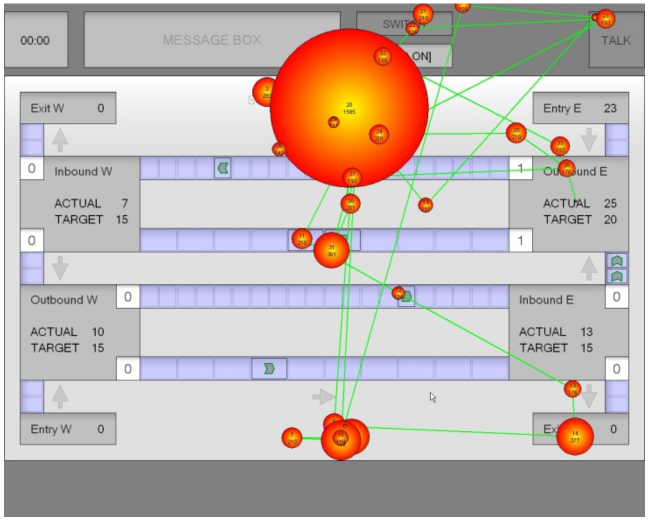
Scenario	1	2	3	4
difficulty	low	medium	medium	high
Overview	n.s	-.24**	-.28**	n.s
Orientation	n.s	-.33*	-.25*	n.s
Anticipation	n.s	n.s	n.s	n.s
Detection	n.s	-.26*	-.29*	n.s
Recheck	n.s	-.28*	-.27*	n.s

n=90; * p < .05; ** p < .01; negative coefficients are expected;

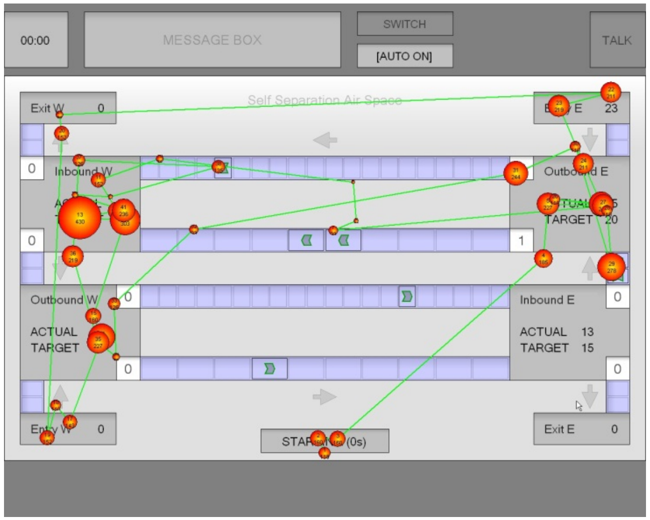
Results Low and high performers
Orientation phase of scenario 2

Distributions of fixations as scanpaths

Test subject
Low performing group



Test subject
High performing group



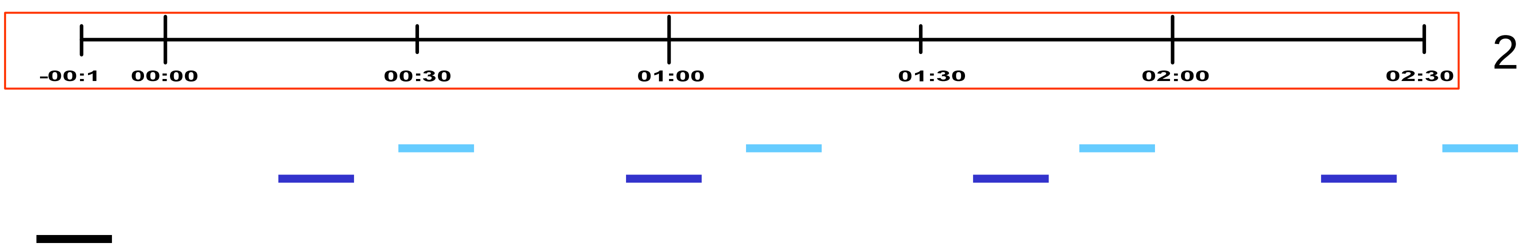
F(2,61) = 6,945; p < .005

Discussion

- O.M.A. *look frequently* at relevant areas to keep an overview, to detect and to recheck tasks in time.

  → Fixation counts
- O.M.A. *gaze long* at relevant areas to orient towards a scenario.

  → Gaze durations
- Results are dependent on difficulty of scenario and phase.



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