Automation in ATM System Design

Human Factors and System Safety Seminar

Dr. André Perott
Outline

- Motives for Automation
- Automation Strategy at DFS
- Conclusion
Introduction
Current Challenges in Air Traffic Control

- **Air Traffic Control** (ATC) in Europe is under tremendous pressure to develop and change.

- **High-level goals for the Single European Sky** in 2012 to be met by 2020 and beyond:
  - Enable a *3-fold increase in capacity* which will also reduce delays both on the ground and in the air
  - Improve *safety by a factor of 10*
  - Enable a *10% reduction* in the effects flights have on the *environment*
  - Provide *ATM services* to the airspace users at *a cost of at least 50% less*

SESAR (2015)
The Promise of Automation

“Automation is more efficient”

“There has to be a technological solution”

“Automation leads to safer operations”

“Automation reduces personal costs”

“Automation reduces workload”

“Automation avoids mental overload”

“Automation overcomes human limitations”
But how to implement good automation?

**Phenomenons**

- More Capacity
- Skill Degradation
- Market Leadership
- Automation Surprise
- Cost Reduction
- Normalization of Deviance
- Taskload
- Better Efficiency
- Workload
- Ironies of Automation
- Situational Awareness
- Management Expectations
- ISO Dialogue Principles
- Complacency
- Human Centered Design
- Task Analysis
- System Usability Scale

**Human Factors Methods**

- Better Efficiency
- Cost Reduction
- Market Leadership

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From Problem Setting to Problem Solving

Context of Use

Problem Setting
Automation Strategy at DFS
What is Automation?

Automation is the **process** and its **result** of passing tasks (and activities) to a machine that were previously executed by humans.

Hauß & Timpe (2002)

1. What is the desired automated **target state** and how do we recognize it?

2. How can we achieve this target state and which **intermediate steps** are necessary (process of automating)?

3. How does it impact the **overall organization** (selection, qualification, training, procedures, roles, etc.)?
DFS - Desired Target State

**C2: Automated Decision Support:**
The system proposes one or more decision alternatives to the human, leaving freedom to the human to generate alternative options. The human can select one of the alternatives proposed by the system or her/his own one.

**Save & Feuerberg (2012)**

**D3: Low-Level Support of Action Sequence Execution:**
The system performs automatically a sequence of actions after activation by the human. The human maintains full control of the sequence and can modify or interrupt the sequence during its execution.

**Save & Feuerberg (2012)**

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Levels of Automation

0
1
2
3
4
5

DFS Systems (Target State)

Fully Automated

Action Implementation
Process of Automating Levels of Implementation

- **Decision Support Systems**
  - Strategic direction for increasing capacity
    - **Design**

- **Support of Information Analysis**
  - Highly automated sub systems
    - **Integrate**

- **Conflict Detection**
  - Basis for every automated support
    - **Optimize**
Optimization of Conflict Detection
Receiver Operating Characteristic (RoC)
Process of Automating
Levels of Implementation

- Decision Support Systems
- Support of Information Analysis
- Conflict Detection

Strategic direction for increasing capacity
  ➤ Design

Highly automated sub systems
  ➤ Integrate

Basis for every automated support
  ➤ Optimize
Support of Information Analysis
Integration of Automated Sub Systems
Support of Information Analysis
Current Stage of Automation

Highly automated sub systems for information analysis

Manual integrated information analysis

Manual alignment of identified conflicts with other information systems

Integrated Information Analysis

Decision
Process of Automating Levels of Implementation

Decision Support Systems

Support of Information Analysis

Conflict Detection

Basis for every automated support

Optimize

Highly automated sub systems

Integrate

Strategic direction for increasing capacity

Design

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Support of Decision and Action Selection
First Conceptual Thoughts

Potential actions
- Change direction
- Change altitude
- Change rate of climb / descent
- Change speed
- Combined actions
  (temporary) omission of actions

Restriction free actions
- Action clear of
  Trajectory based restrictions
  Air space based restrictions
  Conflict based restrictions
  Weather based restrictions
  Chronological restrictions

Optimized actions
- Optimisation based on certain criteria (e.g. minimized distance, minimized fuel consumption, fastest route)

Resolve Conflicts
Traffic Planning and Controlling

Decision
Conclusion
Conclusion

- Automation is considered as one of the key factors to encounter cost and production pressure.
- There is a trend to focus on automation technology instead of the automation purpose (based on the context in which technology is used).
- A automation strategy helps to align different technological developments by providing a consolidated automation purpose.
- DFS suggests three steps for purposeful enhancement of automation:
  - Optimization of current conflict detection tools
  - Integration of (partly) automated sub systems
  - Conceptual design of new decision support tools
- Extension to a company wide automation strategy by incorporating organizational aspects (e.g. selection, training, roles, procedures).
- On an international level: Shift from a currently technology driven discussion (e.g. SESAR, iTEC) to a purpose driven discussion.
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Literature


Graphics References
