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Abstract
The study presented in this paper, attempts to discover how ergonomic guidelines should be visualised in order to support ergonomic aspects throughout the construction process. Field studies were carried out at a company that produce cars for the global market. A prototype of an enhanced visualisation of their ergonomic guidelines at the intranet has been developed and evaluated. It could be concluded that the visualisation of ergonomic guidelines should preferably be based on a set up of main headings and a picture of the physical car with hyperlinked segments easy to relate to a group of guidelines or a specific guideline. A group of ergonomic guidelines are favourably described by headings and a picture of segments related to the physical car. A specific ergonomic guideline should preferably have measurements related to pictures of car objects and human body parts. Using pictures in the navigation structure and the specific ergonomic guidelines will make it easier and more interesting to find and interpret the guidelines. A user-centralised approach of the ergonomic guidelines can contribute to a more successful integration of ergonomic aspects in the construction process.

Keywords
Visualisation, Ergonomic, Guidelines, Field study, Prototypes

1 INTRODUCTION

Technical developments and a competitive market, encourage companies to continuously improve their construction processes. Those processes should benefit the personnel's knowledge, with a customer focus and result in continual improvements. Furthermore, the companies have to consider their strategically overall brand pillars throughout the construction processes in order to maintain and strengthen their market position.

Guidelines and instructions are used in quality systems to ensure high quality and an effective construction and production process. The guidelines and instructions often consist of text documents. However, these do not respond to some company's requirement of supporting the dialogue between their personnel. A study by Woodcock and Galer Flyte (1998) showed that the ergonomic knowledge available in guidelines and documents is hard to acquire, incomplete or not suited to the process or users.

A Swedish company that designs and manufactures cars for the global market was chosen for field studies. The company has approximately 8500 employees including

seven human factors engineers. Their existing system of ergonomic guidelines consists of a handbook on the intranet, where information is presented by text and some pictures. The constructing engineers receive the ergonomic guidelines as printouts distributed by the human factor department, and they have also access to the guidelines via the intranet. The company would like to develop their intranet solution that give the human factor engineers as well as the constructing engineers better access and usage of the ergonomic guidelines.

The aim of the present study is to explore how ergonomic guidelines should be visualised on the intranet and integrate the ergonomic aspects into the construction process. Field studies and experiments at one company have been carried out.

2 METHODS

The studies presented in this paper were conducted in accordance with Kolb's experiential learning theory (Kolb, 1984) and the usability engineering lifecycle (Faulkner, 2000), i.e. a concrete prototype was made supported by frequent feed back meetings and discussions with the participating users. Two students from the mechanical engineering program, with focus on ergonomics and design, worked with the study in collaboration with the first author in order to fulfil a master's degree.

The research of possible approaches to visualize guidelines started with discussions with human factor engineers at a company that produce cars for the global market. It was then followed by literature research, exploration of Internet web sites and field studies at the company.

2.1 Field studies

The field studies took place during four months and started with an examination of how the existing ergonomic guidelines are presented and how they support the human factor engineers' work and their communication with other departments. The study was decided, in dialogue with the human factor department, to be restricted to one part of the interior of the car, the front door. That made the guidelines concerned to a group of seven constructing engineers, and the human factor engineers.

Suggestions were produced as paper made sketches and computer supported prototypes and discussed with the human factor and constructing engineers. The suggestions were discussed and redesigned at several occasions with the participants. A final computer supported prototype, considering the participants' viewpoints as well as theoretical principals about presenting information, was constructed.

The present visualisation of ergonomic guidelines (Figure 1) and a prototype were evaluated. Three constructors and five human factor engineers participated. They were assigned to perform a set up of tasks using the present visualisation and the prototype respectively. The participants should find, interpret and evaluate the presentation of guidelines about details associated with the door. The participants were observed and guided throughout the procedure. Notes about the observations as well as oral comments, were carefully written down. Furthermore, a questionnaire was filled in at the end of the procedure.

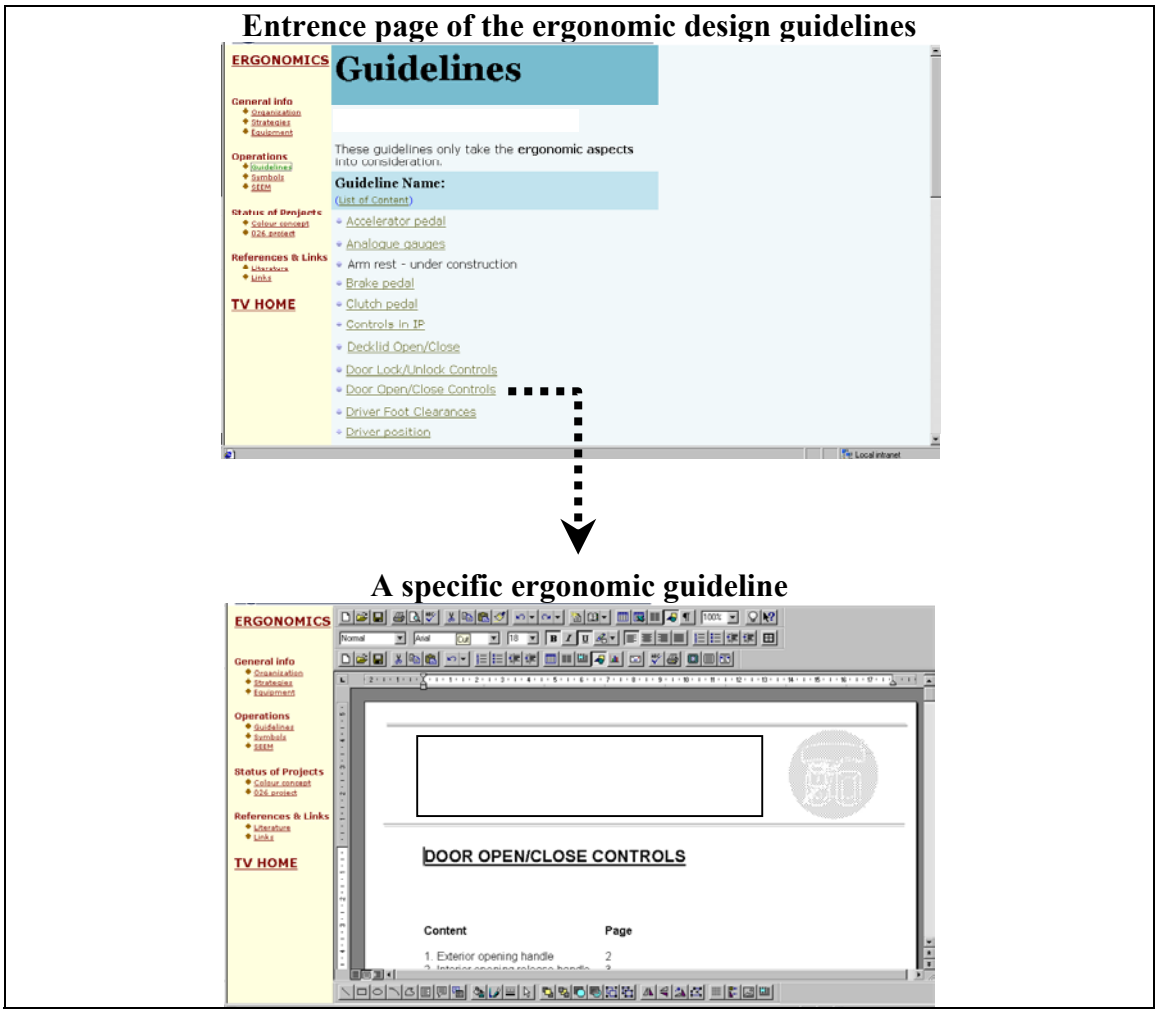

Figure 1. The present system to visualise ergonomic guidelines on the intranet.

3 RESULTS

3.1 Prototype to visualise ergonomic guidelines

Figure 2 shows the computer supported prototype developed in the field study. The prototype consists of pictures and text connected with hyperlinks in four hierarchal levels. An entrance page visualise the overview of the ergonomic design guidelines with linked headings and a picture of a car with linked segments. The user has an opportunity to choose either linked headings or linked segments to receive further information. The specific guidelines are presented with pictures and text in level four, e.g. the Lock knob in figure 2.

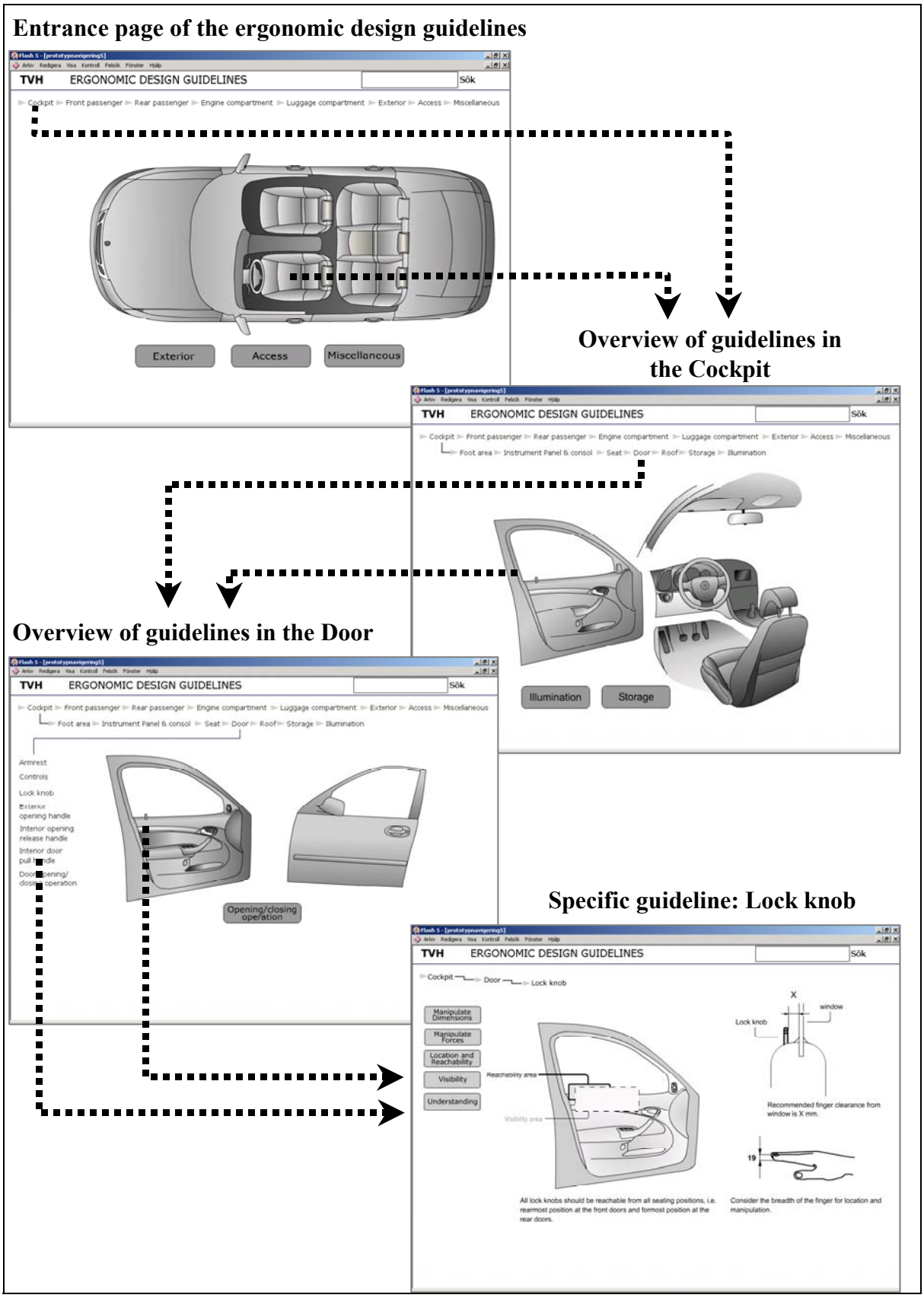

Figure 2. The prototype to visualise ergonomic guidelines on the intranet.

3.2 Evaluation of the present system and the prototype of a new system

Five human factor engineers and three constructing engineers evaluated the present and then the prototype visualisation of guidelines. One of the constructing engineers had not participated in the construction process of the prototype, but his answers did not differ from the others. There were no obvious differences in the answers weather it was a constructing or a human factor engineer. Questions and answers are compiled in Table 1.

Table 1. Questions and distribution of answers about the present and the prototype visualisation of guidelines.

		Answers				
Questions	**Visualisation of guidelines**	**Very easy**	**Rather easy**	**Neither easy nor difficult**	**Rather difficult**	**Very difficult**
How is it to find right guideline?	Present		2	4	2	
	Prototype	5	3			
How is it to understand the information in the guideline?	Present	2	3	3		
	Prototype	1	7			
How is it to use the information in the guideline?	Present		5	3		
	Prototype	2	4	2		
		Very good	**Rather good**	**Neither good nor bad**	**Rather bad**	**Very bad**
Your overall opinion about the system?	Present	2	1	3	2	
	Prototype	4	4			
		Summarised answers				
What advantages are there to present information in this way?	Present	• Clear descriptions • All information at one place				
	Prototype	• Easy to find information • Intuitive to use • Good to use pictures to navigate • Fun and interesting to explore the information • Suitable for newcomers as well as experts				
What disadvantages are there to present information in this way?	Present	• A lot of scrolling • Difficult to find information • Difficult to understand headings				
	Prototype	• Quite a lot of steps to receive information.				
Which system do you prefer?	Present	• 0				
	Prototype	• 8				
Motivate your choice!	Prototype	• More intuitive and distinct • Faster, no need for scrolling • More fun, nice layout, makes the user curious				

The observations and oral comments throughout the evaluation process could be summarized as followed:

- Several of the users misinterpret the levels, e.g. the users expect a detailed guideline from the cockpit overview (see figure 2).
- A user suggested that it should be showed how a detail should be used.
- Confusion about definitions in some specific guidelines.
- None used the search function, but one thought it was a good complement.

4 DISCUSSION

The ergonomic guidelines could be regarded as a checklist to ensure that ergonomic aspects are considered throughout the design process. It is then of great importance that

it is easy to find, interpret, use and verify the information in the guidelines. The study shows that the entrance to the guidelines was preferably based on the physical car, and not just a table of contents. It was considered to be appropriate for experts as well as newcomers. In a case study exploring how the documentation of a quality system should be visualised, a plant layout was preferred compared to a table of contents (Blomé et al, 2002). Thus, the entrance to guidelines and instructions at an intranet should include pictures representing the physical connection. The specific ergonomic guidelines of details should preferably have the dimensions illustrated in pictures with body parts shoving how the details are to be used. An interesting question is if animations, photos or movie clips are preferable to computer made sketches to visualise ergonomic guidelines. And also, the possibilities of importing dimensions recommended by the guidelines into the software, e.g. a CAD program. Another question of interest is how the fulfilment of guidelines should be verified. The design process of the prototype used in this study worked well according to the participating personnel and the two students. During the experiential learning process of this study, each participant became aware of the possibilities with enhancing the ergonomic guidelines and thereby the construction process with respect to ergonomic issues. Thus, the applied procedure probably had a pedagogic impact on the participants that can result in a more successful integration of ergonomic aspects supported by ergonomic guidelines in the construction process.

5 CONCLUSIONS

The following conclusions can be drawn from the study.

- The visualisation of ergonomic guidelines should preferably be based on a set up of main headings and a picture of the physical car with hyperlinked segments easy to relate to a group of guidelines or a specific guideline.
- A group of ergonomic guidelines are favourably described by headings and a picture of segments related to the physical car.
- A specific ergonomic guideline should preferably have measurements related to pictures of car objects and human body parts.
- Using pictures in the navigation structure and the specific ergonomic guidelines will make it easier and more interesting to find and interpret the guidelines.
- A user-centralised approach of the ergonomic guidelines can contribute to a more successful integration of ergonomic aspects in the construction process.

6 ACKNOWLEDGEMENT

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