



PERCEPTION OF ERGONOMICS AND ITS USE IN PRODUCT DESIGN BY ENGINEERS FROM THE FEDERAL UNIVERSITY OF SANTA CATARINA

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Abstract: Starting from the hypothesis that engineers make a small use of ergonomics in the product development process, a case study was developed with engineers at the Federal University of Santa Catarina in order to check the actual understanding of ergonomics and their use in the product project by these engineers. Therefore, the content analysis method was used, through guided interviews, which allowed to determine the design methodologies most used by engineers, and the understanding and use of ergonomics in product design. It could be observed that the use of ergonomics is limited as its understanding for these professionals is also limited. The concept of ergonomics is still not widespread in this area despite its importance, and the difficulty of understanding ergonomics, as well as complicates its use, causes it to be seen as less important.

Keywords: product design; design methodology; ergonomics; engineering.

INTRODUCTION

According to the International Ergonomics Association (IEA, 2000), ergonomics can be defined as the scientific discipline that deals with understanding the interactions between human beings and other elements of a system, and the profession that applies theory, principles, data and methods to projects that aim to optimize human well-being and the global performance of systems.

Wisner (1987) defines ergonomics as the set of scientific knowledge related to man, necessary for the design of instruments, machines and devices that can be used with maximum comfort, safety and efficiency in the activity performed. For Blaich and Blaich (1993), ergonomics is

an integral part of design and design, whenever there is user-product involvement. Appropriate product design requires interaction with ergonomics practice.

The development of projects with an emphasis on ergonomics is a natural necessity when the focus is on the human being, in this sense the ways of designing must consider their capabilities and limitations. It is observed that this approach usually presents itself in a theoretical dimension, that is, it is mentioned in project development processes, but in practice it is sometimes neglected and even disregarded (MERINO, 2014).

Cushman and Rosenberg (2000) emphasize that ergonomics applied to product development aims to create products that work well in human terms. Its focus is the product user, and its main objective is to ensure that products are easy to use, easy to learn, productive and safe.

Integrating ergonomics in the design of new products is an important strategy (BROBERG, 2010; DUL;NEUMANN, 2009; JENSEN, 2002; HENDRICK, 2008, NEUMANN et al., 2006, 2009). Design engineers are often unfamiliar with ergonomic tools and do not take into account the relationship between ergonomics and quality (BROBERG, 1997; HASLEGRAVE;HOLMES, 1994; SKEPPER et al., 2000; JENSEN, 2002; SUNWOOK et al., 2008).

In many cases, the practice of ergonomics in product design ends up being very different from the principles and theories of ergonomics (NORMAN, 1996; WIXON, 2003; STEEN, 2008). Several authors point out that in academia there is not enough research on the practical concerns of ergonomics and user-centered design, and that practice must be studied to understand the barriers and facilitators to the successful integration of ergonomics into product development (GRUDIN , 1991; WIXON, 2003; GULLIKSEN et al., 2006; CAPLE, 2010).

In this context, based on the hypothesis that engineers make little use of ergonomics in the product development process, we intended to verify the real understanding of ergonomics and its use in product design, by engineers taking master's and doctorate degrees from the University Federal of Santa Catarina - UFSC.

METHODOLOGY

This research has an exploratory nature, which according to Gil (1996), aims to provide familiarity with the problem, with the aim of detecting, understanding and interpreting the phenomenon investigated. Based on the bibliographical survey on the subject, qualitative research was carried out, through a case study, which according to Triviños (2006) is characterized as a type of research whose object is a unit that is analyzed in depth.

Therefore, the real understanding of ergonomics and its use by engineering master's and doctoral students at the Federal University of Santa Catarina was investigated, using the content analysis method (BARDIN, 2009), using guided interviews. The information obtained was coded, categorized and interpreted, using the Léxica Survey software (Sphinx Brasil – evaluation version) as support for validating the collected data, without excluding qualitative interpretation.

The method was applied at the Integrated Product Development Center - NeDIP and at the Product and Process Engineering Group - GEPP, in the laboratory meeting room, during the afternoon on two different days. NeDIP is located in the Mechanical Engineering department of the Federal University of Santa Catarina and GEPP is in the University's Production Engineering department. A simplified process was carried out, with 15 interviews (minimum described by Bardin, 2009), for comparative analysis. The choice of study units is justified by the geographic location and the researcher's easy access to the laboratories.

The selection criteria was a homogeneous sample of mechanical engineers and production engineers, with at least 1 year of experience with product development, requiring them to

have taken the design methodology or product development course when they were undergraduates. The ergonomics subject was not used as a criterion because in mechanical engineering it is not part of the curriculum, only in production engineering.

This study was approved by the Research Ethics Committee of the Health Department of the State of Santa Catarina (CAAE: 48799215.9.0000.0121).

RESULTS AND DISCUSSION

8 mechanical engineers and 7 production engineers were interviewed, all postgraduate students from the Federal University of Santa Catarina, who work in the Integrated Product Development Center - NeDIP and in the Product and Process Engineering Group - GEPP, both laboratories of the University. The engineers interviewed were between 23 and 58 years old (mean 30.07, SD 8.64) and had between 1 and 7 years of experience in the area of product development (mean 3.47, SD 2.00), as can be shown in table 1.

Table 1 - Description of the personal and socio-demographic characteristics of the sample (n=15).

Personal and socio-demographic characteristics			
Independent variables	n (%)	Independent variables	n (%)
Sex		Marital status	
masculine	13 (86.67)	single	12 (80.0)
feminine	2 (13.3)	married	3 (20.0)
Age		Education	
< 24 years old	2 (13.3)	master's students	9 (60.0)
25 to 27 years old	4 (26.7)	doctoral students	6 (40.0)
28 to 30 years old	3 (20.0)		
31 to 33 years old	4 (26.7)		
> 34 years old	2 (13.3)		
Time experience		Training area	
< 2 years	4 (26.7)	mechanical Engineering	8 (53.3)
3 to 5 years	7 (46.7)	production engineering	7 (46.7)
6 to 8 years	3 (20.0)		
> 8 years	1 (6.7)		

From the recording of the 15 interviews, it was possible to categorize and organize the information obtained (Table 2).

When asked which product development methodologies they knew, the most cited were Back et al. (2008) by 86.6% of respondents, Pahl and Beitz (1977) by 60% and Rozenfeld et al. (2006) by 33.3%. They were later asked which of these methodologies they used most, with Back et al. (2008) had a frequency of 46.7%. When asked about the use of ergonomics in the development of their projects, 53.3% said they use it compared to 46.7% who do not use it.

Table 2 - Categorized responses from the interviews (n=15).

Categorized Job and Health Interview Answers			
Independent variables	n (%)	Independent variables	n (%)
Known methodologies		Uses ergonomics in product designs	
Pahl e Beitz (1977)	9 (60.0)	Yes	8 (53.3)
Back et al. (2008)	13 (86.6)	No	7 (46.7)
Rozenfeld et al. (2006)	5 (33.3)		

Asimow (1962)	3 (20.0)		
Baxter (2000)	1 (6.6)		
Design Thinking	4 (26.7)	Yes: when do you use it?	
TRIZ	3 (20.0)	Informational	2 (25.0)
DFX	4 (26.7)	Conceptual	1 (20.0)
The company's own methodology	4(26.7)	Preliminary	4 (50.0)
		Detailed	5 (62.5)
Most used methodology		No, why?	
Pahl e Beitz (1977)	3 (20.0)	Don't think it's important	3 (42.8)
Back et al. (2008)	7 (46.7)	Do'nt know	3 (42.8)
Rozenfeld et al. (2006)	2 (13.3)	Don't understand	6 (85.7)
The company's own methodology	3 (20.0)		

Note: the number of citations may exceed the number of observations due to multiple responses.

Regarding your understanding of ergonomics, the most used words and expressions to describe the term were “products”, “use”, “suitability”, “human being”, “comfort/comfortable” and “user” (figure 2), as the following comments illustrate: “Ah, comfortable, right? Less tiredness during the activity” (E.2); “Is it the same thing as usability? Attributes of using a product?” (E.3); “user comfort is...not conflicting with the human body” (E.7); “suitability of the work to the man” (E.10).

Figure 2 - Word cloud with the most used words and expressions to define ergonomics.



Comparing the interviewees' training with the use of ergonomics in projects, it can be seen that production engineers consider this factor more than mechanical engineers, as can be seen in table 3. This is probably due to the fact that the ergonomics course Mechanical engineering does not have an ergonomics subject, while in production engineering the ergonomics subject is optional or mandatory, depending on the university.

Table 3 – Comparison between the training of interviewees and the use of ergonomics in projects.

	Mechanical Eng. n(%)	Production Eng. n(%)	Total n(%)
Yes	3 (37.5)	5(62.5)	8(100.0)
No	5 (71.4)	2(28.6)	7(100.0)

Finally, those interviewed who stated that they did not use ergonomics in their projects were asked why, with 85.7% commenting that they did not understand the concept well, which prevents its use: “the concept is not very widespread among us... I didn’t have time to think, discuss the matter... the most important thing was cost and material” (E.3). 42.8% said they did not find its use important in product development and another 42.8% said they did

not know the application of ergonomics in product development, as the following comments illustrate: “engineering focuses a lot on product performance... we end up ignoring the user in favor of the function” (E.7); “I don’t know how to use it, really. I think I even think about something intentional but I don’t use it in a systematic way, following some logic, with all the potential it could have for application” (E.4).

The interviewees who said they use it were asked whether they generally use ergonomics at the time of the project, with 25% commenting that it is at the time they are eliciting the requirements, in the informational phase; 20% when creating the product design, in the conceptual phase; 50% in the preliminary phase, when they are defining technical and material aspects of the product; and 62.5% are already in the detailed design phase, considering assembly, manufacturing and maintenance, as illustrated in the following comments: “when I am already working on the geometry of the parts, thinking about assembly and maintenance. To reduce maintenance time, and risks too” (E.1); “in the design of the parts, more when I thought about manufacturing, where jobs actually come into play” (E.9).

It can be seen that although more than half of the interviewees claim to use ergonomics in product development, this use is limited as the understanding of ergonomics by these professionals is also limited. While the IEA (2000) defines ergonomics as the science that deals with interactions between human beings and other elements of a system, aiming to optimize human well-being and the overall performance of systems, the engineers interviewed understood ergonomics basically as the suitability of work for the man. This explains the fact alleged by authors Norman (1996), Wixon (2003) and Steen (2008) that the practice of ergonomics in product design often differs from theory, as engineers are not well familiar with the concept (SKEPPER et al., 2000; JENSEN, 2002; SUNWOOK et al., 2008), despite its importance for the area of product development (CUSHMAN; ROSENBERG, 2000).

Engineers generally consider ergonomics when they are already creating the product design, thinking about the design of parts to facilitate manufacturing, assembly and maintenance, which is at odds with what is stated by Blaich and Blaich (1993) and Iida (2005), that the ideal is to consider ergonomics from the beginning of the process. Furthermore, it is clear from the comments made that they rarely think about the end user, which according to Iida (2005) is of great importance to avoid disapproval and non-acceptance in the market. According to the author, the user's characteristics must be considered together with the characteristics and restrictions of the mechanical parts, to mutually adjust to each other (IIDA, 2005).

FINAL CONSIDERATIONS

The results presented through the analysis of the perception of ergonomics and its use in product design by engineers from NeDIP and GEPP at the Federal University of Santa Catarina show that ergonomics is little used in product development projects, being considered only in the final and not from the beginning of the process. The concept of ergonomics is still not widespread in the area of product development, despite its importance (CUSHMAN; ROSENBERG, 2000), and the difficulty in understanding ergonomics, in addition to making its use difficult, makes it seen as less important.

Content analysis was essential to verify the engineers' real perception of the importance of ergonomics in product development. However, as it is a case study, this work does not provide an in-depth analysis of the profession and the field of work, making it necessary, therefore, a more comprehensive and larger study for more detailed conclusions on the use and understanding of ergonomics by engineers working in the area of product development. Therefore, it is expected that this initial research has made evident the need for

further studies in the area, allowing the analysis of how ergonomics is actually considered in the product development process.

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