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ERGONOMICS AND HUMAN FACTORS: AN OVERVIEW OF DEFINITIONS BASED ON LITERATURE

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ABSTRACT

This article addresses the definitions of ergonomics (or human factors) and their varieties and changes since the 19th century when it originated. Seeking this theme, research was conducted aiming at reviewing and surveying the literature. Also, the definitions of ergonomics were contextualized through a timeline. Based on the results, it was possible to verify that the most accepted definition today is that of the IEA - International Ergonomics Association. When analyzing the data, it is concluded that even though the growth in the number of publications in recent years has been almost exponential, there are still gaps in research, so it is recommended to continue this study by expanding the search terms with the inclusion of words correlated to enable a systematic review of the current literature on the topic.

KEYWORDS: ergonomics; human factors; definition.

1. INTRODUCTION

The origins of ergonomics are still controversial, and some reflections suggest that it may be associated with the principles of tool manipulation in the Paleolithic period (ONOFRE et al., 2010). According to Láuar et al. (2010), the adaptation actions of the environment carried out by prehistoric humans and the high number of isolated actions in different times and cultures were factors that contributed to the formation of ergonomics. In ancient cultures, these factors were organized, but there was still no concern in these periods to study or systematize human activities (LÁUAR et al., 2010).

With the European Renaissance, systematic studies in this area began in order to scientifically understand the numerous variables of work dynamics, body, production, movement, among others. This phase of ergonomics is called gestational (LÁUAR et al., 2010). Still in the 19th century, according to Perussi et al. (2010), more systematic studies on work emerged, starting with Taylorism (Frederick Winslow Taylor), the new concept of scientific management. In this concept, it was considered that work should be systematically observed, and for each task, a correct method should be developed to execute it, so that it could be performed in a certain time and using the correct tools (PERUSSI et al., 2010).

Onofre et al. (2010) emphasizes that the formalization of ergonomics has its initial milestone in 1949, almost a hundred years later, when "for the first time, in England, a group of scientists and researchers interested in discussing and formalizing the existence of this new interdisciplinary branch of science met" (MEISTER, 1991). Thus, in this year, the Ergonomics Research Society was founded, known only as the Ergonomics Society (ONOFRE et al., 2010), and in 1959, the International Ergonomics Association (IEA) was founded in Oxford (LÁUAR et al., 2010).

In the United States, as in most nations, there was concern about production

systems, and as a consequence, the tasks and activities of workers became a prerogative for studies, called Human Factors Engineering. These conditions led to increased efforts to research ways to adapt military equipment, in the context of World War II (1938-1945), to the characteristics and capabilities of operators, in order to reduce fatigue and accidents (PERUSSI et al., 2010). In Latin America, according to Onofre et al. (2010), the principle of ergonomics studies began in the 1960s, with research developed at the Polytechnic School of the University of São Paulo, Brazil – a country that, according to Soares (2006), has shown to be the most consolidated in the development of the discipline within the block. The first ergonomics book written by a Brazilian author was published in 1973, entitled "Ergonomics: class notes," by Professor Itiro Iida and Henri A. J. Wierzbicki (FERREIRA E DONATELLI, 2001). Ten years after this publication, Iida, together with Anamaria de Moraes, Franco Lo Presti Seminério, and Ued Martins Manjub Maluf, founded the Brazilian Ergonomics Association (ABERGO), which in 1984 was accepted as a member of the IEA (LUCIO et al., 2010).

Considering this, according to Silva and Paschoarelli (2010), the scope and coverage of ergonomics have expanded, as expected in a scientific discipline. On the other hand, these numerous definitions raise the question: Which definition of ergonomics is the most accepted and used in publications by researchers in the field?

2. OBJECTIVE

The objective of this study is to identify which definition of Ergonomics (or Human Factors) is most commonly used in international scientific publications, as well as to provide an overview of these publications, identifying their main contributions.

3. METHODOLOGY OF STUDY

According to Silva and Menezes (2005), there are various ways to classify research. All research must be classified according to some criteria, namely: nature of the research, approach to the problem, objectives, and technical procedures.

From the standpoint of its nature, this research is classified as basic because there is no practical application (SILVA AND MENEZES, 2005). In terms of its

objective, it is classified as exploratory, as according to Gil (1991), it aims to provide greater familiarity with the problem in order to make it explicit. Lastly, regarding the approach, it is a qualitative research, as it does not use statistical analysis (SILVA AND MENEZES, 2005). In terms of technical procedures, a bibliographic research was conducted.

Considering the objective of this work, a search was made on the CAPES Journals Portal (Coordenação de Aperfeiçoamento de Ensino Superior) on the topic of Ergonomics in December 2018. The terms searched for collecting materials were "definition of ergonomics" and "definition of human factors" as both are equivalent considering that the term Human Factors is widely used in North America and Ergonomics in other countries, the scope of this study was limited to the search of these terms.

After the initial selection, the scientific texts were read and tabulated resulting in a classification of the definitions of ergonomics used by the authors. In addition, the articles were analyzed taking into account the following aspects: year of publication, country of publication, and relevance to the theme of this study. Subsequently, the analyzed data is discussed in the context of such research.

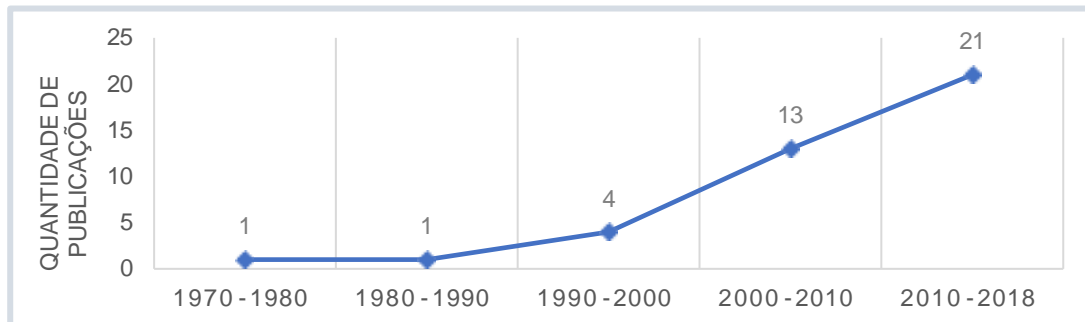
4. RESULTS

4.1. STUDY OVERVIEW

A initial research on the definitions of Ergonomics and Human Factors in the CAPES Periodicals Portal yielded 52 articles spanning from 1978 to 2017. Of these articles, 16 were excluded from the analysis for the following reasons: 7 were unavailable, 4 were duplicates, and 5 addressed "human factors" outside the context of ergonomics, lacking relevance to the research. Thus, 36 publications remained as the basis for this study.

In this scenario, it was possible to identify that over 30 years (1970 to 1999), there were a total of 6 publications that included the definition of ergonomics. From 2000 to 2009, 13 productions were observed, and from 2010 to the present (2018), 21 publications were found. This demonstrates the increasing interest in studies addressing the definition of ergonomics, as shown in Graph 1.

Graph 1: Number of publications with the definition of ergonomics and human factors over the years



Source: The authors, 2018.

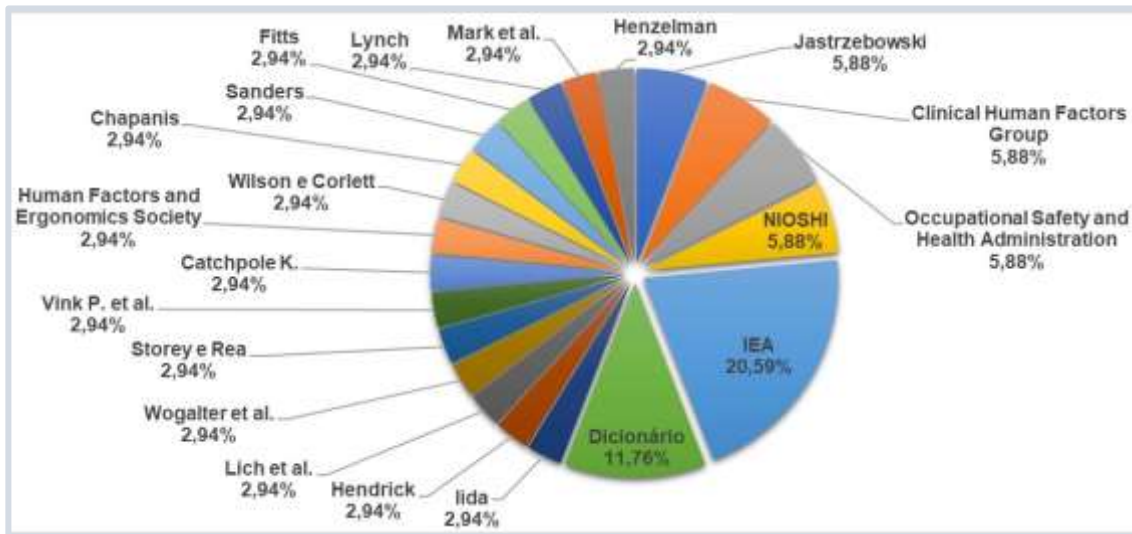
Additionally to the number of publications, another factor considered in this research was the nationality of each article. Thus, it was possible to identify that the United States is the country with the highest number of works, presenting 22 articles, and secondly, England, with 4 research papers. Furthermore, Germany, the Netherlands (Holland), and Canada have 2 publications each, while Iran, Colombia, Brazil, and Serbia only have 1.

The most referenced definitions of ergonomics and human factors were also analyzed in this study, leading to the most cited authors in these publications. Thus, it was concluded that the definition of the IEA (2000) was referenced 20.6% of the time, being the most cited among the analyzed articles. Jastrzebowski (1857), Clinical Human Factors Group (2011), Occupational Safety and Health Administration (2002), and NIOSH (2000) – National Institute for Occupational Safety and Health – represent 5.9% of citations, while dictionary definitions were used in 11.8% of cases. It is worth noting that authors who used the dictionary definition did not specify the dictionary used.

Finally, it was observed that the majority of articles (44.1%) referenced different authors in each of the works, whose definitions were cited only once based on this research. These authors include Iida (2005), Hendrick (2002), Lichet al. (1989), Wogalter et al. (1998), Storey and Rea (1985), Vink P. et al. (2006), Catchpole K. (2011), Human Factors and Ergonomics Society (2000), Wilson and Corlett (1995), Chapanis (1996), Sanders (1988), Fitts (1951), Lynch (1984), Mark et

al. (1987), and Henzelman (2000). Thus, Graph 2 shows the percentage of citations for each author in defining Ergonomics and Human Factors.

Graph 2: Frequency of citations of other authors in publications

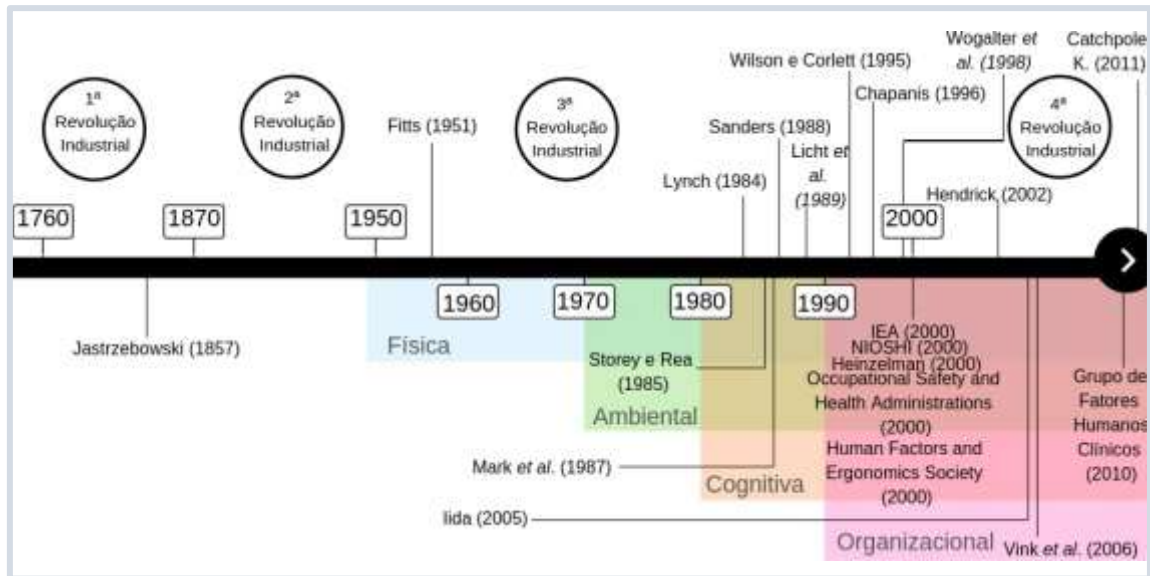


Source: Authors, 2018

4.2. Ergonomics and Human Factors: Definition

Figure 1 shows a timeline of the citations of definitions of Ergonomics and Human Factors in the analyzed publications, representing the variety of definitions on the subject. For analysis purposes, the histogram was organized to represent the historical evolution of ergonomics according to Hendrick (IIDA AND GUIMARÃES, 2016). In the 1950s, with the end of World War II, physical ergonomics originated, which over the years, in the 1970s, led to environmental ergonomics. Studies in cognitive ergonomics occurred in the 1980s, which propelled the rise of organizational ergonomics studies in the 1990s. This organization is important because throughout history the role of ergonomics has increased both in scope and in its range of activities.

Figure 1: Chronological timeline of Ergonomics citations in publications



Source: Authors, 2018

As shown in Figure 1, the term ergonomics was first coined by the Polish author Wojciech Jastrzebowski in his article "Essays on ergonomics or the science of work, based on the objective laws of science about nature" in 1857 (FRANCESCHI, 2013). Jastrzebowski (1857) defines ergonomics as "the involvement of human factors (physical and mental capabilities and their respective limitations) of the worker with the machines and equipment found in the work environment."

Over the years, in 1951, Fitts discussed ergonomics as guidelines that optimize performance (i.e., efficiency and safety) by ensuring that the workplace (environment, machine, product, or system) fits with human capabilities and needs (FITTS, 1951). Subsequently, in 1984 and 1987, Lynch and Mark et al., respectively, addressed ergonomics based on Fitts' definition (LYNCH, 1984; MARK et al., 1987).

Still in the 1980s, Storey and Rea (1985) argued that ergonomics is not a science or technology but rather a set of concepts that help maximize the design of interaction between humans and machines, systems, work methods, and environments while considering the physical safety, mental capacity, and productive potential of the workers themselves (STOREY AND REA, 1985).

The last definitions mentioned in the late 1980s were those of Sanders (1988) and Licht et al. (1989). Sanders draws on previous authors in his definition and defines ergonomics as "that branch of science and technology that includes what is known and theorized about human behavior and biological characteristics that can be validly applied to the specification, design, evaluation, operation, and maintenance of products and systems, to

increase their safe, effective, and satisfactory use by individuals, groups, and organizations" (SANDERS, 1988). For Licht (1989), ergonomics is "the science that studies work and the development of tools for the assessment and improvement of working conditions in a system."

In the 1990s, with the emergence of Organizational Ergonomics, new definitions for Ergonomics or Human Factors were expressed. The first definition in this century was presented by Wilson and Corlett in 1995, where they reiterated that the definition of human factors is "the division of work between humans and machines." For the authors, "humans are assigned to tasks and machines are assigned to functions" (WILSON AND CORLETT, 1995).

In 1996, Chapanis observed the applicability of Ergonomics to design and defined human factors as "a body of information about human abilities, human limitations, and other relevant characteristics" (CHAPANIS, 1996).

Two years later, in 1998, a complement to the definition of Ergonomics was introduced by Wogalter et al., who added that, in addition to being a science, it is "a technology applied in problem-solving involving interactions between humans and systems" (WOGALTER et al., 1998).

In the year 2000, there was an increase in publications on Ergonomics and Human Factors, with most of these studies conducted by recognized organizations such as the IEA (International Ergonomics Association) and Ergonomics Society. According to the IEA (2000) and the Ergonomics Society, Ergonomics (or Human Factors) "is the scientific discipline related to understanding the interactions between humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being." It also emphasizes the importance of the contribution of ergonomists to the design and evaluation of tasks, jobs, products, environments, and systems to make them compatible with the needs, abilities, and limitations of people (IEA, 2000).

Also in 2000, Ergonomics is succinctly defined by the Occupational Safety & Health Administration as "[...] the practice of designing equipment and managing workplaces to fit the needs of the worker" (BEAUCLAIR AND SLAPER-HAWRANKO, 2017).

Finally, the last definition found in the 1990s was that of the National Institute of Occupational Safety and Health (NIOSH), which conceptualizes Ergonomics as "[...] the time and task where human needs at work are taken into consideration in order to adapt the work to the worker" (NIOSH, 2000). Furthermore, Heinzelman (2000) adds that "[...] we are concerned with understanding the environment in which a device should be used and the particularities and constraints of that environment" (HEINZELMAN, 2000).

In 2002, Hendrick defines "system" based on the IEA's definition of ergonomics. According to Hendrick (2000), "a system is defined as two or more people interacting with a work design." Then, Iida (2005) argues that ergonomics "is defined as the adaptation of work for humans, covering planning and designing activities that occur before work is performed and controlling and evaluating activities that occur during and after work has been done." All of this is necessary for work to achieve the desired results. Work should fit the human and not the other way around (IIDA, 2005).

Vink et al. (2006) assert that ergonomics can contribute to the prevention of inconveniences and, to a considerable degree, improve system performance in terms of increased productivity (VINK et al., 2006). Alongside this, for Catchpole (2011) and the Clinical Human Factors Group (2010), Ergonomics is a means of improving system performance through understanding the effects of teamwork, tasks, equipment, workspace, culture, and organization.

Finally, according to Morales et al. (2013), it is necessary to create bridges between different paradigms instead of using a general definition of ergonomics. The practice of ergonomics makes it possible to study the human being and provides an understanding and form of intervention in public health.

5. CONCLUSION

In order to meet the objective of this research, a search was conducted on the CAPES journal portal for publications presenting definitions of ergonomics or human factors. The publications cited in this article, extracted from the portal, represent an overview of studies in the field that encompass the definition of ergonomics. It was possible to observe a growth in the number of publications since the 1990s. Over nine decades (from 1870 to 2000), 19 publications were found, while in the last 8 years, 21 publications were found, with the highest number of research studies recorded by the United States (23), followed by England (3), highlighting a higher frequency among economically more developed nations.

Especially in the year 2000, the most referenced definition by authors (20.6% of cases)

was published, which is the definition by the IEA (International Ergonomics Association). This definition represents an expansion in scope and coverage compared to definitions cited earlier, particularly by explicitly stating that in addition to improving human well-being, it is necessary to promote overall system performance improvement in parallel.

The contributions of these articles elucidate the definitions of various authors on ergonomics over time, as well as present practical studies and important research related to different areas of ergonomics. Finally, it is recommended to continue this study by expanding the search terms to include related words in order to facilitate a systematic review of current literature on the topic.

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