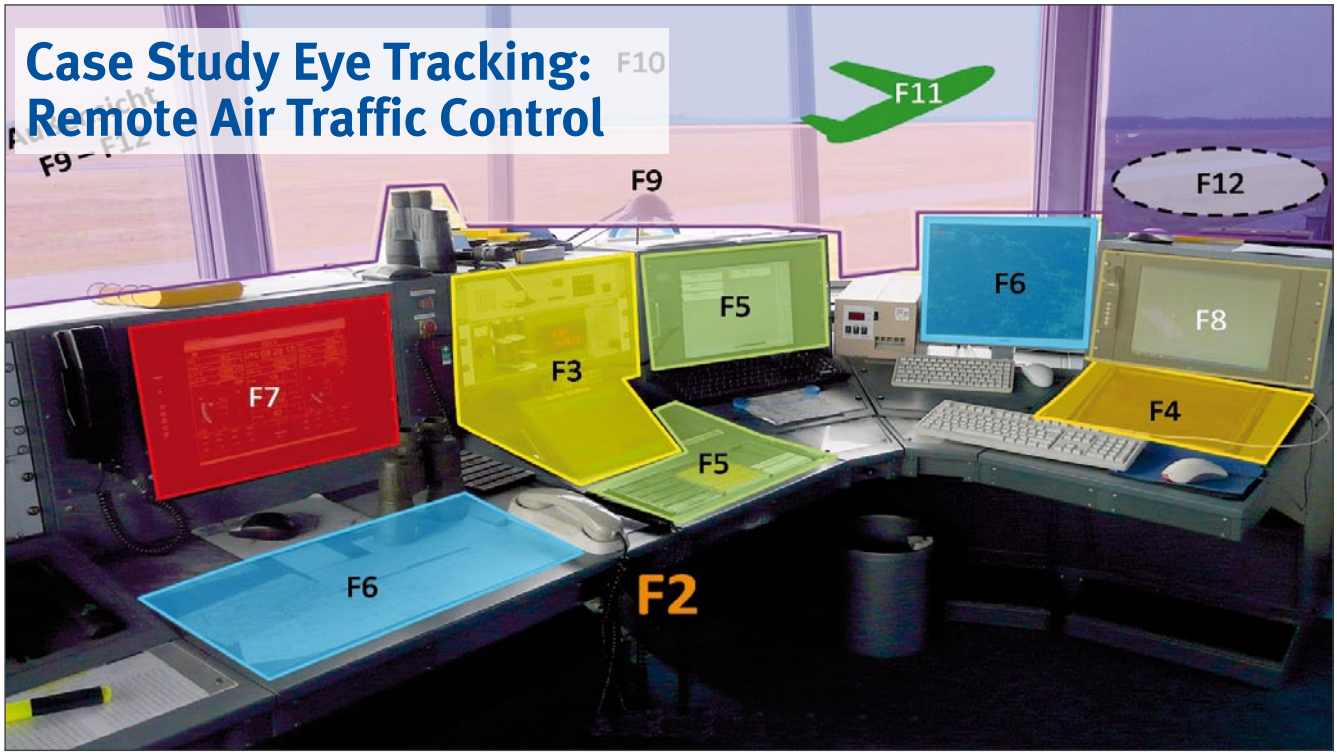
SMI
SensoMotoric Instruments

Human Factors Consult

DFS Deutsche Flugsicherung

Case Study Eye Tracking: Remote Air Traffic Control



The German Air Traffic Control and Human Factors Consult conducted a field research concerned with the development of a remote tower facility for small and regional airports. The analysis of gaze behavior of tower controllers conducted with SMI mobile eye tracking technology was a key method used within a user-centered approach.

BACKGROUND

For nearly one century, air traffic control has been based on visual surveillance of the airport premises and the adjacent airspace out of the tower window.

However, this approach is limited by the expansion of airports, where visibility is more likely to be obstructed, and limited by inclement weather. These challenges triggered efforts to build a controller workplace independent of visibility conditions and location.

The project VICTOR (Virtual Control Tower Research Studies) is concerned with the development of a remote tower facility especially for small and regional airports. VICTOR is part of the German Aviation Research Program, iPort.

The first step of the overall research plan within VICTOR was a workplace analysis conducted by the German Air Traffic Control and the usability consultancy Human Factors Consult GmbH.

www.dfs.de
www.human-factors-consult.de

CHALLENGE

Multiple approaches for remote tower control workplaces have been developed for large international airports.

However, a standardized workplace concept designed for remote control at smaller or regional airports faces unique challenges: the heterogeneity of equipment and infrastructure and a large portion of hard-to-schedule traffic.

SOLUTION

In order to develop requirements for a new controller workplace, the German Air Traffic Control and the usability consultancy Human-Factors-Consult GmbH (HFC) performed a workplace analysis at three regional German airports.

The analysis of gaze behavior of tower controllers conducted with SMI head-mounted mobile eye tracking technology was a key method within this user-centered approach.

CONCLUSIONS

Besides the traffic volume, gaze behavior seems to depend on the technical inventory present in the tower. Information and assistance systems are looked at frequently when available at the workplace. If equipment is scarce, the view out of the tower window is the major source of information.

In order to establish processes of air traffic control independent from visual surveillance, the development of special instruments with sensor-based data is essential.

BENEFIT

Based on the workplace analysis, a catalog of requirements for the new controller workplace was developed. Eye tracking data was used to weight the importance of pieces of visual information for air traffic control tasks.

Detlef Schulz-Rueckert, German Air Traffic Control (DFS):

"...Eye tracking was an essential tool within our study because it provided objective data on the visual information intake and communication processes required for air traffic control tasks..."

Case Study

STUDY DESIGN

The study was conducted at three regional German airports, each of which differ in traffic density and traffic mixture. The layout of the airports is similar, but the workplaces differ considerably regarding equipment and arrangement of technical aids.

The main goals of the workplace analysis were the investigation of the controllers' visual information intake, processes and the tasks to be fulfilled.

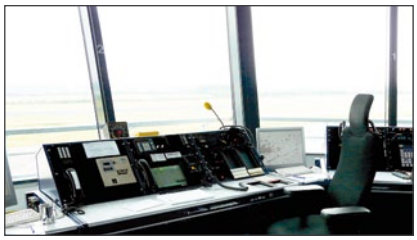
Eight traffic controllers with an average age of 32 years took part in the study. An observation session took 60-90 min for each controller and was conducted during the regular work shift.

Methods used:

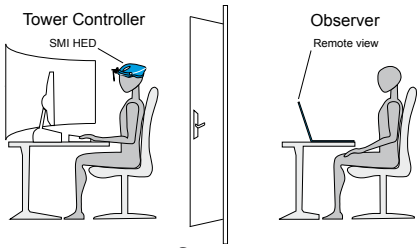
- Mobile eye tracking
- Two cameras in the tower interior and the apron plus audio data
- Session followed by questionnaire & standardized interview

The gaze-data was prepared for analysis by integrating the different camera perspectives into one overall video stream playable framewise.

For each airport tower, twelve comparable Areas of Interest (AOIs) were defined. They represented the sources of information available to the controller to fulfill his or her tasks.



Workplace Dortmund airport

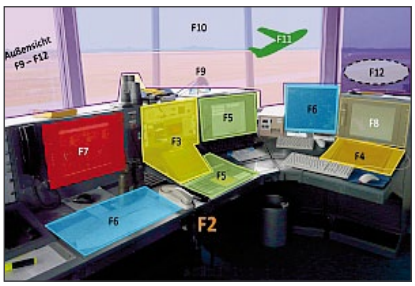


Set up

Camera leading to tower interior

FINDINGS

1 AOIs assigned to sources of information



The gaze videos were analysed for usage frequency (how often an AOI was gazed at) and usage duration (how long an AOI was gazed at compared to the overall observation time).

2 View out of window most frequent!

Share of attention (%)	Airports		
Information Category	AOC	NRN	DTM
out of window	53.8	28.0	26.2
day flight plan	n/a	13.0	n/a
weather monitor	10.7	3.0	3.6
radar/table maps	1.8	19.2	30.9
flight strips	12.9	12.7	20.5
lighting control panel	0.8	2.6	1.6
radiogoniometer	3.8	2.9	3.6
other	14.1	15.2	12.9
error/not codable	1.9	3.3	0.6

Depending on the airport, the view out of the window was used most or second most frequently. The proportion was highest at the airport which did not have a radar monitor.

3 Long duration for view out of window!

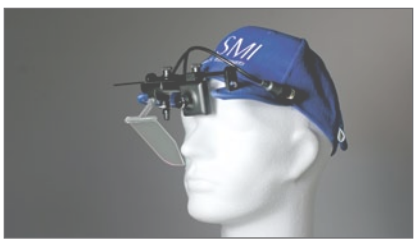
Gaze duration (s) mean	Airports		
Information Category	AOC	NRN	DTM
out of window	4.9	4.7	4.0
day flight plan	n/a	5.2	n/a
weather monitor	2.9	2.4	1.9
radar/table maps	3.2	2.3	4.1
flight strips	4.5	4.4	2.6
lighting control panel	2.4	2.3	3.8
radiogoniometer	2.0	3.2	1.7
other	5.0	5.9	3.3
error/not codable	3.1	4.1	3.2

The higher share of attention for the view out of the tower window corresponded with the relatively long gaze durations for this category.

SMI EYE TRACKING

The SMI HED mobile eye tracking solution provided data on the gaze behavior of tower controllers. The wide angle objective was used to cover the large field of view within the tower and out of the window.

Eye tracking was essential to objectively assess the role of different sources of information for air traffic control tasks. Only with this information, valid requirements for instrumentation of a remote ATC workplace could be defined.



SMI HED

Contact Information

SensoMotoric Instruments GmbH
Warthestr. 21
14513 Teltow
Germany
Phone: +49 (0) 3328 – 39 55 – 10
Fax: +49 (0) 3328 – 39 55 – 99
E-mail: sales@smi.de

SensoMotoric Instruments Inc.
28 Atlantic Ave
236 Lewis Wharf
Boston, MA 02110 USA
Phone: +1 - 617 - 557 - 00 10
Fax: +1 - 617 - 507 - 83 19
E-mail: sales@smivision.com

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