The Use of Simulation Models for Airport Planning and ATM Analysis at the Institute of Flight Guidance
Overview

1. Key areas and sites of DLR
2. Characteristics of the Air Transportation System
3. Institute of Flight Guidance – motivation, challenges and mission
4. Use of Models at the Department of Air Transportation
5. Recent projects in the Department for Air Transportation
6. Outlook and Vision
7. Networking – International cooperation (AT-One)
The DLR
German Aerospace Research Center
Space Agency of the Federal Republic of Germany
Key areas

- Aeronautics
- Space
- Space Agency
- Transport
- Energy
Sites and employees

5,700 employees working in 29 research institutes and facilities

- at 13 sites.

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Forecast of Eurocontrol

Quelle: Eurocontrol
Motivation – SESAR D1 Results

2005: 10.5 Millionen
Motivation – SESAR D1 Results

2005: 10.5 Millionen

2010: 12.5 Millionen
Motivation – SESAR D1 Results

2005: 10.5 Millionen
2010: 12.5 Millionen
2020: 17.2 Millionen

YEAR 2020
17.2 millions
Economic Effects of an Airport

1 Slot at FRA equals Employment:

At the Airport: 750
At the vicinity: 1,650
Total: 2,400

Source: Fraport

1000 t Freight equals Employment:

At the Airport: 8
At the vicinity: 16
Total: 24

Income:

At the Airport: 1
At the vicinity: 1,7

Employment effect:

At the Airport: 1
At the vicinity: 3

Source: Fraport
Gate to Gate Quality Example of a Daily Scheduled Flight

Distribution of the differences between planned and real on block times with different distances to the source airport

- **Deutschland** (n = 1024)
- **Südostasien** (n = 1401)

Relative frequency

Deviation on planned on block time [Min]

- too soon
- too late
European Aeronautics Research: Vision 2020

- Phillipe Busquin, European Research Commissioner
- Group of Personalities (GoP)
  „Meeting society‘s needs and winning global leadership“
  3x as much airtransportation companies as it is today
- 1/5 of today‘s accident rate
- 99% punctuality
- 15-30 min transfer time
Statistic in total loss 1959-1995

82% from all the accidents are on or near the airports

Quelle: BOEING
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Institute of Flight Guidance
Our site in Braunschweig!
Institute of Flight Guidance (FL) – Challenges

Challenges to a future Air Transport System:
- Environmentally friendly
- More efficient
- Higher capacity
- “Safe” and “Secure”

AIR TRAFFIC MANAGEMENT and airport movements / processes are optimized via
- more automation and
- determination of the optimal role of the human operator.
Institute of Flight Guidance (FL) – Mission

- conducts applied research in the Air Traffic Management area,
- designs concepts, processes, procedures and tools;
- develops adequate prototypes,
- evaluates internal and external products
- with the focus on the **Airport** and the **Terminal Area**.

The Institute of Flight Guidance is the Air-Traffic-Management (ATM) competence centre within DLR and the “Research Centre of Excellence for Airport Airside Management” in Europe.
Institute for Flight Guidance (FL) – Products and Services

- Consulting
- Studies und Concept Development
- Solutions and Prototypes (Procedures/ Software/ Hardware)
- Evaluation und Validation
- (Training )
- (Implementation & Service)

- ISO-9001 Certificate
Institute of Flight Guidance (FL) – Market share „Technology-readiness-level“ (TRL)
## Institute of Flight Guidance (FL) – Organisation

### Structure
- **Departments**
  - Air Transportation
  - Controller Assistance
  - Pilot Assistance
  - ATM Simulation
  - Operations Control
  - Human Factors
  - Management Services
  - Business Manager

### Resources
- ~ 140 employees:
  - ~ 70 Scientists
  - 1 Guest Scientists
  - 8 PhD Students
  - 10 Diploma Students
  - 5 Trainees

### Infrastructure
- **IT**
- Fast-Time Simulation
- Human-in-the-Loop-Simulation
- Ground Operations
- Cockpit
- Data Links
- Test Aircraft
- Research Airport Braunschweig
- A-SMGCS Test bed
- GBAS

### Networks
- **AT-One**
- DLR Institutes
- Universities
- Industry
- Bodies / MoU / Action Plans
- Eurocontrol
- NASA / MIT / FAA
- EATRADA, ASDA,
Department of Air Transportation

- Modelling the air transportation system with analytical and fast time simulation models
- Evaluation of infrastructural and operational changes at the airport and the TMA for capacity and environmental questions
- Consultancy of airport stakeholders
- Drafting of experts’ reports of airport capacity
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R&D Projects

Research and Development (Tools and Methods)

- Concept
- Prototype
- Implementation

Analytical Models
Fast-time simulation
Real-time simulation
Flow Monitor
**Capacity – Capacity curve**

- **Traffic flow [a.c./h]**
- **Average delay [min/vehicle]**

- 4-Minutes - Capacity
- 8-Minutes - Capacity
- 'Real' capacity
- Saturation capacity
- Increased capacity
- Increase of traffic flow
- Lowering the level of processing delays

- 30 a.c./h: 4 min/vehicle
- 35 a.c./h: 8 min/vehicle
Analytical Models
Simmod
Simmod: Characteristics

- Microscopic modell of the air side
- Originally created in the 80’s by the FAA (Federal Aviation Administration)
- Different versions on the market
- Widespread
- Simple node – link structure
- Typical simulation time of one traffic day is between 1 and 2 minutes
- Closed system
- **SIMMOD Pro: missions execute profiles**
AirTOp
AirTOp Fast Time Simulator: Characteristics

- Single graphical user interface
- Integrated map and 3D views
- Project management support
- Multi agent architecture
- En – route simulation
- Approach and departure
- Airport ground movements
- Intuitive simulation analyses
- Extensive and customizable
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Recent Projects in the Department

- SPADE I/II: The objective of the SPADE project is to develop a user-friendly decision-support system for airport stakeholders and policy-makers;
- CREDOS: aims at developing mitigations for wake turbulence separation minima for departure operations namely through the monitoring of the meteorological situation;
- JTI Clean Sky: will develop breakthrough technologies to significantly improve the impact of the air transport on the environment;
- EWMS: was developed to support, simplify and enhance the process of simulation analysis and evaluation.
SPADE - Supporting Platform for Airport Decision-Making and Efficiency Analysis

SPADE platform will integrate set of use cases as defined by airport stakeholders in SPADE Workshop. Examples of use cases:

- Identification of bottlenecks
- Impact of new equipment / procedure
- Loss of capacity due to contingency
- Alternative airport layout
- Changes in traffic volume
CREDOS – Crosswind Reduced Separations for Departure Operations

- Background
- Scope
- Objectives of the Project
- Organisation of the Project
- Expected results
- Meeting the SESAR objectives
JTI (Joint Technology Initiative) Clean Sky

- Largest European research project
- 50% reduction of CO2 emissions through drastic reduction of fuel consumption
- 80% reduction of NOx (nitrogen oxide) emissions
- 50% reduction of external noise
- A green product life cycle: design, manufacturing, maintenance and disposal / recycling
EWMS - The Extensible Workflow Management for Simulations

- Internal project
- History
- Objectives:
  - Data backup strategy
  - Transparent post processing
  - Standardised reporting
- Vision
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The Air Transportation department

- Analyses for users, stakeholders, and developers of Air Traffic Systems potential improvements in terms of new techniques and procedures

- Models under the constraints of safety, environment, performance, and economy effects of system modifications and

- Determines the capacity of the systems by using traffic throughput and delay criteria.
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Facts & Figures

- Strategic Alliance of the DLR Institute of Flight Guidance and the NLR Air Transport Division
- Shareholders: 50% DLR, 50% NLR
- Locations: Braunschweig, Amsterdam & Brussels
- Total employees: ~ 260
- Yearly Turnover: ~ 35 M€
- Background: additional 1400 employees in Air Transport Research

The largest ATM research organisation in the world
Network – AT-One Infrastructure

- Simulators
- Research Aircraft