CCTV - case study traffic management highway tunnel

Kirsten B.J. SCHREIBERS Eur. Erg. (1) and Joost L.A. BOUCHIER (2)

1. INTERGO human factors & ergonomics, Utrecht, The Netherlands
2. Dutch Ministry of Infrastructure and the Environment, The Netherlands

Abstract. For traffic managers supervising a newly built highway tunnel the existing individual video wall with four 30"LCD-TFT displays was replaced by six 46" LCD-TFT displays. Obvious deterioration of some video wall qualities occurred: smaller images, lower resolution, twofold increase of monitor luminance (risk of glare). However the traffic managers were much happier. Which parameter really influences perceived image quality?

Keywords. Closed Circuit Television (CCTV), control center design, traffic control, perceived image quality.

1. Introduction

As part of a research project aiming for human factors guidelines for CCTV control center design, eight cases were examined (Pikaar & Lenior, 2014). The purpose was to gain insight in CCTV operator tasks and current CCTV instrumentation. One of the case studies was a dedicated workstation in a traffic management center including an individual video wall, meant for supervising a newly built four-tube highway tunnel of 1.7 km.

Within a year after start-up the traffic managers asked the IT-department for more video images (without decreasing the image size), in order to improve their ability to prevent traffic jams in the tunnel. As a consequence, the display area should be enlarged.

The workstation consists of a personal desk with six 22” LCD-TFT monitors and a personal video wall. The video wall originally consisted of four 30" LCD-TFT displays (2560 x 1600 pixels, ratio 16:10 and pixel size 0.251 mm, specified brightness 350 cd/m^2) at 1.4 m viewing distance. Each display was allocated to one tunnel tube. On each display a choice of eight out of 32 possible images were presented. In addition ten low priority images were shown on a screen located on the desk. Upon their request the IT department decided to replace the existing video wall with a larger one. The new video wall consists of six 46" LCD-TFT displays (1920 x 1080 pixels, ratio 16:9 and pixel size 0.53 mm, specified brightness 700 cd/m^2) at 2.2 m viewing distance. Bezels of the new monitors are hardly visible. Human factors professionals analyzed the differences in user experience between the old and the new situation.

2. Methods

Relevant information was gathered by an experienced ergonomist during two on-site task analyses. The analysis focused on the situation (drawings, technical data, photographs), observation of operator task performance and semi-structured interviews with operators based on relevant variables from literature review (Schreibers et al., 2012). One visit concentrated on the 'old' situation and one on the 'new' situation. The analysis in

the new situation took place approximately eight weeks after installation. A standardized task analysis protocol was developed and used (Schreibers et al., 2014).

3. Results

The workstation of the highway tunnel traffic manager is part of a regional traffic center, with four other, almost identical workstations for regular highway traffic management. Operators rotate daily over the workstations.

Figure 1: Impressions of the workstation with 'old' (left) and new video wall (right).

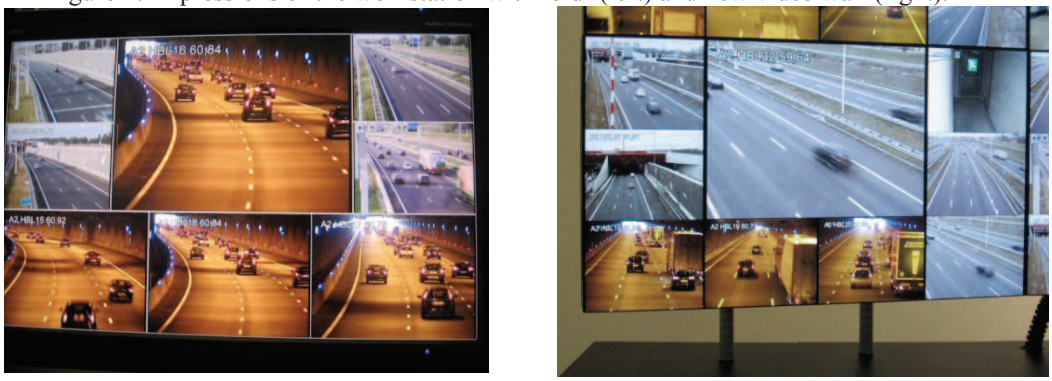

Figure 2: Detail of old (left) and new (right) video wall monitor units; different layouts for overview.

A standard layout for each tube has been realized (see figure 2): three consecutive images in a tunnel tube for detection tasks, preceded by two images in front of the tunnel and followed by two images immediately at the end of the tunnel. The larger image in the middle is a automatic copy of the second/ central image of the sequenced tunnel images, meant for detailed identification.

Considering technical changes the results are contradictory. Notwithstanding the aim for similar size images, the detection task images on the new video wall appeared to be smaller. This is the result of the lower resolution and the larger viewing distance. The detailed identification task images do not differ in size effectively. In spite of the observed lower resolution and ratio changes users did not remark themselves other changes like granularity or distortion (although present). The most remarkable difference was an up to 200% higher monitor luminance (about 700 cd/m^2). This increase leads to risks of large contrasts, compared to looking at other monitors on their workstation (250 cd/m^2).

4. Discussion

The human factors question is, to what extent does the higher display luminance possibly compensates for the smaller image sizes and lower resolutions? Which parameters really influence the *perceived* image quality? In new follow up experiments the influence of contrast and brightness will be related to the viewing tasks monitoring, detecting,

recognizing and identifying (Bennis et al., 2014). Verification and validation tests could thus be improved in future.

With the increase in amount of images presented, including a larger traffic area, operators felt better equipped for pro active traffic management. This may be contrary to laboratory research which shows that an increase of the number of cameras for a single operator has a cost in a decrease in target detection performance (Wood, 2014). Results varied from 85% accuracy for target detection on one monitor gradually declining to 53% accuracy for the same target detection tasks on nine monitors. Wood (2014) also states that monitoring of flows along a highway to keep a general overview, with large numbers of images can be acceptable.

It particularly seems that the apparent more properly balanced experienced workload over the workstations contributed to the satisfaction of the operators. The traffic managers anyhow were much happier and hoped all other video walls to be replaced soon. They felt that the workstation looked much more impressive than before.

The latter argument agrees partly with findings from Reinstra & De Groot (2014). Another possible explanation for the preference of the new video wall might be the almost universal need of any operator for more information and images. While designing a new CCTV-system for remote bridge and lock operation the HF engineers involved experienced that the operators preferred more camera images than the HF engineers considered useful, based on necessary sight requirements. The main reasons for the final compromised 10% expansion of their images were related to tasks that officially did not belong to their responsibilities, feelings of being insecure about task performance, and the desire to express feelings of performing important and complex tasks (Reinstra & De Groot, 2014).

In this case the human factors specialist reviewed the results of a change and did not participate in the design process nor evaluated the process, thus only guessing after exact motivations. New ongoing research on tasks and complexity of CCTV images will point out to what extent changes like this, expanding amount of CCTV monitors, will influence workload and thus task performance of the operator (Pikaar & Lenior, 2014).

Acknowledgement

This research would not have been possible without the funding by H.I.T.T. Traffic, IHC Dredgers/ IHC Beaver Dredgers, Nedap Security Management, Rijkswaterstaat, Rijksbelastingdienst, Dutch Railways, ProRail ICT Services, Royal Haskoning DHV, Total E&P, Vopak Management Netherlands B.V., Waterschap Hollandse Delta, DG-Organisatie Bedrijfsvoering Rijk and Province of North-Holland.

References

Bennis, A., Landman, R.B., & Lenior, D. (2014). CCTV mediated observation versus non-mediated observation: measuring technology effects on perceived image quality. In: O. Broberg, et al. (Eds.) Proceedings of the XI conference on Human Factors in Organizational Design and Management (pp. this issue). Copenhagen.

Pikaar, R.N, & Lenior D. (2014). Human factors guidelines for CCTV control center design. Introduction to a symposium. In: O. Broberg, et al. (Eds.) Proceedings of the XI conference on Human Factors in Organizational Design and Management (pp. this issue). Copenhagen.

Reinstra, S. & Groot de, N. (2014). How to sell a room without a view? In O. Broberg, et al. (Eds.) Proceedings of the XI conference on Human Factors in Organizational Design and Management (pp. this issue). Copenhagen.

Schreibers, K.B.J., Landman, R.B., Pikaar, R.N. (2012). Human Factors of CCTV; Part 1. Technology and Literature review. ErgoS, HAN University, Intergo, **vhp** humn performance, p/a Enschede: ErgoS Engineering & Ergonomics.

Schreibers , K.B.J., Landman, R.B., Jansen, J., Weide van der R., Bruijn de D. (2014). CCTV supervision or

surveillance - What's in a name? In O. Broberg, et al. (Eds.) Proceedings of the XI conference on Human Factors in Organizational Design and Management (pp. this issue). Copenhagen.

Wood, J. (2014). CCTV - Human factors challenges. In O. Broberg, et al. (Eds.) Proceedings of the XI conference on Human Factors in Organizational Design and Management (pp. this issue). Copenhagen.