Controller Support for Time-Based Surface Management

First results from a feasibility workshop

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Motivation – Trajectories

“the description of movement
of an aircraft both in the air and on the ground
including position, time, and at least via calculation,
speed and acceleration.“

Source: The SESAR Integrated Dictionary
CADEO: Controller Assistance for Departure Optimization

- DLR´s Departure Management System (DMAN) prototype
- Implements concept „Departure Sequence Optimization“
CADEO: Controller Assistance for Departure Optimization

• DLR´s Departure Management System (DMAN) prototype
• Implements concept „Departure Sequence Optimization“
TRACC:
Taxi Routing for Aircraft: Creation and Controlling

• DLR´s Surface Management System (SMAN) prototype
• Conflict-free time-based trajectories on ground
• Speed and route advisories for air traffic controllers (ATCO)
Flight Tables
Traffic Situation Display
Advisory Panel
Trajectory
Speed Panel

LH073 Speed: 17.1 kt

08:58:11
A First Feasibility Workshop: Human-in-the-loop (HITL) Simulations

## Aims

<table>
<thead>
<tr>
<th>Aims</th>
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<tbody>
<tr>
<td>Feasibility and acceptance of time-based concept</td>
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<tr>
<td>Usability of TRACC HMI</td>
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<tr>
<td>Applicability of the coupled CADEO and TRACC</td>
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## Assumptions

<table>
<thead>
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<tbody>
<tr>
<td>Airport Collaborative Decision Making</td>
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<tr>
<td>4D-Flight Management System</td>
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<td>Compliance of arriving aircraft</td>
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<td>Execution of exact taxi speeds</td>
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</table>
Layout and Traffic Flow

- 30 Arrivals per hour
- 20 Departures per hour
Simulation Environment
Simulation Environment
Experimental Design

<table>
<thead>
<tr>
<th>Schedule</th>
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<tbody>
<tr>
<td>Baseline training (ca. 30 min)</td>
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<tr>
<td>Baseline (ca. 60 min)</td>
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<tr>
<td>TRACC training (ca. 30 - 50 min)</td>
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<tr>
<td>TRACC (ca. 60 min)</td>
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<tr>
<td>TRACC &amp; CADEO (ca. 60 min)</td>
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<tr>
<td>Distance-based operational procedures</td>
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<tr>
<td>EFS, Ground Radar</td>
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<tr>
<td>Time-based operational procedures</td>
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<td>TRACC HMI</td>
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</tbody>
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Participants: 4 Air Traffic Controllers
Selection factors: location, age, certification experience
Measures

During runs: comments

After runs: semi-structured guided interviews
- Guaranties discussion of all topics
- Allows ATCOs to select focus

Interview Topics

Concept and Implementation
- Precise Speed Advisories
- Stability and reliability of trajectories
- Optimization parameters
- Acceptability
- Satisfaction
- Efficiency

Usability of the TRACC HMI
- Information: Arrangement, timeliness, quantity
- Conflict and critical events notifications
- Traceability
- Transparency
- Plausibility
Results

More than 500 Answers and Comments

| Favorable | Neutral/ Nonspecific | Critical | Ideas for Improvements |

Considerable amount of favorable comments (190)
- Concept generally accepted
- Planned trajectory in traffic situation display was valuable
Results II

Focus

- Some Neutral/Nonspecific comments (75)
- Many Critical Comments (160)
- Many Ideas for Improvements (120)

Deducted Improvements
## Deduced Improvements

### Concept and Implementation

- Higher stability of trajectories/
  Less frequent adaptations
- Increased safety buffers
- Less speed changes in trajectory
- Reduced amount of curves
- Automatic command transmission
  (e.g. data link)

### Usability of the TRACC HMI

- Information in flight tables optional
- Clearance status and remarks
- More information in aircraft label
  (e.g. last speed command)
- Connect corresponding information
  by highlighting
- Button to prevent disappearing of
  advisories
- Transparency of reasons for adaptions
Workshop

Revised

Different colours
arrival / departure

Lock-button

Event-icon

Visualized remaining
command time

Commands

11  LH4790  Pushback approved FB37s.

25  LH038  Reduce speed to 9 kt.

50  LH038  Reduce speed to 8 kt.

67  LH007  Line up rwy 33.

85  LH4790  Taxing via taxiways A, G, R to rwy 33.

LH038  Increase speed to 8 kt.

LH007  Line up rwy 33.

LH4790  Tax via taxiways A, G, R to rwy 33.

LH4790  Increase speed to 23 kt.
Workshop

Revised

No status input / output display available

Status selection panel

- NONE
- Start-Up Requested
- Start-Up Given
- Push-Back Requested
- Push-Back Given
- Taxi-Request
- Taxi-Given
- Handover
- Cleared to Cross
Different colours
arrival / departure
Conclusions & Future Work

Conclusions
• Concept is feasible
• Acceptance by ATCOs

Constraints
• Aircraft must be able to adhere to precise taxi speeds
• SMAN must be highly reliable

System Improvements
• Reduce amount of voice communication
• Increase safety margin
• Improve coupling of TRACC and CADEO

Future Work
• Validation of improved TRACC and CADEO coupling and revised HMI
• Proof benefits of coupled 4D air-ground trajectories
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More Information About…

- **TRACC**
  

- **TRACC and CADEO Coupling**
  

- **360° Tower Simulator**
  