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How do designers represent to themselves the users' needs?

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Abstract

This paper reports on an ergonomic study carried out during the design of a cutting machine-tool for the composite material in carbody parts casting. During this design process, the users' needs were inferred by the designers on the basis of their own mental representations of the use of the new device. These representations of the users' needs, correct or false, play a decisive role in the choice of a solution. The aim of the study is to identify their particularity. Analyzing the design meetings, we have highlighted that users are considered either as subsystems or basic design principles or elements of an imagined scenario. We have shown that these representations are linked to the types of meetings held during the design process. Accordingly, a diversification of the types of meetings should be promoted by the project leader, so that designers extend their points of view of the operators.

Keywords: User-centred design; Project management; Cooperative design

1. Introduction

When designing products and devices, designers do not have many direct inputs concerning the real needs of the endusers. Indirect inputs, such as human factors information provided by ergonomics guidelines and task analysis can bridge this gap. But this does not prevent the designers from referring to their own experience and knowledge of the user's likely behaviour. These representations of use—correct or false, rich or poor, partial or complete—play a decisive role in choosing a solution. This paper begins with this issue.

1.1. Human factors in design

Designers of workplaces—and especially methods, industrial or manufacturing engineers who are in charge of designing manufacturing devices—must satisfy design constraints related to industrial processes, existing machines and tools, tasks and operating processes. While integrating these different aspects of work into their design, it is difficult for designers to incorporate ergonomic information on the operators' needs and the future use of the device, as mentioned for instance by Feyen et al. (2000) or Fulton Suri and Marsh (2000).

There are various means to help overcome this difficulty and promote user-centred approaches depending on the size of the company, on the importance of the design project and on the dissemination of user-centred practices in the firm. Some firms have a company ergonomist or will hire an external ergonomist for the duration of the design project. Their expert appraisals, such as prototyping or user trials, can bridge the gap between designers and users, pushing forward the issues related to the use during the design process. In some other firms, the managerial staff relies on quality circles to highlight the users' needs. In the best case scenario, participatory design approaches are adopted for a design project or as a firm culture (see the collection of papers presented in Clement and Van den Besselaar, 2004).

For ergonomists, part of their mission is to promote methods to efficiently integrate human factors information during the design process. There are many advances in this area. Participatory design is currently seen as a promising approach that provides a holistic view of the design

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process, a broad conception of working conditions, as well as specific methods such as design games and scenario building (see for instance Brandt and Messeter, 2004; Carroll, 2000; Clement and Van den Besselaar, 1993; Greenbaum and Kyng, 1991; Kensing and Blomberg, 1998; Johansson Hanse and Forsman, 2001).

1.2. Difficulties for designers to adopt user-centred approaches

However, designers are sometimes frustrated by the results of user-centred approaches. A first reason is that human factors analysis provides data about people's capabilities regarding singular design variables (e.g. biomechanical predictions) but generally does not lead to design solutions (Fulton Suri and Marsh, 2000; Feyen et al., 2000). Moreover, ergonomic standards often focus on physiological aspects of human operator performance, while psychological and subjective factors such as knowledge and competences are not well represented in guidelines. Another reason, as emphasized by Butters and Dixon (1998), is that the available data and recommendations in ergonomic guidelines are often incomplete and out-of-date and do not reflect the developments of contemporary devices. Last but no least, user-centred approaches—and associated qualitative methods—are expensive in terms of time and money. This cost increases with the amount of direct involvement of the users. The more participatory, the more expensive the process is for the company (Damodoran, 1996; Heller et al., 1998).

Another facts that mitigates against the designers integrating the user as a full dimension of design is that their professional training does not promote user-centred approaches. It is worth noting that one of the most well-known engineering design frames, presented by Pahl and Beitz (1995) in a book on systematic approaches to designer does not mention the "user" at any time in its index. The term "use" is referred to under the keyword "use-value analysis/cost-benefit analysis". The same trend is observed in recent research in engineering design as presented at the International Conference on Engineering Design. Out of the 200 papers presented during the 14th edition of this conference (Folkeson et al., 2003), only six mention the term "user" in their title.

Of course, designers are concerned with the notion of use. Some methods recommended by design methodologies—such as functional analysis—provide indications on the usage aspects of devices. Many designers, such as the methods engineers, are to some degree familiar with the context in which the devices will be used. In some factories, the jobshops are located quite near the methods or manufacturing engineering office. But users' future needs are often anticipated by designers on their own assumption of users' likely behaviour, rather than on ergonomics rationale. These representations underpin the functional analysis of the product, guide technical decisions and therefore have a considerable influence on the design of the device.

2. The challenge

There will always be phases of the design process in which the users' needs will not be directly provided by the users themselves, nor indirectly formulated by a user representative (e.g. an ergonomist). The aim of this exploratory study is to understand how designers, during these phases, mentally evoke the uses, the function and the place of the future users. We argue that a better knowledge of these mental representations built by the designers about the future users could help improve a user-centred approach.

These representations can be inferred from the analysis of the verbal exchanges that take place during design meetings. Their analysis is presented in the first part of this paper. In a second part, we examine whether it is possible to find a link between the different types of meetings that the designers take part in and the way in which they represent to themselves the operators' needs. Our hypothesis is that the type of design meeting (e.g. functional analysis meeting, project review meeting or information meeting) has an effect on the type of user's representation which is evoked by the designers. If observed, this effect would lead to some prospect of transforming and modifying methodologies of design meeting management, so as to generate a richer and enlarged view of the operators' needs.

3. Industrial context

This study has been carried out in the field of car body parts casting. At the time of the study, the plant belonged to a French firm, Matra-Automobile. The composite material to be cast was manually cut by manufacturing operators using a craft knife on a cutting table. Because of the growing occurrences of work-related musculoskeletal disorders, an ambitious design project was launched aimed at performing all the cutting operations with a numerically controlled machine-tool (see Fig. 1). The methods department was in charge of writing the specifications related to this new device which was engineered by an external firm.

This design process lasted 2 years. It was led by a steering committee of the methods department consisting of the project leader, a mechanical engineer, the company ergonomist and the scheduling manager. Two technical sub-groups were also involved in the process: an external *design team*, made up of three systems engineers and the *specialists group*, made up of four to six engineers belonging to the methods department (maintenance, mechanical engineering, control, computing) as well as the head foreman. These engineers came to the meetings according to the subject dealt with during the meeting. All these stakeholders are named *designers* in this paper.

This design process was partly enduser-centred since the manufacturing operators were asked to give their point of