Ergonomic Design - a Research Line in Human-Technology Interfaces

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ABSTRACT

Although technological developments in recent decades have improved the quality of life for many, these developments have also led to a certain amount of friction regarding human-technology interfaces. Several such cases are related to the occupational or everyday activities of users. Ergonomic design is an area of scientific understanding based on methods of biomechanical and usability evaluation, employed during the development of products and systems, whose purpose is to eliminate or minimize problems in human-technology interfaces. This area characterizes the studies developed in the Laboratory of Ergonomics and Interfaces (LEI) in the Design Postgraduate Research Program (Masters and PhD), at the Faculty of Architecture, Arts and Communication at the Univ. Estadual Paulista (Brazil). The studies are characterized as cross -sectional, and comply with the ethical principles for research with humans. Among the different studies in this area, are presented: the user experience and the usability of web-sites; ergonomic considerations in fashion and clothing; usability considerations in packaging; influence of product shape in symbolic and aesthetic aspects; biomechanical considerations in hand tools; assistive technology and product development for elderly and disabled persons; among others. The results of these studies are useful for the project and development of products and systems, once its results demonstrate the real problems of human-technology interfaces and provide reliable ergonomic and usability parameters.

Keywords: Ergonomic Design, Usability, Technology

INTRODUCTION

Although technological developments in recent decades have generated numerous benefits to contemporary life, friction in the user x technology relationship is being increasingly observed with greater intensity, especially in the use of interfaces.

Scientific studies that attempt to answer the questions on the user x technology relationship are under the same scope as those that deal with the man x work relationship, which characterize the discipline of ergonomics.

Historically, such studies had the discoveries of Vitruvius (100 BC), Cennino Cennini (1370-1440), Leonardo Da Vinci (1452-1519) and Bernardini Ramazzini (1633-1714), among many others who helped to "write" the prehistory of ergonomics. Yet it was not until the mid-twentieth century that it became a scientific discipline, and studies in this field have become more systematic with more consistent methods, capable of answering questions of the man x work relationship, ever present in modern society, more properly.

With the technological developments of the late twentieth century and the transformation from modern to

contemporary society, the friction observed between man and work began to be observed in almost all daily activities, usually involving a certain "user" and a given "system". Thus, the definition of ergonomics as the "human-system interface technology" (Hendrick, 1993) appears to be the most relevant.

Currently, ergonomics presents different scopes and research lines, among which stands out so-called "ergonomic design," or application of ergonomic knowledge in the design of technological devices, with the goal of achieving safe, comfortable, efficient, effective and acceptable interfaces (Paschoarelli, 2008), with principles based on the interrelation between ergonomics and design.

In fact, studies in this field are characterized by integration of quantitative (e.g.: biomechanical strength) and qualitative (e.g.: perception of comfort) methods, employed during the evaluation and development of products and systems, in order to eliminate or minimize problems with the technological interfaces (Paschoarelli, 2009).

The purpose of this text is to present this line of research, especially based on studies conducted at the Laboratory of Ergonomics and Interfaces (LEI) in the Design Postgraduate Research Program (Masters and PhD), at the Faculty of Architecture, Arts and Communication at the Univ. Estadual Paulista, in the Bauru city, state of São Paulo, Brazil. These studies are mostly characterized as transverse, mixing parametric and subjective approaches, and fully respecting the ethical principles of research on humans.

LABORATORY OF ERGONOMICS AND INTERFACES -LEI

The LEI is the basis of the research line on "Ergonomic Design," at the UNESP-Bauru campus. In its facilities, scientific research and studies on the interfaces between human aspects and technological systems are developed. The LEI is associated with the Design Postgraduate Research Program (Masters and PhD) and the Department of Design at the Faculty of Architecture, Arts and Communication at the Univ. Estadual Paulista.

The LEI started its activities in 2003 and is linked to the Research Group, "Industrial Design: Design and Interfaces" (GDPIPI) (http://dgp.cnpq.br/buscaoperacional/detalhegrupo.jsp?grupo=03306122VDXCZE), registered in the CNPq (Brazilian National Research Council) directory. The LEI's coordination is certified by ABERGO (Brazilian Ergonomics Association) and is research with Productivity Grants (PQ-CNPq-1D).

In terms of physical space, the LEI has a reception area, space for studies and theoretical analyses, and space for assessments and practical simulations. It also has equipment for anthropometric, biomechanical and usability assessments, among other uses.

Since its first year (2004), the LEI has shown notable academic production:

- 70 articles in scientific journals, particularly "International Journal of Industrial Ergonomics", "Work", "Human Factors in Design", "Ergodesign & HCI", "Brazilian Journal of Physical Therapy", "Estudos em Design", "Caderno de Estudos Tecnológicos", "Design & Tecnologia", "Infodesign" and "Educação Gráfica", among others, with at least nine citations recorded on the Web of Science and ten citations in Scopus;

- 22 published books, organized or editions, by important Brazilian publishers in the field of design;

- 78 book chapters, published in works by prominent Brazilian publishers of the design field, as well as international publishers such as "CRC Press", "Taylor & Francis" and "Spring – Verlag";

- 367 full papers, published in proceedings of conferences, especially congresses in the field of ergonomics and design.

Training and development of human resources was also significant, thus far awarding seven PhDs, 36 Masters degrees and 32 scientific initiations. Most research projects developed had funding from major Brazilian research funding agencies – CAPES ("Coordination for the Improvement of Higher Education Personnel – Brazil"), CNPq, FAPESP ("São Paulo Research Foundation"), FAPEAM ("Amazonas Research Foundation"), FACEPE ("Pernambuco Research Foundation") and FINEP ("Brazilian Innovation Agency").

Those Masters and PhD degrees at LEI carry out their academic and teaching activities in well-known universities: UNESP, UEM (State University of Maringá), UFAM (Federal University of Amazonas), UFMA (Federal University of Maranhão), UFPE (Federal University of Pernambuco), USC (Sagrado Coração University), UNIPAR (Paranaense University), among others. In 2006, LEI promoted the 6th Ergodesign - International Congress of Ergonomics and Usability of Human-Technology Interfaces: Products, Information, Built Environment, Transportation and 6th USIHC - International Congress of Ergonomics and Usability, Design Interfaces and Human-Computer Interaction; and in 2009 the 5th CIPED - International Congress of Design Research.

Other highlights were various recognitions (awards) from respected entities and companies, notably: ALCOA - Latin America and the Caribbean, Whirlpool Latin America, ABRE - Brazilian Packaging Association, Brazilian Design Biennial and the Brazilian House Museum (São Paulo).

KEY STUDIES DEVELOPED IN THE ERGONOMIC DESIGN RESEARCH LINE

In the past ten years, several studies conducted in the LEI have characterized the academic production that are the basis of its "Ergonomic Design" research line. In fact, the first study that suggested this nomenclature was characterized by a master's degree thesis (Paschoarelli, 1997) dealing with the relationship between children (users) and pre-school furniture (system). Next, a study (doctoral thesis) developed at the Federal University of São Carlos, with LEI's support, examined the relationship between sonographers (users) and transducers (system), which consolidated the theoretical foundation for the beginning of the first studies effectively developed in this subject (Paschoarelli, 2008).

Among the different studies which evaluated the relationship between children with Cerebral Palsy and Scoliosis (users) and seats (system), is highlighted. A seat with a support control for the wearer's torso was developed, and the system was evaluated by means of biophotogrammetry, confirming that the ergonomic design of the system can reduce users' problems (Ganança, 2006). Another study examined the use of wheelchairs for the elderly, by using biomechanical and perceptive approaches. The results indicate that regular wheelchairs are not suitable for this audience (Carriel, 2007). Following this same line, there is a study (funded by CAPES) that examined the conditions of use furniture and equipment in a regional hospital in the interior of Brazil by obese individuals (Lucio, 2007).

Biomechanical studies developed by LEI have included evaluations of workstations in the Manaus Industrial Center (funded by FAPEAM) (Falcão, 2007) and on ergonomic evaluation methodologies in multifunctional activities (Ligeiro, 2010). In terms of anthropometrics, studies on foot size of the female audience, its relationship with levels of discomfort (Valente, 2007), and the dimensional variability of the feet of obese and non-obese individuals (funded by FAPESP) (Menin, 2009), were developed.

Among the studies that examined the interface between users and systems (products) of everyday use, those on the handgrip force of individuals of different genders (male and female) and ages stand out (Razza, 2007). Those are: a study on infantile handgrip forces and the possibility to design packaging safe for household disinfectants (Dahrouj, 2009); a study on handgrip forces on handles by groups of individuals of different ages (youth, adults and elderly) (Campos, 2010); and a study of handgrip forces for opening packages of soft drinks by young people, adults and elderly (Silva, 2012).

All of these studies were developed with funding from FAPESP. Another study in this area that analyzed handgrip forces for opening mouthwash containers involved not only a biomechanical evaluation, but also the usability of the packaging (funded by CAPES) (Bonfim, 2014).

Another set of studies developed under the "Ergonomic Design" research line involves the relationship between users and computer systems: the analyses comparing print and digital news media (Thomaz, 2009), development of websites from the users' perspective (Nomiso, 2010), and usability of websites by elderly individuals stand out (Fernandes, 2013).

There are studies in several other areas, such as the ergonomic aspects of visual identities (funded by FAPESP) (Silva, 2012), the influence of fashion, and the perception of discomfort in the use of jeans (Lima, 2012).

Recently, new perspectives of influence of the aesthetic and symbolic aspects on usability have become part of the scope of "ergonomic design". At least two studies have contributed to this discussion: one considers the influence of the symbolic function of everyday products on perception and biomechanical effort (funded by FAPESP) (Lanutti, 2013), and the other considers the perception of usability in the use of disposable razors, analyzed from the perspective of the semantic environment (Razza, 2014).

FINAL CONSIDERATIONS

All of these studies seek not only to answer questions involving the interfaces of use (user x technology relationship), but also to contribute to the design of products and systems analyzed with knowledge and parameters.

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