

# Towards an Ecological Design of a 4-Dimensional Separation Assistance Interface

SCCSM08 Workshop, Delft

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Department of Control & Simulation



## Department of Control & Simulation

### Research:

- Dynamics and control
- Human-machine systems

### Focus within human-machine systems:

Navigation, in future Air Traffic Management Concepts

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## The Predicted Future of Aviation

### Forecast for 2026:

- World passenger traffic increase by 4.9% per annum
- IFR movements within Europe increase by 3% per annum
- Number of frequencies offered on routes more than double

### Europe: Single European Sky ATM Research

- User preferred routing
- Managed vs. unmanaged airspace

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## The Concept of Self-Separation

### Human is main separator, not Air Traffic Control

#### Assisted by:

- Airborne Collision Avoidance System (ACAS)
- Airborne Separation Assurance Systems (ASAS)

#### Predictive-ASAS:

- Explicit conflict resolutions
- Low Traffic Awareness

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# Human Supervisory Control and Ecological Interface Design

## Human Supervisory Control

- Human control task is highly automated, human role shifts from controller to supervisor of the automated system
- Human relies on feedback and resolutions provided by automation

## Danger appears in case of unanticipated events:

- Human needs Traffic Awareness for resolutions
- Human needs indication of urgency
- Human needs understanding of consequences of resolutions

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## Content

- Introduction
- The EID design paradigm
- The actual design
- Conclusions
- Future Research

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## Ecological Interface Design

- Human actions are constrained by the environment or work domain, so the work domain must be understood before starting a design
- It is possible to design interfaces that provide information that the human can pick up and use
- There are visual ways of displaying information that can reduce the need for memory or mental calculation

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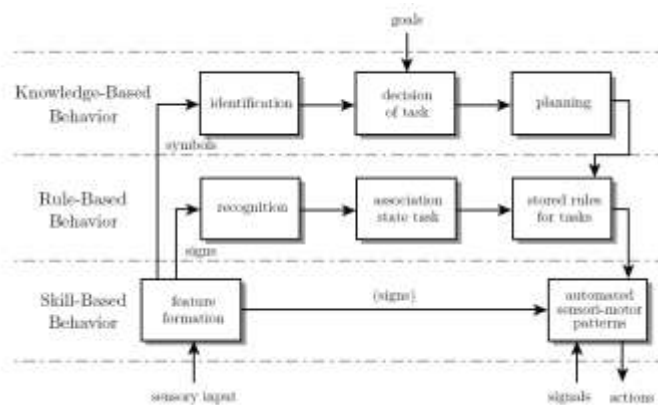
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## Skill, Rules, Knowledge Behavior



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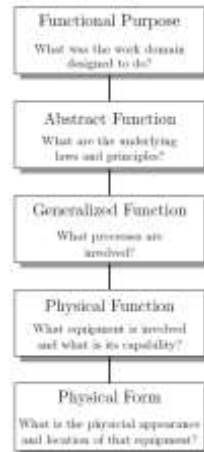
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## Approach in EID

- Work domain analysis
  - Cognitive and environmental constraints
  - Abstraction Hierarchy
- Visualize the workspace constraints



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## Previous Research within C&S (1)

### Available Displays in the cockpit:

- Navigation Display *Speed and Heading*
- Primary Flight Display: *Climb/Descent and Heading*
- Vertical Situation Display: *Climb/Descent and Speed*

### Horizontal plane

- (Extended) Airborne Trajectory Planning

### Vertical plane

- Vertical Separation Assistance Display

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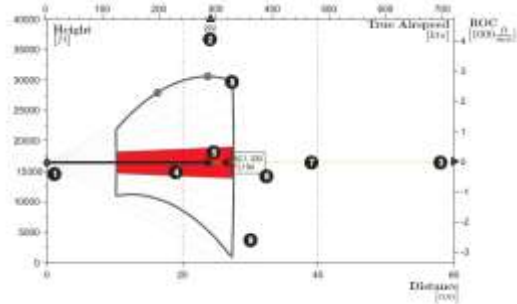
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## Previous Research within C&S (2)



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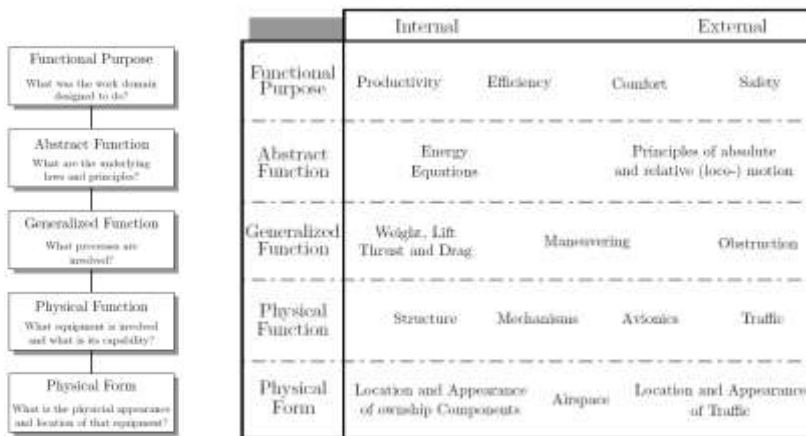
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## The Abstraction Hierarchy



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## The Information Requirements

Abstracion Level	Information Requirement
Functional Purpose	Information of the destination (spatial coordinates and time) Information of the user-preferred trajectory Information on the (conflict) situation with intruder(s) Information of (efficiency of) resolution possibilities
Abstract Function	Information of the energy balance Information on the (loco-) motion of the intruder(s)
Generalized Function	Information on the performance characteristics Information of the ownship configuration Information on the ownship kinematics
Physical Function	Information of the intruder(s) characteristics Information of the structure Information of the mechanisms Information of the avionics Information of the traffic
Physical Form	Information of ownship state variables Information of ownship control variables Information on intruder(s) state variables Information on intruder(s) control variables Information of the surrounding airspace

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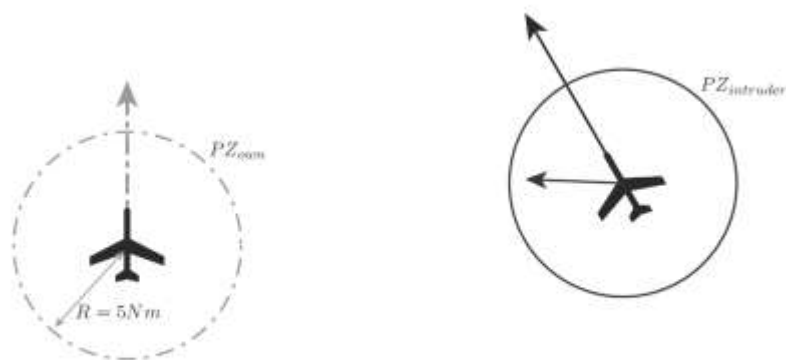
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## Relative Speed and Protected Zone



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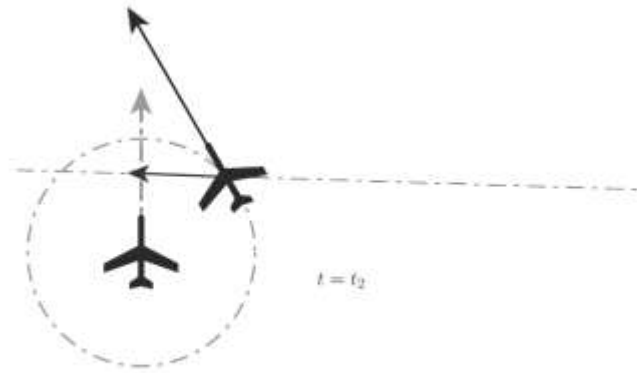
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## Relative Intruder Motion



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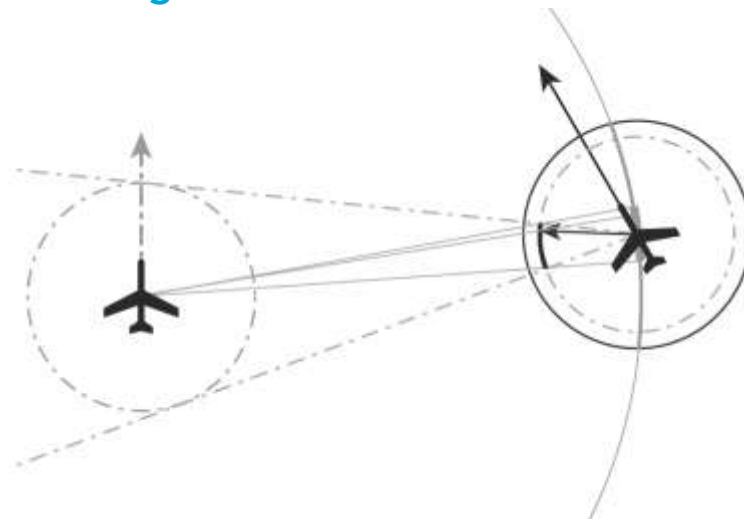
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## The Danger Area Protected Zone



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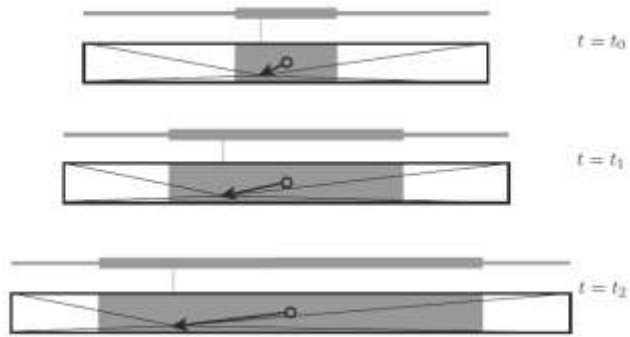
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## A Horizontal Situation Visualization



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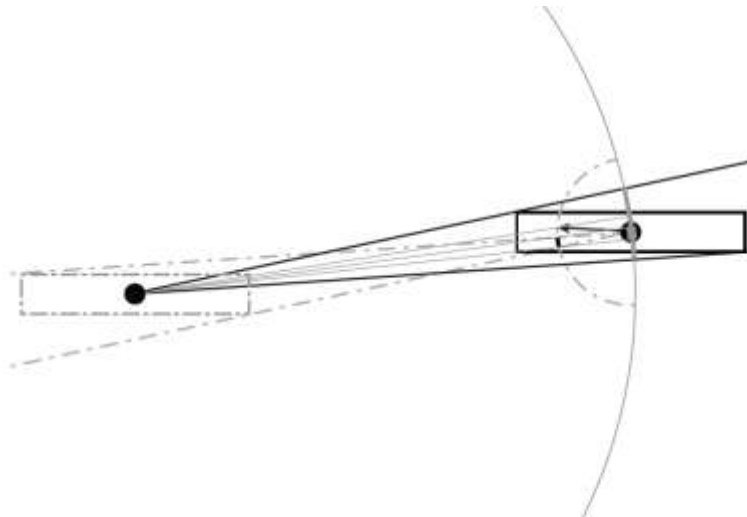
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## The Vertical Situation



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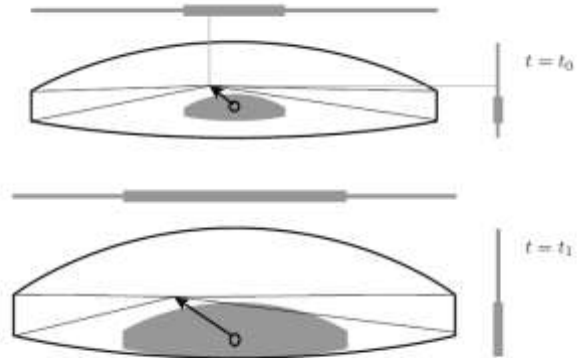
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## The Resulting Visualization



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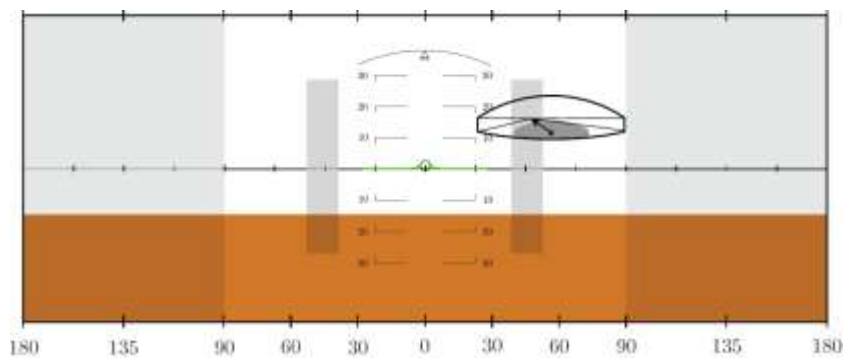
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## The 4-Dimensional Self-Separation Assistance Interface



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## Future Research

- Implement rest of requirements
- Research required resolution behavior
- Experiment with human in the loop
  - Investigate Traffic Awareness pilot
  - Investigate the Functional Purpose of the system

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