LIFE AT RISK – AN EMPIRICAL INVESTIGATION OF THE DESIGN OF WORKPLACES IN CONTROL ROOMS

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ABSTRACT

Control rooms for supervising traffic or emergency situations are increasingly introduced in companies and other governmental organisations. Employees of safety-critical workplaces have to deal with a large amount of problems every day: Quick decision-making, coping with an overload of information and stress are the most important. Designing appropriate workplaces for employees in such organisations is essential. The following paper describes the results of an investigation in two companies with control rooms. Results indicate that the systems deployed in such control rooms support the operators efficiently. Stress is a more important influencing factor. We could not find any significant gender effects concerning the design of workplaces in control rooms.

KEYWORDS

Interface design, gender, evaluation, large screens, decision making.

1. INTRODUCTION

Supervising complex processes in industry and governmental organisations is an increasingly important research area. Power plants, traffic control, and the organisation of emergency and rescue operations require a close control. Computer technology is typically used to achieve this. It is clear that the supervision of such processes is a challenging activity and has to be supported appropriately. In this context, the design of the workplaces of control room operators plays a

crucial role so that the attention of these employees is maximised and stress minimised. A specific challenge in this context is, for example, the fact that control room operators work with large screens. Therefore, information has to be presented in a way so that the necessary data can be perceived immediately. In addition, gender issues have to be taken into account. It is an open question whether the appropriate design of control room workplaces can help to make them more attractive for women.

The investigation presented in this paper addresses these issues. On the one hand, we studied, more generally, how the physical design of the workplace influences the work of the control room operators. In this context, we are especially interested in the design of the interfaces of the large screens which are used in control rooms. In addition, we also addressed more general issues of workplace organisation (choice of chairs, personalisation of workplaces,…). We did not specifically address the issue of work organisation, because this is beyond the scope of our paper. Nevertheless, we are aware that organisational issues are also very important in this context.

We also addressed, more specifically, the issue whether physical workplace design might be one factor which is responsible for the lack of women in control rooms. There is some indication in the literature that under some circumstances women might prefer a different interface design than men.

The research described in this paper was conducted in the context of a research project. We were lucky to be able to cooperate with two organisations which permitted us access to control room operators who were willing to participate in this study. It is well known that such access is difficult to get, therefore, our results are especially valuable.

2. DESCRPTION OF THE PROJECT

The aim of the project GenSiSys was to analyse the work in control rooms and also to develop a set of recommendations how to evaluate gender and diversity aspects in safety-critical workplaces regarding needs and requirements of employees in ergonomics and human-computer interaction.

Safety-critical workplaces are systems where decisions, actions or mistakes by operators and controllers directly affect human lives. Working at a safety-critical workplace means to make quick decisions, coping with an overload of information and stress.

We were lucky to find two very open and cooperative partners who provided the project team with comprehensive support. One of the partners was the emergency call control centre of Lower Austria (144 Notruf Niederösterreich) in St. Pölten. The other partner was the operations management centre of the Austrian Federal Railways (ÖBB).

In the context of the project, we conducted an extensive review of the literature. Based on this, we developed 19 issues which have to be taken into account when investigating the physical work environment of control room operators. We also identified a set of research methods from Social Sciences and Human-Computer Interaction which are appropriate for the investigation of these issues. In the following, we present one of the studies we conducted during the project which is based on a subset of the issues mentioned above and two methods – focus groups and stakeholder interviews.

3. RELATED WORK

Work in a control room requires the usage of a special software, for instance for taking and holding incoming calls in an emergency call center or for monitoring different routes, tracks and railway stations. Operators need this software to make quick decisions under pressure (Coskun & Grabowski 2005). The mistake of an operator can lead to damage of property, loss of money or even worse – loss of human life (Knight 2002). Therefore, the software and the user interface must support quick decision-making. How should the user interface of this software be designed so that it relieves the operator? Are there any differences between men and women in the usage of the software? What we have to keep in mind when talking about gender-sensitive design: "…*we must remember that no single female will likely have every trait statistically associated with females, nor will any single male likely have every trait statistically associated with males. For example, some males process information in the comprehensive style statistically associated with females, and some females process information in the more linear style associated with males. Thus, designing software in ways that support these differences does not penalize either gender—it helps everyone.*" (Beckwith et al 2006, p. 101).

There are several features of systems deployed in control rooms which influence the quality of the work of the operators.

Size of the display: Large displays raise challenging new questions concerning interface design. One of the most important problems which may arise in this context is the fact that humans only perceive a small portion of the screen with high acuity (change blindness, inattentional blindness). Due to the size of the screen it may happen that relevant parts of the information are not perceived by the user. Mancero et al (2007) discuss empirical results concerning these issues. They argue that change blindness can have negative effects on the efficiency of users of large displays. They point out that there are several aspects which have to be taken into account. Slow changes, for example, are difficult to perceive. Changes which happen outside the focus of attention of the users are often overlooked. Saliency of important information should be aimed at. In addition, they also point out that meaning and relevance play an important role.

Complexity of the System: Providing the user with the right information and visualisation at the right time is necessary for prompt decision making. It is therefore important to support users to deal with a complex system. A complex system provides a large amount of information from heterogeneous sources and a great variability of interaction possibilities. On average, simplicity of a system is more important to women than men (Stadler, 2006). A high complexity of the system often leads to stress.

Decision making: Men and women *"... both carefully process information, retrieve the relevant decision-related data from their memories, categorize the data if they are very diverse, think logically about the alternatives, predict results, evaluate the consequences, solve the problems posed by the situation, and monitor all the decision stages."* (Sanz de Acedo Lizárraga et al. 2007, p. 387). Making fast decisions and analysing data seem to be more important for men, whereas women, on average, seem to take more time and are more worried about the consequence of their decisions (Reiter, 2013).

Design of the displays: In control rooms, the usage of large displays has increased (Pohl, 2013). It is very challenging to find relevant information on large displays. Large displays with a wide field of view can support both women and men, although women benefit more (Czerwinski et al. 2002). Scientific literature indicates that females and males use different

strategies when navigating between different views in a complex software product. The result of the study by Czerwinski et al (2002) shows that there are ways to design interfaces so that women are specifically supported, especially in highly complex environments. Icons are a way to provide users with important information: it is necessary to use simple figures which are easy to recognize for the user, and they should be used when the user's interaction is required (Yu & He, 2010). Not only in control rooms, also in emergency medical situations icons have to be promptly recognized (Salman et al. 2012): to guarantee that, it is a viable option to design and implement icons together with the users. This cooperation of user and designer is necessary to achieve a reliable recognition of an icon (Gatsou et al. 2011).

Personalisation: According to Wells (2000) personalisation of workplaces can have a positive impact on job satisfaction and well-being. Ease of use and sense of control of software can be positively influenced by personalisation (Henriksen & Pedersen, 2009). This effect is stronger for women than for men. This indicates that the possibility of personalisation helps women to feel more comfortable with software.

Stress: Stress as a factor influencing the work of operators in control rooms has been discussed extensively, e.g. in the context of nuclear power plants. Desaulniers (1997) provides a general discussion of stress in control rooms. He discusses the consequences of stress (narrowing of attention, reduced working memory capacity, …) and possibilities to reduce the number of stressful situations in control rooms (training, improved procedure design, …). Farkas et al (2011) point out the importance of reducing the operator's mental load to ensure that he or she can react efficiently in emergency situations. Mukherjee et al (2010) discuss the design of control rooms, especially the trend to reduce the amount of information which is presented to the operator. In this context, some of the tasks which were carried out manually by operators were taken over by computers, especially repetitive and monotonous tasks. This leads to a reduction in panel complexity. In this way, stress can be reduced.

Design of chairs: One essential aspect of stress reduction in workplaces is the design of the chairs. There is an increasing amount of research addressing this issue as the majority of employees nowadays work in a seated position. One of the results of this is an increase in backpain. Corlett (2006) points out that one important aspect in this context is the interaction between seat and workplace. Sitting posture should minimise the load on the spine and musculature. This is also related to the subjective feeling of comfort or discomfort (De Looze et al 2010). The authors discuss whether it is possible to relate this subjective feeling to objective measurements. Empirical evidence indicates that the most significant relationship is with pressure distribution. There might be other variables such as posture, movement, muscle activity or spinal load which might also play a role, but there is not yet enough evidence to support this.

4. DESCRIPTION OF THE INVESTIGATION

The goal of the investigation described in this paper is to identify how workplaces for employees in control rooms can be improved to reduce stress and increase the efficiency of their work. The work described in this paper focuses on this issue and does not address the problem of work organisation, but both issues are, of course, related to each other.

Our research goal was to identify which factors concerning the workplace influence the quality of the work of operators in control rooms. We were especially interested how the design of the system affected the decision-making process. We also assumed that stress is an important

factor in this context. The research questions were developed as a result of an extensive literature study by experts from different fields (usability experts, ergonomics experts, cognitive psychologists, gender-studies experts).

There are several possibilities how the quality of the design of the workplace could be investigated. We think that the employees' views and attitudes plays an important role in this context, therefore we chose focus groups and stakeholder interviews as research methodologies. We conducted three focus groups with control room operators of two organisations. We conducted focus groups with the operators because we were interested in the discussion among these employees and the shared sense-making processes. In addition, we conducted interviews with stakeholders from management to clarify their view of the issues related to the work processes in control rooms. We decided to conduct interviews with the managers because we also wanted to discuss more sensitive issues with them which could not be discussed in a group.

To analyse the data, we conducted a qualitative content analysis (Schreier 2012). We developed categories based on the literature review and assigned verbal utterances from the focus groups and the stakeholder interviews to these categories. This allows us to describe the contents of the discussion in the focus groups and interviews in a systematic way. We used paraphrasing to describe the attitudes of the study participants, therefore, the colloquial character of the utterances is to some extent retained. We also want to point out that the analysis of the results describes the attitudes of the interview partners, not the attitudes of the authors.

The two organisations that participated in this investigation were the operations management centre of the Austrian Federal Railway (ÖBB) and the emergency call centre of Lower Austria. The main task of the employees of the control room of the Austrian Federal Railways is to organise the train movements to ensure that trains operate safely and run according to schedule. Employees of this control room work in two shifts (from 6 a.m. to 6 p.m. and from 6 p.m. to 6 a.m.). Under normal conditions the work is not described as being extremely stressful, but in emergencies there is a considerable amount of pressure on the employees. There are approximately 3% women working in these control rooms. The main goal of the emergency call centre of Lower Austria is to provide emergency medical care, operating from ambulances. The employees also work in two shifts (similar as in the control rooms of the ÖBB). There are basically two different categories of employees – call centre agents who receive emergency calls and emergency medical dispatchers who organise medical care with ambulances. The emergency medical dispatchers are the more senior and experienced employees. Approximately 44 % of the employees are women. There is a constant level of stress, especially in the evenings when doctors' surgeries are closed.

4.1 Focus Groups

Focus groups are group discussions. They are a form of qualitative research (Kuniavsky 2003). A facilitator using guidelines asks participants questions they can and should discuss. Possible ambiguities can be removed through repeated discussion of an issue. One main advantage of focus groups is that unclear or controversial issues can be clarified in the discussion. Sometimes, problems occur when single participants in focus groups dominate the discussion. Facilitators can mitigate this phenomenon by encouraging all participants to share their thoughts with the others.

While conducting experiments in safety-critical systems, special constraints have to be considered: operators cannot leave their workplace for long. In many situations, tests can only

be conducted after the employee's shift, which often lasts 12 hours, or during a break. Therefore, we were glad to get the chance that a considerable number of employees took time to participate in the focus groups. It has been a great advantage for our work to get to know employees and to talk about their problems, issues and needs in a real setting.

Based on the literature, these were the questions we asked:

Ergonomics: Are you satisfied with your chair?

Complexity of the systems: On the one hand, there are systems which provide many features and are therefore difficult to learn and master, on the other hand there are systems which have fewer features and are therefore less error-prone, easy to learn but do not provide many features. How would you describe your system?

Decision making: How do you make decisions in situations where you have to act as quickly as possible?

Displays: How do you get along with many/big displays? Do you ever have the feeling of overlooking something important? Are there any ambiguities in the software? (Icons, shortcuts,…) Do they lead to delays? Are there any parts of the software where graphics should replace text or vice versa? If so, why?

Icons and shortcuts: Are there icons that are not clear? Does this influence the speed of decision making?

Personalisation of software: Which parts of the software can be personalised? Do you use it? What do you use personalisation for? Is there a need for more? If so, why and where?

Stress: How would you describe your stress level at work? Which actions or times of day are most stressful? Do parts of the software stress you? How do you cope with stress, do you take stress home? If you think of a typical work day, when are the most stressful situations?

4.1.1 Focus Group NNÖ (Emergency call control centre)

At "144 Notruf NÖ" two focus groups with a total of eight participants were conducted; four male and four female. Complexity of the used system, decision making, orientation/coping with many screens and stress seem to be the most interesting themes.

Ergonomics: Women are in general more dissatisfied with the chairs. They complain that the seating area is too small. One of the male employees agrees with this view. One of the female employees still uses an old chair because she has problems with the new chair.

Complexity of the Software: Employees are in general satisfied with the software because it is continually developed further and their feedback is taken into account. Nevertheless, there is some controversy in the group: Long-term employees are well acquainted with the software. In contrast to that, newer employees have to get used to the system, the features and the processes fairly quickly. Therefore, the newer employees find the systems less intuitive and challenging to use. The common opinion concerning the complexity of the system is that it is directly linked to the main task. There are, basically, two groups of employees – call takers and dispatchers. Call takers receive emergency calls and decide which action has to be taken; dispatchers organise all activities (e.g. ambulances which are sent to a road accident). Call takers do not need as many functions as the dispatchers because of their fewer responsibilities. Most of the dispatchers are highly experienced females, whereas the call takers are younger males.

Decision making is a very important part of the participants' job; they think that the system provides the right amount of support. Participants who have worked for a longer period of time for 144 Notruf NÖ think they have no problem with choosing the right protocol when it comes to an emergency call (every emergency has its own protocol, so employees can ask the caller

the right questions and provide help), whereas less experienced employees are not always that sure. If there is a difficult decision to master they are never left entirely on their own: asking a colleague or the shift supervisor for help is always an option. The experienced female employees are better able to cope with difficult situations due to their longer experience.

Displays: Call takers use two displays, whereas dispatchers have got four displays which provide them with different information: the first is for transportation, the second for showing ambulances, the third for the map and the fourth is for additional information. The prevailing opinion is that, due to the fixed places of the displays, it is clear which display provides which information. Some of the calltakers would also prefer to have four displays. They get the same information as the dispatchers, only smaller. Therefore, their information can get confusing sometimes, especially the map representation is not clear enough.

Icons and shortcuts: In general, icons and shortcuts are clear. Calltakers complain that they do not know the meaning of some of the icons, but they usually do not need these icons. Employees are encouraged to try out the icons to learn their meaning. On mouseover, users get information about the functionality of the icons. In general, male calltakers found the icons more confusing because of less experience.

Personalisation: Concerning personalisation, the attitude of the participants was divided. Some of them argue that it is helpful to organise the screen in a way adapted to the individual needs of the user. Others think that the system is optimised already and should not be changed. In addition, it is difficult to work in the workplace of another employee when screens are personalised. In contrast to the results in the literature, no gender differences can be observed.

Stress seems to be the most important issue of the two focus groups, due to the diversity of stress factors: medical service which starts at 7 pm, the wish for more personnel and issues regarding the building (e.g. heat) are mentioned as stress factors. In Lower Austria, it is possible to get advice from a physician after 7 p.m. via the Notruf, either on the telephone or, in emergency cases, in the form of a personal visit of a physician. This leads to an increased workload for the call takers after 7 p.m. and acts as an additional stress factor. Another period of increased stress is in the morning when hospitals need an increased number of ambulances for patient transport (e.g. for patients who are discharged). Four participants mentioned that the building, a low-energy house, is not ideal: sometimes it is too warm; high levels of noise are also a problem. No gender differences can be observed.

The participants did not just talk about stress factors; they also were trying to find solutions during the focus group: a resting place, power napping and separated rooms were suggestions which came up in the discussion.

4.1.2 Focus Group ÖBB (Austrian Federal Railway)

At the ÖBB, one focus group with six participants was conducted; three of them male and three female. We would like to point out that this does not reflect the composition of the workforce according to gender. The female participants were very outspoken and had clear opinions about the topics discussed. Six topics were addressed: ergonomics, complexity of the used system, decision making, displays and personalisation, icons and stress.

Ergonomics: There are right now many different models of chairs available in this control room. The employees complain more about the more modern models of chairs than about the older ones. Employees can choose freely which model they want to use. They prefer a model for the night shift that is more flexible and allows to lean back. For the day shift this model is less convenient. No gender differences can be observed.

Complexity of the system: Participants use many different systems; the prevailing opinion is that systems which are used often are well known. Systems are kept simple, but most systems are quite comprehensive. Employees are rather satisfied with the operation of the systems and are not overwhelmed by the features these systems provide. One participant observed that the telephone provides too many features; most of them are not used often which can lead to a tedious search. In general, women and men find the systems easy to use.

Decision making: Decisions are made according to a protocol. This protocol is represented in the system as a list with checkboxes containing everything that has to be taken into account. In difficult situations, employees cooperate intensively, and nobody is left alone. Female operators complain about confusing feedback from the system which makes them uneasy.

Displays and personalisation: Personalising the screens is very important for the employees to make it easier for them to find all information they need in emergency situations. One participant mentioned that she moved unnecessary information to the top right screen because she knows that this is her "blind spot". The disadvantage of personalisation is that employees cannot use another person's workplace easily, as they need to log out and then in with their own profile. There seem to be no systematic gender differences.

Icons which are needed in safety-critical situations are well known; an icon catalogue provides help if needed. Disturbances are shown in yellow unless they are acknowledged. A blue signal indicates a track disturbance and a textbox shows which trains are affected and which measures should be taken. A search function is a proposal of one of the participants and is approved by the others. No gender differences were observed.

Stress "can go from zero to one hundred very quickly", it depends on the disturbance. Malfunction of the switch, construction works and conservation work are mentioned as typical disturbances. Participants think that an update of the database is stressful, because they cannot access the information system during that process. Most disturbances are handled on the phone, so a failure of the telephone system would also lead to a stressful situation. Noise is not such an issue.

We also discussed with the participants how they cope with stress. They mention that there are regular training courses (1x per year). It is important to separate work from the private life. Usually this is not such a problem, but if a suicide occurs this is difficult. No gender differences could be observed.

4.1.2 Discussion

In our study the number of participants is too small to make a general statement about gender. Nevertheless, we think that we can clarify some methodological issues for research in this environment and, in addition, indicate some areas where further research is necessary. We identified seven areas which are relevant for the design of workplaces: ergonomics, complexity of the system, decision making, displays, icons, navigation/personalisation, and stress.

In both control rooms, it was possible to adapt the seats and workplaces to the employees' needs. Most of the employees were standing during approximately 10% of their working hours. The chairs in both control rooms are very modern and can be adapted to individual needs. Nevertheless, there was some concern about the modern chairs. Some gender differences were observed at Notruf.

In general, employees in the control rooms we investigated were quite happy with the systems they used. This indicates that the problem of designing large displays for control rooms is not as challenging as is discussed in the literature (Mancero et al 2007). This is to a certain

degree dependent on the experience they already have. A few minor usability issues were mentioned. Personalisation is used to counteract possible negative effects of these large displays. This seems to be a possible solution for some of the problems of large displays. Decision making processes are fairly well supported by the systems. The employees also mentioned that cooperation between them is very important for reliable decision making. Stress is mentioned as the most important problem by employees from both organizations, although it is more relevant for Notruf than for ÖBB. The participants of the focus groups not only discussed stress but also made interesting suggestions how this could be overcome.

Gender does not seem to be a factor which is highly relevant for workplace design in this context. We could not identify indications that there are different approaches based on gender as has been suggested in the literature. We would also like to point out that Notruf is a specific kind of organization because a considerable number of operators, especially the dispatchers who have more responsibilities than the call takers, are mostly women. These women feel very comfortable with a fairly complex system. This also indicates that the situation in control rooms is not as stereotyped as can be expected from the literature.

4.2 Stakeholder Interviews

Stakeholder interviews offer, in combination with other evaluation methods, in particular with a focus group, a high gain in knowledge (Bortz & Döring 2006, Goodwin 2009). The analysis can be done in areas such as work environment, workplace design, software interaction, stress perception and problem awareness. The two perspectives (stakeholder, focus group) decrease the risk of a one-sided analysis. Furthermore, stakeholder interviews are characterized by low cost in equipment, as only sound recording (e.g. with a voice recorder or mobile phone) is necessary. The interviews can be conducted by a single person who should have experience in negotiation (clear language and skills in conversation techniques). Unlike other methods - contextual inquiry, for example - this method is not tied to the actual workplace, but can take place wherever the requirements for a confidential, undisturbed conversation are provided.

While there are some advantages, there are also a few disadvantages. For one, the organisation of appointments for the stakeholder interviews and working on an interview outline can be time-consuming. Evaluating the recorded interviews is also rather laborious, as they ought to be transcribed or at least summarized. The aggregation of the results and the knowledge analysis is yet another time consuming-task.

The topics discussed at the stakeholder interviews are based on the literature research and the results of the focus groups. We discussed all the topics addressed in the focus groups with the stakeholders, but on a more general level. Therefore, the analysis is based on fewer categories. In addition, we also discussed the question of work atmosphere and measures to enhance the percentage of women in the workforce. This topic does not address the main research question of this study, but we assume that it provides some background information about the workplace.

4.2.1 Stakeholder Interview NNÖ (Emergency call control centre)

The four main topics of the three stakeholder interviews (with three male participants) conducted at "144 Notruf NÖ" in Lower Austria were ergonomics, monitors/design of interfaces, stress level and work atmosphere.

Ergonomics: One of the challenges stated in these interviews was to acquire appropriate chairs to ensure that employees can sit comfortably for as long as possible. At the control rooms, employees can choose between three different types of chairs by various manufacturers. Though, these chairs do not always comply with the various requirements of the employees. Some of the chairs are not appropriate for women because of their size.

Monitors/Software: To reduce the quantity of information, the work environment itself is characterized by a low number of monitors and the possibility to personalise the software environment to one's specific needs. Decision making is supported by the computer, but in the end decisions have to be taken based on experience and gut feeling. Furthermore, usage of the colour red in the user interface was reduced, as important elements did no longer stand out enough.

Stress: The main focus concerning the topic stress level was the work load (processing emergency calls and dispatching vehicles), especially when dealing with major emergencies. So, the primary goal is to improve the standardised procedure (Advanced Medical Priority Dispatch Systems – AMPDS), so that the semi-automated decision process can help reducing the stress level for employees. Furthermore, measures like basic and advanced training and pre- and post-care are offered, and simulated situations are being run through to increase experience and help in turning tasks into a routine more quickly.

Work atmosphere: The interviewed stakeholders put emphasis on the fact that the equal gender ratio makes for good teamwork in the individual teams. Interaction between employees is more accepting and respectful than with teams consisting of men only. The balance between male and female operators is due to the fact that the percentage of women and men working as paramedics is even, and these are the people mainly applying for a job in the emergency call control centre. On the one hand, the jobs in the emergency call control centre are not attractive for women because of shift work, on the other hand, employees have a lot of contiguous spare time which is also more convenient for women.

Operators at Notruf have to have good communication skills to be able to relate to persons in critical situations. A substantial part of the work consists of telephone conversations with persons seeking help. Women are sometimes better at this job.

4.2.2 Stakeholder Interview ÖBB (Austrian Federal Railway)

In the interviews, carried out with four stakeholders of the Austrian Federal Railways (3 male, 1 female), four topics were discussed. These topics are ergonomic issues concerning the work places, the monitors/software, coping with stress and the work atmosphere.

Ergonomics/personalisation: Almost all of the employees use the possibility to set up an individual workplace adapted to their requirements during their shift. This encompasses the desk height which can be adjusted to sitting or standing posture or the content of the monitor (e.g., adjusting the colour of the track lines, which show the location of the trains in real time). The profile of an employee is active when they log into their account at their workplace. There are no two employees who have the same configuration of their workplace. There is a new software update that enables employees to change sizes of elements on the screen or choose the positions of windows on the screen according to their own needs. These features are used quite often.

Monitors/Software: As mentioned, every employee has 10 monitors to interact with, although some of them only use around five of them, as the work profile of the dispatcher varies

and includes diverse needs. The occupational health care and the transport inspection limited the monitors to 10 in regard to the limit of the coverage possibility of a human being. One of the problems is that some situations do not occur very often, and employees tend to forget the protocols related to these incidents. In such situations, it is necessary to ask colleagues or the manager. The situation now is quite different to the situation in 1990s. At that time, most of the calculations had to be done manually, now this is done by the computer. Nevertheless, there are still open issues. Conflict identification in electronic timetables is still not perfect. There are still too many parameters which have to be taken into account. Therefore, many things still have to be done manually. In the future, these activities will be done automatically, and humans will only supervise these processes.

The problem is that nowadays employees have no practical experience concerning the practical aspects of the switching operations. One of the stakeholders suggested that employees should get this experience during training to get a better understanding of the practical problems that occur in the day-to-day railway traffic.

Stress: At times of normal operation, the level of stress in the control rooms of the Austrian Federal Railway is not very high, especially because of the IT support, but there are several sources of stress. The employees work in an open plan office and the background noises which naturally come with this form of work organisation were mentioned by some interviewed stakeholders as disturbing. In emergency situation employees are supposed to cooperate to reduce the stress of a single person. IT support is still not good enough to support employees in emergency situations efficiently. Stress also occurs when schedules are not met or when there is dense traffic, not only in emergency situations. Another problem is that during routine operations the employees' attention might be distracted. It is challenging to change from routine operations to emergency situations in time. Employees have to be trained for this transition from routine to emergency situations.

Work atmosphere: In general, training is seen as support for the employees. Cooperation is an important aspect, especially between more senior with younger colleagues.

In the control rooms of the Austrian Federal Railway, verbal communication also plays an important role. An important part of the work is talking to other people on the telephone. This causes some noise in open plan offices. The stakeholders also mention that the communication is more respectful when women are part of a group, even if they are a small minority. The communication with the switching operators outside is, nevertheless, still a problem. Nowadays, it is accepted that women work in technology-related areas for railway companies. The stakeholders do not see a difference in the approach of women and men. Some employees are more cautious, others react very quickly. This has nothing to do with their gender. If a qualified woman applies she is preferred to the male candidates because there are so few women in this occupation, but in general there are only few qualified candidates, therefore women are welcome. It is not very easy to raise children when working in a control centre because of shift work, but there are also male employees who go on paternity leave.

4.2.3 Discussion

Interview partners in the stakeholder interviews talked mostly about ergonomic issues and stress. They pointed out that workplaces can be arranged individually to make it easier for the employees to work in front of computer screens for several hours and to enable them to concentrate on their work. Operators can choose between different types of chairs, change the height of their tables, personalise the contents of their screens etc. Screens and interfaces are

designed in a way to support human perception (e.g. reduction of the number of screens, avoidance of the colour red). Both organisations adopt measures to reduce stress (improved protocols, training).

Stakeholders from Notruf especially pointed out the gender balance in their organisation in control rooms. Stakeholders from both organisations argue that women in teams lead to a more respectful interaction between employees. A substantial part of the work in both control rooms is communication, especially via telephone. At Notruf, women are especially able to cope with difficult communication situations.

Stakeholders from the Austrian Federal Railway point out that in the control rooms, the development in IT has led to substantial changes in the work, but there are still many activities that have to be done manually. They argue that there is a lack of qualified candidates for this kind of work, and women are welcome.

5. CONCLUSION

The goal of the study presented in this paper is the analysis of workplaces in control rooms. The emphasis was on the design of the computer interfaces and the physical design of the workplaces. We conducted focus groups with employees and interviews with the managers. This provides us with the possibility to look at the challenges of the design of control rooms from different perspectives. The employees tended to discuss these issues from the point of view of their personal experience. In general, they were satisfied with the interface design of the software systems they used and had no major problems with the system. Working with large screens does not pose specific problems. Based on existing literature, we had expected that working with large screens would pose more serious problems. The interview partners mentioned several possibilities how to cope with the large amount of information provided by large screens (especially personalisation and appropriate screen design). The major problem mentioned in both organisations was stress, especially in Notruf. The managers discussed these issues from a leadership perspective and mentioned various measurements taken to alleviate the problem of stress (training, collaboration among employees, improvement of protocols).

It is well-known that the employees in most control rooms are predominantly male. Therefore, we also addressed the question whether aspects of the interface design or the physical organisation of the workplace favour male employees. In our investigation, we could only find few examples for this. There is some indication that office chairs sometimes favour males. We would like to point out, however, that one of the organisations we cooperated with (Notruf) had an even distribution of women and men as control room employees. On the one hand, this might have influenced our results. On the other hand, it indicates that the work of operators does not per se have a "male" character. The character of the organisation seems to play a more important role. Notruf belongs to the medical sector where traditionally a high number of women work, whereas the Austrian Federal Railways are traditionally associated with technology and have predominantly employed men in the past. Our results indicate that experience is more important than gender for the ease of interaction with complex software systems in control rooms.

Conducting studies in control rooms poses specific challenges. It is one of the advantages of this investigation that, thanks to the cooperation with the two organisations, we had access to a considerable number of control room employees. Due to their workload it is, in general, not possible to conduct investigations with this type of employees during working hours. Therefore,

focus groups and interviews are appropriate methods for this kind of investigation. We found, that we were able to gain interesting insights into their work processes and the specific problems they have.

One limitation of this study is the fact that we were only able to conduct focus groups and stakeholder interviews with a limited number of persons. This makes it difficult to generalise these results. Nevertheless, we would like to point out that it is extremely difficult to find interview partners in this area. Therefore, this study is still a relevant contribution to the field. Another limitation is that we did not investigate work organisation and relationship among employees. It can be assumed that gender issues are more easily visible in this area. Nevertheless, we did not want to mix up these two issues (design of workplaces and work organisation). There is less research concerning gender issues in the design of computer interfaces and more general in the layout of the workplace, therefore we wanted to investigate this issue in more detail.

Further research concerning these topics is necessary. One possibility in this context would be to conduct a study with more participants from other organisations. In addition, it would be valuable to include additional questions, as for example, organisational issues and also additional aspects from the area of ergonomics. It would also be interesting to study the workflow of the employees in more detail to get more objective data on the interaction processes of the participants with the IT systems.

ACKNOWLEDGEMENT

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