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PhD thesis

Analysis of built and furnished environment by ergonomic aspects, practical application of ergonomics

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Research objective

The aim of this study is to evaluate and methodize the body of knowledge of ergonomics and related principles and methods from the standpoint of the objectives of product design, and to help the information gained from it to become more accessible to practical application. It is aimed that ergonomics, beyond its role to add value in general, could provide principles and views for product design in practice.

A further objective is to propose and present design tools for the assessment and prediction of the ergonomic quality of a product in the design phase already.

Scientific background

The relationship between ergonomics and product design has been studied by many authors in the last decades (Orbay Péterné 2003: Konyhatervezés, Invest-Marketing Bt., Budapest; Dr. Iványi Attila Szilárd 1984: Termékstratégia, gyártmánypolitika, műszaki fejlesztés, Műszaki Kiadó, Budapest; Becker György - Kaucsek György 1996: Termékergonómia és termékpszichológia, Tölgyfa Kiadó, Budapest; G. Pahl - W. Beitz - J. Feldhusen - K. H. Grote 2007: Engineering Design, Springer-Verlag London Limited).

In the literature and practical life, a number of solutions can be found which relate the present study. There are several solutions proposed for evaluating or classifying from ergonomics points of view. However, after studying them, the user must see that these principles and procedures are either overly general (Karl T. Ulrich – Steven D. Eppinger 2004: Product Design and Development) and it is difficult to arrive at practical results, or on the contrary, they are subject-specific

(Klein Sándor 2004: Munkapszichológia, EDGE 2000, Budapest; N. F. M. Roozenburg J. Eekels,1996: Product Design: Fundaments and Methods, John Wiley & Sons). Application of those methods is only straightforward in the indicated area and problems at hand (e.g. anthropometry); they can be hardly adapted to the examination of other areas.

Research method

As an approach to answer the questions put up, processing of the available literature and a new, targeted synthesis of the same was undertaken as a starting point. It comprised the evaluation of previous surveys and practical examples. This aimed to point out the deficiencies with regards to the questions I chose to deal with, as well as to illustrate the distance between theory and practice. The theoretical study was followed by creation of models based on experimental investigation. It was my objective to demonstrate the possible practical benefits of the answers that I gave to the questions outlined.

The structure of the thesis work is defined by reasoning from theory towards practice: review of the necessary historical and theoretical background, proposal for integrating the same into the design, suggestion of practical tools for the implementation.

Results

The results of the study can be summarized in four units according to the investigation carried out:

1.) The interpretation and application of ergonomics is based on system theory. The relationship is much more complex than what has been explored in this area. The system as a whole can be interpreted on multiple levels. It can be

interpreted on a scientific level, where ergonomics is a subsystem. In addition, it can be interpreted as a subsystem in the design process. If we take the product itself, it is regarded as a subsystem of the man-machine-environment system that can be further decomposed. The breakdown may result in the subsystems of form, functionality, dimensions, material and that of structure.

2.) The life of the product is a complex process. There are many components and influencing factors. However, in order that the product could get from the idea phase to realization, use and disposal on a continuous path, each of the phases, which are dependent on each other, must compose a logical chain. It is already known from the previous paragraph's assumptions, that the ergonomics is an important element of both the product and the creative process. Based on these, I set up a guide for design, which contains all the phases, which are included in the product life cycle, and for each phase I defined tasks pertinent to ergonomics.

3.) The gap-theory for those designs, which involve special categories of users, is already known. However, the extension of this theory, as well as interpretation on the definition level of ergonomics is a novelty. The gap can be found in those design tasks, where efficiency, comfort, safety, and preservation of health are target issues.

4.) We are not all alike, that is why design for all is a difficult task; mainly because the general assessments tools are subjective. In the fourth unit of the thesis work I prove through a case study that both the QFD method, and the method of factorial experiment are appropriate tools for designing ergonomic quality into a product; furthermore, based on the complex relationship between the products' technical parameters and the indicators of ergonomic quality.

Areas of utilization of the results

The results of the thesis in particular can be applied in the ergonomic design of the built and furnished environment, as well as in education programs. With the help of the outlined principles it is possible to identify ergonomic problems (e.g. special users) and cognitive product design is also possible.

Theses

1.
The discipline of the product design has to be primarily based on the science of ergonomics. All of human demands can be traced back to ergonomics (or should be formulated on the basis of ergonomic). The user needs to be subordinated to the design, namely the principles of ergonomics in the economic, aesthetic and technical aspects should be mainstreamed.

2.
The product, as a system can be modeled by subsystems' relationship. From the product design point of view basically the following subsystems has to be considered:

- subsystem of form
- subsystem of function
- subsystem of structure
- subsystem of material
- subsystem of dimensional

3.
It was found that the method based on the science of ergonomics is able to eliminate the gap, which appeared in the course of the interaction between the user and the product. Therefore, a new task of ergonomics in the product

development is to eliminate this gap from the interaction of user and product.

4.
Based on my investigations I proved that the ergonomic quality has a number of components. Each component is determined by the design parameters of a product. The ergonomic quality components, derived from customer needs can be satisfied by complex methods of analysis. QFD can be a candidate method, the adaptability of which in ergonomic design is demonstrated.

5.
My investigations lead to the conclusion that the components of ergonomic quality can be dealt with as dependent variables the level which is determined by the product-related quantitative and categorical (qualitative) characteristics as independent variables. Based on that assumption I worked out a factorial experimentation model of the ergonomic quality characteristics.

6.
The existence of mankind and the mover of the society are the change, and the direction toward to a positive change is considered as a progress. The care for each other and the community development are driven by morality. The technical manifestation of all of this is ergonomics; with the help of this science may we strive to maintain human comfort, safety and health for the benefit of all.

7.
The designer brings his information system into the planning process and with the creative work and organization of creative process he establishes special relations with the new

expectations of the system. In the course of his work he uses those tools in the system design that are best suited to the needs of established special space. Thus, it becomes the creative process of planning system, in which system the activities of various elements' relationship and mutual relations are formed.

The research work has been documented and published in the following publications:

1.) *Horváth Péter György* 2002: Kerekesszékes fiatal értelmiségi nappali tartózkodási és dolgozó helyének kialakítása, Irodabútorok, InfoProd, Budapest, pp. 40-41.

2.) *Horváth Péter György* 2004: Milyen tényezők befolyásolják a bútorok méretét?**,** Irodabútorok, InfoProd, Budapest

3.) *Horváth Péter György 2006*: Megfogni és megszeretni, Irodabútorok, InfoProd, Budapest, pp. 33.

4.) *Horváth Péter György 2005*: Antropometria és embermodell, Egyetemi elektronikus jegyzet, NymE FMK TGYI, http://tgyi.fmk.nyme.hu

5.) *Horváth Péter György 2006*: Irodabútorokhoz használt anyagféleségek, Irodabútorok, InfoProd, Budapest

6.) Dr. Kovács Zsolt – Horváth Péter György 2006: Termékbiztonság, a HEFOP 3.3.1. projekt keretében készült tananyag az Ipari Termék- és Formatervező Mérnöki BSc. képzéshez, Budapest-Sopron elektronikus jegyzet, http://www.gszi.bme.hu, http://tgyi.fmk.nyme.hu, pp. 1-64; 130-244.