Impact of future time-based operations on situation awareness of air traffic controllers

Koen van de Merwe, National Aerospace Laboratory
Akos van der Plaat, ATC the Netherlands
SARA\textsuperscript{1} Project Partners

\textsuperscript{1} Speed And Route Advisor
Contents

• Current operation
• LVNL strategy
• SARA project
• SARA functionality
• Real-Time Simulation
• Operational trial
• Conclusions
Current operation

• Schiphol = hub and spoke – peaks
• Schiphol fed by ACC via 3 IAFs
• Amsterdam FIR about 120 NM across
• Flights planned 14 mins (about 90NM) before IAF
• 11 different adjacent centres/sectors feed arrivals
• Bunching major problem
• Target over IAF: +/- 120 sec
LVNL Strategy for Time based operations

Metering at IAF to achieve efficient fixed routes and CDA’s in the TMA

Avoiding conflicts pre-tactical in the TMA

Avoiding conflicts in the pre tactical in the Sectors
First Step: Ground based AMAN

• Meeting early SESAR and NextGen requirements
• Tailored arrivals on the whole fleet in high density airspace
• Short term implementation
• Striving to comply with SESAR - CTA
SARA project

• Concept of Operations
  – Develop & Validate

• Increase accuracy at IAF
  – Increased predictability for air and ground

• Efficient aircraft descents
  – Flight efficiency
  – To manage workload for controllers and aircrew

• Inter-centre coordination
SARA functionality

SARA is an Area Control tool

SARA Scope

UAC

FIR Boundary

ACC

IAF

TMA

TOD
SARA Concept overview

**Concept 1**
Speed

**Concept 2**
Speed
Static Route

**Concept 3**
Speed
Dynamic route
Conflict
Management Tool
SARA functionality

SARA generates advice

Speed: IAS 270K
Route: N3B (via ROBIS)
ATC Performance Model\(^1\)

**PROCESS**

- **Information processing**
  - **Situation assessment**
    - **Perception**
      - Monitoring
      - Identification
    - **Attention management**
  - **Interpretation (mental picture)**
    - Interpretation
    - Anticipation
    - Checking

- **Planning & decision making**
  - **Conflict solving**
    - Creativity
    - Not ‘adhoc’
    - Flexibility
  - **Decision making**
    - Prioritizing
    - Initiative
    - Temporality

**OUTCOME**

- **Traffic handling**
  - Communication
  - Co-ordination
  - Strip & label management
  - Equipment operation
  - Safety
  - Efficiency

**Influences**

- Workload management
- Teamwork ability
- Attitude

\(^1\) Oprins, Van Weerdenburg and Burggraaf, 2006
Automation support & SA

- **SA is a key competence**\(^1\)
- **Increase in automation expected**\(^2\)
- **Out-of-the-loop performance**\(^3\)
  - Less insight in system versus;
  - Mitigation reduction of SA

- **SARA partial automation**

---

\(^1\) Oprins, 2008
\(^2\) SESAR, 2007; NextGen, 2008
\(^3\) Endsley, 1995
Real-Time Simulation Setup

- 8 LVNL controllers & 8 pseudo pilots
- Measurements
  - EAT accuracy
  - SA (SASHA-Q)\(^1\)
  - Workload (R/T load, TID & ISA)
  - Observers & interviews

<table>
<thead>
<tr>
<th>Run</th>
<th>Target time over IAF</th>
<th>System support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Within plus or minus +/- 120 sec</td>
<td>Present</td>
</tr>
<tr>
<td>2</td>
<td>Within plus or minus +/- 30 sec</td>
<td>Delta-T in label</td>
</tr>
<tr>
<td>3</td>
<td>Within plus or minus +/- 30 sec</td>
<td>SARA Speed only</td>
</tr>
<tr>
<td>4</td>
<td>Within plus or minus +/- 30 sec</td>
<td>SARA Speed &amp; Route</td>
</tr>
</tbody>
</table>

\(^1\) Dehn, 2008
Real-Time Simulation Setup
Real-Time Simulation Results

- EAT accuracy
  - Improved

- Situation Awareness
  - Affected

- Workload
  - Affected
Real-Time Simulation Results - Qualitative

1. Stricter focus on time
   - Different traffic handling
   - Impact on mental process

2. Automation support
   - Different strategy
   - Conflict solving: late vs. early

3. Familiarity
Operational trial
Setup

- Live setup
- 8 sessions
- Speed-only SARA
Operational Trial
Preliminary results

1. Improvement in EAT accuracy

2. Focus on time
   - Different traffic handling

3. Automation support
   - Monitoring
   - Situation Awareness
Conclusion & Discussion

• Improved EAT accuracy
• Change in working method
  – Time-based Operations
  – Automation support

• SA in TBO influenced by system design
  – Trade off between accuracy, SA and WL
  – Gradual implementation required

• Requirements for SA in TBO
  – Active controller
  – Responsible controller
Thank you for your attention

Koen van de Merwe
merwe@nlr.nl

Akos van der Plaat
A.H.vanderPlaat@lvnl.nl
Slides for additional discussion
Applications of the model

- Selection of ATCOs
- Assessment in training
- ATM system design

Goal: reduction of work complexity

2 most important reasons for failing (research all trainees 2003–2006)
- Situation Awareness
- Workload Management

‘Less learnable’ competences
SARA Technical Principle

- Surveillance
- Trajectory Predictor
- Meteo
- Inbound Planning EAT
- SARA Speed & Route
- ATC
Real-Time Simulation
HMI
Real-Time Simulation
SARA design cycle
Real-Time Simulation Results - Workload

- Run 2 highest ISA score
- $F(3,68) = 17.256, p < .001 \ \eta_p^2 = .432$
Operational Trial
Preliminary results

- EAT adherence
Real-Time Simulation Results - EAT adherence

- Significant difference between runs
- $F(3,63) = 40.918, p < .001, \eta_p^2 = .661$
Situation Awareness

- $F(3, 29) = 37.304, \ p < .001, \ \eta_p^2 = .794$
• $F(3,3) = 21.985, p < .05 \quad \eta^2_p = .956$