How to sell a room without a view?

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Abstract.
The locks and bridges of a large seaport are locally operated. A consortium of Human Factors engineers, installers and simulator engineers investigated the possibility of operating the locks and bridges from a remote control room, supported by CCTV. The end users (lock operators and bridge operators), participated in the design process but they had serious objections and considered the project as an unrealistic option.

The main question in this case study is: how can HF engineers meaningful cooperate with end users in a design process when the end users are not motivated for the future situation? Another question concerns the number and locations of CCTV camera's needed for remote control.

Keywords. Closed Circuit Television (CCTV), remote control, user participation

1. Introduction

1.1 A case study

This case is situated in a large seaport, and concerns the impact of end-user participation in a design process. It shows the results of applied HF Engineering. It is important for HF practitioners to be able to learn from practical experiences (Pikaar, 2012). This is particularly important in the case of CCTV applications, because there is only a very limited amount of publications available on HF of CCTV-systems (Schreibers et.al., 2012). In our view, best practices deserve a place within the theoretical framework of system ergonomics. By presenting this case study, we hope to identify the most relevant (engineering) issues that need to be studied by the ergonomics community.

1.2 The case situation

In the harbour, there are local operated large locks and bridges scattered over the dock area. In view of an increasing density of shipping traffic, the port authorities intend to centralise the operation of all the locks and bridges. As a consequence all objects will be operated remotely in a central control room.

In the present workplaces, local operators have mostly inadequate direct sight on shipping, roads, and train traffic. Further, they have radar and some CCTV cameras at their disposal to monitor the situation. Clearly, for remote control, there will be no direct sight. So in a central control room, CCTV will become one of the main tools for operating the objects.

1.3 The project

A consortium of HF engineers (ErgoS Human Factors Engineering), installers and simulator engineers was awarded an assignment to investigate the possibility of remote control of locks and bridges. The investigation should lead to a Proof of Concept: a real time test of a control room where a bridge, respectively a complex of two locks are operated on new designed workplaces supported by CCTV.

2. Method

HF Engineering focuses on systems in which people interact with their environment. The environment can be complex and consists generally of the physical environment, the organisational environment and the social environment (Moray, 2000; Wilson, 2000; Carayon, 2006).

In this case study there are a number of elements in a complex system: operators, workplaces, tools like CCTV and radar, technical processes, built environment, operator tasks, and a number of stakeholders (maintenance officers, captains of the ships, etc.) Organising a design process in a complex system needs a Systems Ergonomics Approach in which (consistent with ISO 11064-1) seven steps can be distinguished:

Step 1. Feasibility: a review of the project owners' human factors assumptions.

Step 2. Problem definition: a general description of the project and the purpose of the system to be designed. It also includes the structuring of the ergonomic input in the project.

Step 3. Situation analysis: getting insight in existing and future tasks. This includes activities such as:

- collecting formal documents, specifying the existing system;
- analysing the existing situation by observations and interviews regarding work tasks, the problems end users experience, and wishes they might have for the new situation;
- gathering relevant knowledge on the new system (to be designed).

Step 4. Functional Design Specification: the allocation of system tasks. This includes a discussion on the level of automation, job requirements, and the design of a local work organization. Following, a program of functional design requirements has to be drafted.

Step 5. Detailed Design/Engineering based on a set of functional design requirements. In this phase, various design solutions can be developed and brought up for discussion. This implies weighing all aspects involved, including ergonomics.

Step 6. Implementation: the new designed system is being built. Ergonomic assistance is often required to make sure the ergonomic features are properly implemented.

Step 7. Commissioning and evaluation: an ergonomic review of the new system.

The organization of user participation

To organise user participation, a user committee was formed, consisting of seven experienced bridge keepers and lock keepers, working on different workplaces. After finishing step 1 (Feasibility) and step 2 (Problem definition), the HF engineers analysed the existing system, using semi-structured interviews with lock keepers and bridge keepers, on the job. The HF engineers presented the results of the analysis to the management and the operators for feedback. A discussion in the meetings led to agreement on the analysis. This was a starting point for all the stakeholders in the following design process steps.

Later on in the design process (step 4 and 5), the issue of the CCTV design had to be elaborated. This was done in a small working group consisting of some experienced lock keepers, bridge keepers and a HF engineer. The CCTV working group submitted their results to the user committee. When they agreed to the design, the HF engineer brought the CCTV design into the detailed design of the new workplaces.

3. Analysis

In step 1 (Feasibility) and 2 (Problem definition) it became clear that most of the operators opposed to the plan of the harbour authorities to operate the locks and bridges remotely and also that they probably would be distrustful towards the HF engineers. The harbour authorities considered this as a threat for the success of the project. To meet to this attitude of the bridge keepers and lock keepers the HF engineers visited a large amount of operators, also on the harbour authorities' request: 21 bridge keepers on 9 different workplaces and 13 lock keepers at 6 different locks. The visits took place on various periods of time during day shift (7.30 am □7.30 pm), as well as on the night shift (7.30 pm □7.30 am). Each visit lasted several hours. On several visits, the operators were at first quit reserved towards the HF engineers and it took them some time to be more forthcoming. During each visit, the HF engineers systematically observed and interviewed an operator while executing his task. Issues on the interview list were: work tasks, workload, instrumentation on the workplace and the opinion of the operator towards the future developments.

3.1 The work tasks

Operating a lock, the lock keeper initially makes a lock-planning of the in and outgoing ships. Passing the lock, the operator has radio contact with all ships, monitors the process and intervenes when irregularities occur. Besides that, there are some administrative tasks. On most of the locks the lock keeper performs his task at a lock tower in which he has a high viewpoint.

At a single bridge, one bridge keeper controls the bridge, the barriers and the traffic lights. When the bridge needs to be opened, a ship requests the bridge by radio (VHF) or telephone. So does a train driver when he wants to cross the bridge. Bridge keepers also have a safeguarding role in case of maintenance work.

At a lock complex (two locks and four bridges) one bridge keeper operates four bridges and four lock doors from the lock tower.

On many occasions bridge keepers claimed they also have other tasks. However, these tasks officially did not belong to their range of duties:

- Take names and addresses of drivers who ignore the red lights and the barriers.
- Keep an eye on the shipping traffic and road traffic in the bridge area.
- Register all the ships that pass a bridge.
- Supervise the technical state of a bridge.

3.2 The workload

It became clear that the workload of the operators varies and depends on the number of ships passing a lock or a bridge in a shift, the number of lockages, and the number of times a bridge opens. This resulted in a rough estimate of the workload, expressed in a percentage of the working time operators are occupied executing their tasks:

- Lock keepers on a lock complex: 30 □70%
- Bridge keepers on a lock complex: 20 □50%
- Bridge keepers on a single bridge: 10 □40%

In the interviews none of the operators complained about the workload being too low or about getting bored. Some of them were even worried about expansion of their workload in the future. During the periods operators are not engaged in their work tasks they have all kinds of activities like, gaming, reading, surfing on the internet, watching television, etc.

Bridge keepers feel that they are held responsible by their management for the safety of the shipping and the traffic that pass the bridge. However, they also claim that they don't have the means to exercise their authority when for instance a truck driver ignores the red traffic lights. They consider this to be a potential stress factor.

3.3 The instrumentation

Each workplace has radar with AIS (Automatic Identification System). AIS enables the operator to identify all ships sailing in the harbour area. Operators find radar with AIS a good resource to get situational awareness.

In the present situation, CCTV is installed on the workplaces in addition to direct sight. Visiting the workplaces, the HF engineers came across several CCTV images of very poor quality. So the operators did not have a very good example of the possibilities of CCTV at their present workplaces.

3.4 The opinion of the operators towards the future developments

Many of the bridge keepers and lock keepers are > 50 years of age doing the job for more than 10 or 20 years, often at the same object. Some are former sailors; others have a background as maintenance engineer. Many of them are used to working alone or in a small team, during 12-hour shifts. The researchers sensed a feeling of proudness, responsibility and ownership amongst the operators towards the object they operate.

In the interviews, it became very clear that most operators believe that operating the locks and bridges in a remote control room is not a realistic option. According to the operators, direct visual sight is an important and indispensable requirement for the job and they just could not imagine executing their task without it. They expect that camera images can never replace direct sight properly and that the loss of direct sight will lead to unsafe situations. However, on several workplaces the HF engineers concluded that direct sight is very limited and insufficient. In addition, at those workplaces operators already have to rely on CCTV and radar.

Other aspects regarding the attitude of the operators towards the future developments were their concerns about losing autonomy and getting moved from their familiar workplaces.

Despite the assurance by the harbour authorities that there will be no loss of operator jobs; the operators were still worried about their job.

4. CCTV design

Half a year before the consortium got involved in the design and engineering of the Proof of Concept, the harbor authorities already started the engineering of a CCTV system for one bridge. A bridge operator and an electrical engineer prepared a CCTV camera layout, and made a report based on their own feeling and experience. Only few of the college operators appeared to be informed on this report.

There were serious shortcomings in that camera layout, such as:

- cameras and images were added for tasks that do not belong to the range of duties of an operator;
- some images contained only 5-10% relevant information;
- many blind spots;

- too much "sky" in the images, resulting in a considerable chance of blinding sunlight.

It was decided to redesign the camera layout in a more systematic and task related way. First the working group divided each operating task (for example: operating a bridge) into single operational steps (such as: switch on the red lights, close barriers). Next, the working group added ‘sight requirements’ to each operational step. For each operational step, a check has to be done, before taking an action. For example: before opening the bridge, the bridge keeper checks whether the area between the lowered barriers, including the part of the bridge that rises, is free of cars, trucks, cyclists and pedestrians. This leads to a viewing requirement: the operator should be able to see the traffic lanes between the barriers, including the footpaths and cyclist lanes (if any).

Next, the HF engineer had to determine corresponding camera positions. For this purpose, a 3D model (simulator) was available. The model simulated water levels, sight lines, different ships and different positions of the sun. Putting the cameras in position the simulator produced screen images, which the HF engineer presented to the working group to check if they really answered the operational requirements. After the working group agreed to the selected screen images, they were presented to a larger group of end-users, first in a mock-up setting, and later on in the Proof of Concept.

During this design process, it appeared on a number of occasions that the operators preferred more camera images than the HF-engineers considered useful, in relation to the sight requirements. These issues were brought up for discussion between the operators and the HF engineer in the working group. From the HF engineer’s point of view, there should be as few as possible screen images. The ambition was to design a compact, well-organized workplace. The more screen images needed, the more space would be needed on the workplace and an overview would get lost. Considering the operators’ field of view of 70°(EN 894-2) there is only limited space on the workplace available.

The operators had a different point of view. Even though they basically agreed on the viewing requirements, they wanted to add cameras (and images):

- related to the tasks that officially were not theirs;
- because they kept feeling unsure about seeing enough to do a good job;
- to illustrate that they have an important and complex job.

Eventually their support for operating the locks and bridges in a remote control room by CCTV did not only depend on the content of the images but also simply on the amount of the images (more is better). The outcome of the discussion led to a compromise: some (10%) extra cameras and screen images were added to the CCTV design.

Taking part in the working group took quite some time for all members. Overall, the working group met six times. There were several discussions and as in the interviews, the operators emphasized repeatedly that operating the locks and bridges in a remote control room is not a good idea. During the design process the operators gradually realised that there was ample attention to their point of view. That increased their confidence in the HF engineers and in the outcome of the design process.

5. Discussion and Conclusion

So far, there are hardly any ergonomic guidelines available for a good CCTV design (Schreibers, et.al., 2012) that can be helpful in a case like this. Looking back, the HF engineers are strengthened in their idea that a task related approach (as recommended in ISO 11064-2), is the only sound basis for a CCTV design. This includes a detailed inventory of operator tasks (and actions) combined with related sight requirements.

In this case, the HF engineers had to anticipate on the opposition of the end-users. They paid extra attention to the operators' tasks and their opinion towards the future developments: they planned twice as much interviews and working group meetings. During the process, this extra effort gave the HF engineers a very good insight in the tasks and the way of thinking of the operators. Furthermore it gave the operators the feeling of being recognized in their position and after a while, they let go on their distrust towards the project key members. However the operators kept their initial concerns towards the project ambitions. In the end, it led to a solid CCTV design with some extra-added cameras (and screen images) on indication of the operators.

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