Understanding Work in Public Transport Management Control Rooms

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CSCW '17 Companion, February 25 - March 01, 2017, Portland, OR, USA
ACM 978-1-4503-4688-7/17/02. http://dx.doi.org/10.1145/3022198.3026341

Abstract
Urban transport systems are increasingly important for modern cities as they provide sustainable transport and a positive social environment. The systems that allow controlling transport infrastructures integrate many legacy systems and require increasing resources for maintenance. Authorities managing public transport facilities not only need to dynamically adapt to the daily fluctuations in city life, but they also strive to be in constant dialogue with the citizens. In this poster paper, we present our preliminary insights from a study where we looked closely at the operations centre of a light rail and bus operator in a major German city. Through contextual inquiry, we chart emerging issues and design challenges. We showcase how urban facility managers negotiate legacy systems and cooperate with each other to keep transport systems functioning.

Author Keywords
Control room; work environment; public transport.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Background
Early research on Computer-Supported Cooperative Work (CSCW), stemming from traditional Human Factors, looked

at work settings and understanding computer support for complex workflows in highly formalised work settings. Notably Heath and Luff investigated the intricacies of operating the London Underground [2]. While the scope of the field expanded, traditional infrastructure-oriented control rooms began receiving less attention. Concurrently, central command in situation rooms is still a relevant topic in the emergency response field, where recent research shows that modern control rooms are dynamic information spaces that use hybrid tools such as cloud storage [3, 5]. In this work, we examine a modern control room and investigate how the evolution of infrastructural control room technology affects the everyday work of light rail operators.

Furthermore, we are observing a trend where city authorities want to be involved in a constant dialogue with citizens so that the city infrastructure can be improved to best benefit its users. The usage of mobile data and social media enables rapid incident reporting and providing feedback about the services while using them. Research advocated designing new technologies for increasing citizen participation in designing infrastructures [1], e.g. through participatory sensing [4]. Our study looks into how those tasked with maintaining city infrastructures deal with the increasing amount of end-user input and the ways they aim to use information from the citizens effectively.

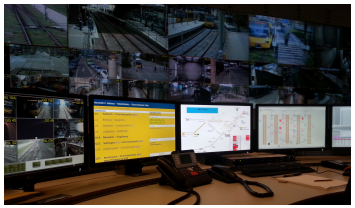

Figure 1: Personal desk with the power wall in the background.

Method

We conducted our study in cooperation with the local light rail and bus operator. After an initial meeting, we were given permission to conduct contextual inquiry in the company's control room. After an initial interviews with the control room manager, we decided to study three time periods typical for the control room operations. First, we looked at morning rush hour traffic during a weekday (6 am to noon). We then conducted observations during a low-intensity period on a weekday (10 am to 4 pm). Finally, we spent time working with the traffic managers on the weekend night shift (9 pm on Saturday – 3 am on Sunday), which also includes an integrated taxi service for citizens concerned with security. The control manager requested that the workers provided us with explanations of their actions when this did not impact the efficiency of their work. We took extensive notes throughout the inquiry, which we complemented with photos. Audio or video recordings were not permitted due to security reasons. Our observations were focused on: (1) How control room workers manage the different system infrastructures to build a coherent picture of the current transport situation and (2) understanding the communication between the different roles in the control room and how information is communicated between shifts.

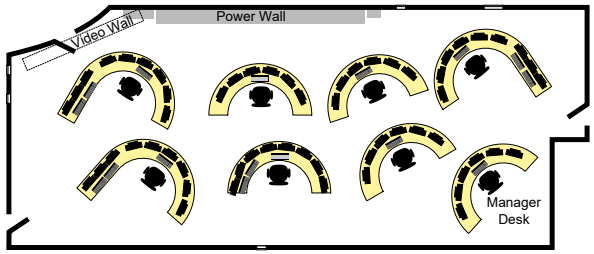

Figure 2: Floor plan of the control room studied in this paper. There are eight work stations present and a maximum of seven are in use. A backup desk is always present. Less than seven employees handle traffic during off-peak periods.

After concluding the contextual inquiry, we built an overview of the systems used. Affinity diagramming was used to establish provisional themes in the aspects of the work on which the control room workers reflected. We conducted iterative team meetings were we rearranged the affinity diagrams to identify key insights and opportunities for design.

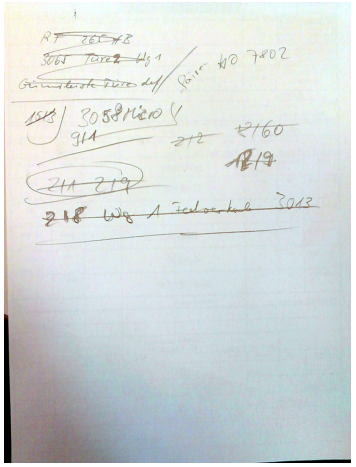

Figure 3: Personal notes took during one shift.

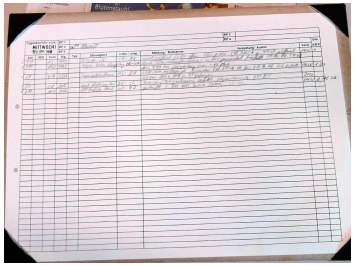

Figure 4: Documentation of major events.

Findings

Our study shows that the public transport control room is a complex sensing where multiple systems and users need to cooperate to maintain the infrastructure effectively. The control room employees are in charge assigning tracks to train, updating passenger information systems, handling emergencies and managing driver shifts. The control room uses seven employees at any given time (seated at eight desks, see Figure 1 and 2). It is also equipped with a power wall (a very large high resolution display) displaying images from security cameras at stations. As not all the camera views fit onto the power wall, the control room also uses a projector canvas pulled over the door to the smoking area as additional screen space. All control room workers are trained to operate any of the roles possible and continuous attention is used to assure engagement and efficiency (the are former train or bus drivers). Six to twelve screens are used at each work station and they correspond to the different systems used, e.g. the real-time timetable system, the track and train management system or the passenger information signage management controls. Custom scenario switches are used to manage screen configurations for different tasks. The control rooms also handles emergency calls from dedicated telephones at train stations and monitors social media and the local transport mobile app for reports from commuters.

We observed that the close quarters of the control room enabled face-to-face communications between the employees, even in the form of utterances. The systems do not support explicit communication between workstations and walking to talk to a colleague was an often-employed solution. We also noticed that current systems did not enable handling disruptions, which led to the employees developing personal note schemes (see Figure 3). The workers would note issues that required attention thus creating a personal log of disruptions. The notes would be discarded after the end of the shift, but their contents would be relayed to the next employee taking the post if any of the issues were still active. Furthermore, an additional analogue form of communication was developed in the form of a cardboard board (seen in Figure 4) with general information for everyone in the control room. Information about construction work or permanent re-routing would be displayed there. The workers remarked that the systems did not enable them to store that information and the board served as a useful tool for quick reference.

One of the control room employees was tasked with answering calls from emergency station phones and communication devices inside trains. An overview of the transport situation was required to understand the context of the information provided. Consequently, that employee would often scan the power wall and switch view scenarios. The same person was also responsible for audio announcements at stations and the loudspeaker system was separate from the rest of the infrastructure. Additionally, disruptions needed to be documented on paper forms due to legal requirements. This diverse set of tasks illustrates that the control room work required constant attention switching and simultaneous use of multiple unconnected systems. The control room employees were aware of the high cognitive workload their job required. One participant remarked:

One must remember a lot [in this line of work].

Discussion & Outlook

Our observation from the modern control room suggest that there is room for improvement and designing new solutions that will enable seamful coordination of the hybrid infrastructure involved. We plan to conduct design workshops to investigate if tools can be developed to manage disruption effectively and in a transparent way. There is also a

lot of room for improvement in terms of input technologies and the collaborative use of multi-screen environments. Currently, collaborative problem solving is conducted with workers sitting at their desks. One could imagine that a more collaboration-oriented environment, e.g. one that uses touchscreen could enable the control room workers to deal with traffic disturbances more efficiently.

We see an opportunity for further developing note systems for control rooms. In our study, the users use three levels of notes: personal notes (mostly illegible), public notes (available on the cardboard board) and official notes (the protocols that need to be generated during the shift). As there is overlapping information on the three levels, we plan to build systems that would reduce the redundancy in storing the information while supporting the sensemaking process. We recognise that the role of the tangibility of the information artefacts created is important for the participants in our study, similarly to past work which investigated air traffic controllers [6].

As the systems in our study are safety-critical, the potential for design interventions is limited as systems require extensive testing. The public transport operator is in possession of a backup control, which we plan to use to explore new interactions for specific scenarios. Yet, possible improvements will require consensus between multiple stakeholders and infrastructure providers, so we hope to be able to understand the innovation process in complex safety-critical system better. In order to answer that question, we plan to conduct extended interviews with public transport workers, infrastructure managers and city authorities.

Conclusion

In this poster paper, we presented preliminary insights from our study of a public transport control room in a major German city. We conducted contextual inquiry in a public transport control room to understand the collaboration practices connected to the computer systems in place. We found that the workers perceive their work as highly cognitively demanding and they developed a number of analogue support tools to mediate information between the diverse systems in place and facilitate team communication. In the future, we plan to conduct interviews and design workshops to identify how to build new systems to improve cooperation in control rooms.

Acknowledgements

This work is partly supported by the DFG within the SimTech Cluster of Excellence (EXC 310/2) and ECâĂŹs H2020 Program under FETPROACT-1-2014: GSS, agreement #641191 CIMPLEX

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