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ERGONOMICS EDUCATION AND TRAINING - A PERMANENT CHALLENGE

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Abstract: *This paper presents the main objectives of education in ergonomics, as well as the main standards associated with it. Training in ergonomics is presented as a function, as an organizational process or from the perspective of macroergonomics. Relevant issues regarding professional certification in ergonomics, certification criteria, key competencies, the body of professional knowledge, professional practice in ergonomics and credibility of ergonomists are presented.*
Key words: *Ergonomic education; training macroergonomics; macroergonomics skills; professional certification; the model of ergonomist training; body of knowledge.*

1. INTRODUCTION

"*Ergonomic education* is a precondition *for ergonomics competence"* [1]. "Ergonomics *is not simply a common understanding;* professional expertise is required" [2].

Education and training, which have a long history in the consciousness of people, have now become concepts of great interest, both for the academic and business environment, and for many scientific fields, including *ergonomics*. The history of humanity is nothing more than the expression of the way in which education and training were programmed as *prerequisites of authentic knowledge*. In other words, each *historical time* corresponds to a *paradigm* whose function is to provide, including, a *model of education or training*. However, being a broad framework of the historical incursion, we mention only that many of the scientific debates or practices used in the field of education and training in ergonomics have finally suggested the formulation and introduction of new requirements, criteria and principles or of *new educational models*. Therefore, we unreservedly adhere to the opinion of specialists in the field, who consider that *ergonomic education* is a *precondition* for competence in the field of ergonomics [1].

Therefore, it is necessary to intensify the concerns for the *promotion* of a *new paradigm of the education oriented towards new competences* or of a *new educational model* that will generate a much more *comprehensive* perspective, interdisciplinary and holistic on the socio-technical systems and a *new scientific and explanatory* support or allow an adaptation as soon as possible. more flexible in the changes of the organizational and social environment, in general, or of the working environment, particularly.

2. EDUCATION IN ERGONOMICS

As it is known, there is no more problem in life, in general, or in the life of modern organizations, for their evolution and success than education. Therefore, *education is a key factor* in the sustainable development of modern organizations, but in order to become as efficient as possible, it must be perceived and understood not only as a *public function*, but as a continuous and very complex *organizational process*, and not in those followed as a permanent challenge. From this perspective, *the way in which ergonomics education is perceived and understood* depends on the development and consolidation of ergonomics as a scientific field

and profession. Therefore, we unreservedly adhere to the opinion of specialists in the field, who consider that ergonomic education is a precondition for competence in the field of ergonomics [1].

According to some reputable specialists, fully justified, there are at least *two distinct areas of ergonomics education* [3]: *Education within the discipline itself* to obtain the necessary skills; *Education for raising awareness of ergonomic factors*.

2.1. Main objectives of education in ergonomics

In the conception of prominent personalities such as *Waldemar Karwowski* [1], former President of the IEA, the *main goals of education in ergonomics* [4] (Figure 1) are:

- *Ensuring extensive ergonomic knowledge and skills*: knowledge base about human-centered or end-user design philosophy; principles for adapting human boundaries;
- *Learning some ergonomic methods of thinking and action*: identifying information on the benefits and risks of artifacts and systems (products, services, etc.); participation in decision making regarding the purchase and use of artifacts and systems;
- *Capacity building of practical ergonomics*;
- *Applying the basic concepts of ergonomics* to obtain the necessary information regarding the artifacts and their use, as well as the benefits or risks associated with them.

In addition, *Karwowski*, a recognized founder of the *American School of Ergonomics*, proposes, in 2005 in parallel with a *model of education technology* developed by the National Academy of Engineering *ten standards associated with education in ergonomics* [5]: features and objectives of ergonomics; the basic concepts of ergonomics; the connections between ergonomics and other fields of study of science; the economic, social, cultural and political effects of ergonomics; the role of society in the development and use of technology; the effects of technology on the environment; the essential features of ergonomic design; the role of ergonomic research; implementation of processes associated with ergonomic design; assessing the impact of products and processes on system performance, as well as occupational safety and well-being.

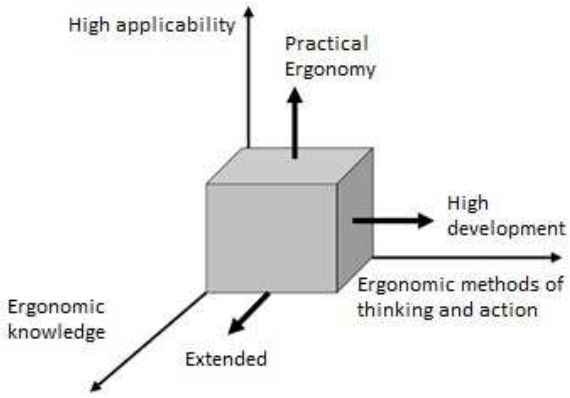

Fig. 1. The main goals of ergonomic education [1]

The main objectives of ergonomics education are in our opinion realistic and fully justified because they aim at developing a better understanding of the nature and role of ergonomics as a scientific discipline and profession; the need to develop skills to implement user-oriented ergonomic design processes, as well as to assess the impact of products and processes on human security and well-being [1].

2.2. Macroergonomics of training systems

Although, in the knowledge or in the public consciousness, the term *training* has spread over time, in fact, the *understanding of the concept of training is relatively limited*, if one considers its content quite broad and comprehensive. Summarizing, the variety of terms widely discussed in the literature, we can say that *training* is most often *understood as a systematic process of acquiring new concepts, knowledge, skills and attitudes that results in performance improvement* [3; 6]. A close conception, but with additional mentions, belongs to a group of authors [7] from the *University of Florida*, who believe that "*training*" can be a systematic acquisition of knowledge (*WHAT we need to know*), skills (*WHY we need to act*) and attitudes (*WHAT we must take into account*), which together lead to

increased performance in a particular environment [7].

Therefore, the *training* represents the *function or activity of an educational character*, organized, structured and carried out in order to improve the individual and organizational performances. That is why, in many modern organizations, *training* has become a *way of life*, a *permanent challenge* and has started to be an *important business* because the competitive and sustainable success of an organization cannot be assured without proper training of its employees through learning, training and development [7].

From the presented perspectives, in order to fulfill the *specific objectives of the macroergonomics* that are concerned with the development and application of the *technology of the human-organization interface*, the modern companies elaborate *training programs in ergonomics* that correspond to the requirements of the subsystem of personnel within the socio-technical system as well as to the new technologies introduced in the place for work. Therefore, from the *macroergonomics perspective*, *training* is not only an organizational function or process, but also an *integral part of any work system* [8]. This is part of a comprehensive, systemic approach to *integrating ergonomics into the organization*, as well as the process of introducing within it, knowledge and practices in the field of ergonomics.

The *macroergonomic approach to training* also allows it to play a *key role* in aligning the organization's business objectives with the practices of increasing organizational efficiency, while facilitating the necessary change processes [8; 9; 10; 11]. In other words, *ergonomics training programs* can improve existing work methods or design new methods, solve many work-related problems, user-centered design and play an active role in implementing ergonomics and the decisions or solutions adopted. Successful *implementation* of *training programs in ergonomics* also *ensures* the acquisition of new knowledge and the development of employees' skills so that they can change their work environment, reduce exposure to risk factors associated with work, promote effective work practices, safe and healthy.

The *training itself*, *not isolated*, *does not constitute a program in the field of ergonomics*, it is not a *panacea* or a *universal remedy* for reducing errors, dysfunctions, discomfort or working practices, unsafe and unhealthy; ergonomics training provides a mechanism, as [11] points out, through which employees "performance and well-being are enhanced to *maximize organizations" investments in people and technology*.

High-quality training in ergonomics also includes a participatory approach that ensures that each employee learns and acquires knowledge, skills and motivation to provide *useful feedback* for improving organizational design in general and socio-technical or work systems special. In other words, *successful ergonomics training aims to promote participatory ergonomics*.

Therefore, according to *ergonomic theory and practice*, *participation* (*participatory ergonomics*) and *learning* (*organizational and individual learning*) are two particularly important *key concepts* for *change management* [9] *to which we adhered unreservedly*.

2.3. Macroergonomic components of a training program

The success of an ergonomic training program is ensured by *relevant macroergonomic components* presented widely in reference works [8]:

- *Creating a receptive organizational environment* - acceptance of the program by all stakeholders as well as participation of managers and supervisors in the training process;
- *Supporting active participation* - active involvement in the initiation, development, implementation and evaluation of the training program, which allows a better understanding of it, as well as creating a special sense of commitment to support the proposed objectives;
- *Continuous learning* - training should be considered part of the general program for

implementing ergonomic requirements and standards, which means the creation of lifelong learning means; proactive process, which is approached and developed, increasingly comprehensive;

- *Development of active learning* - what implies the involvement, including the trainers; the strength of this approach is that it uses appropriate case studies, which promotes an active learning environment and stimulates motivation; creates an *interactive approach* and brings *the experiences* of the students from the *real world*;
- *Ensuring continuous feedback* - performance improves faster when people are given feedback on their results or lack thereof [10; 11] the feedback provides information for the achievement of two key objectives: improving the ergonomics training program and identifying the necessary corrective actions (corrective ergonomics); enhancing positive outcomes and benefits as well as using the skills learned in the workplace. From the systems theory perspective, feedback is a critical concept) and multifactorial and therefore, it is very important that it facilitates the monitoring of any work system. When this does not happen, unsustainable behaviors that may occur can no longer be corrected [12; 13];
- *Commitment and support of senior management* - when senior decision makers support *the mission and goals of an ergonomics training program*, as well as an adequate education, significant organizational changes may occur [12; 14];
- *Understanding the function of error as a means of training* - although the description of human error as a complex phenomenon can be traced over time, however, in the opinion of many authors, such as mention in [11; 12; 13; 14], *human error* becomes an object of scientific study due, in particular, to the increase of concerns related to the increasing cost of human error; under these conditions, error reduction has become a major goal of ergonomics [13]; at the same time, new means or approaches have been developed regarding error management in the training process: training for error prevention; error management training [14].

Therefore, the *macroergonomic components* of *training* are not only very important but also *particularly useful* due to their *positive and sustainable effects.*

3. PROFESSIONAL CERTIFICATION IN THE FIELD OF ERGONOMICS

Ergonomics as a scientific field and profession not only does *not have a sufficiently strong perception of its nature and role*, *but has often diminished its value or strategic contribution* because practitioners have not always accepted or received a formal education in the field of ergonomics. There are many people who declare themselves or call themselves ergonomists, who, in fact, do not have any *education or training in the technology of the human-system or human-organization* interface, as well as its application [2].

Certification, which is used in many professions to ensure *a defined level of competencies*, *is in ergonomics a voluntary process* that validates the qualifications of individuals in a specific field of professional practice (*the Board of Certification in Professional Ergonomics, BCPE*) [15]; it is the recognition of the special capacity conferred on individuals who meet the requirements of education, competence, experience and other requirements in a specific field of practice [16]. From this perspective, *the certification of the profession of ergonomist is* also *justified by numerous other arguments*: the ability to carry out complex holistic and interdisciplinary research; acquiring the skills and skills needed to study and identify interactions within socio-technical systems; establishing ergonomic design criteria and specifications; identification of ergonomic dysfunctions and risks; as well as the realization of a potential of superior collective research that facilitates the increase of

professional competence through scientific, theoretical and practical collaboration.

In coordination with the *Center for Registration of European Ergonomists (CREE)* and in cooperation with the *Education and Training Committee of the IEA*, The BCPE has adopted the *Ergonomist Training Model (EFM)* as a fundamental structure for professional competence in ergonomics [17], a model that is also in *accordance with the criteria* of the curriculum used by the *Human Factors and Ergonomics Society (HFES)* in the accreditation process for graduation programs in ergonomics.

Further information, particularly important on ergonomic education, training and skills *can be found* in the work of numerous authors, such as [16; 17], as well as in various *working procedures of the IEA* and *HFES*.

3.1. Criteria for professional certification in ergonomics

Based on the *Ergonomist Training Model (EFM)*, The *BCPE* has defined *two career paths for certification* [18] that differentiate *two levels of professional practice in ergonomics*, namely: *Certified Professional Ergonomist (CPE)*; *Certified Professional in Human Factors (CHFP)*. Therefore, the CPE indicates *the main name* for *the professionals* in ergonomics.

From this perspective, *BCPE* has developed *a monograph* on the *policies*, *procedures* and *practices* established [19] to inform the individuals who, aspire to *the following titles*: *CPE, CHFP* and *CUXP*.

To meet the growing need for *certified ergonomists that use generally accepted tools and techniques* to analyze and improve human performance in existing systems, BCPE has also established *a level of qualification for techniques* called *Certified Associate in Ergonomics (CAE),* which is not enough to offer *a broad perspective of the systems*, to define the most relevant design criteria, nor to offer the most adequate solutions to the particularly complex problems of the socio-technical systems. The *minimum criteria* for certification at *AEP level* or at *CAE level* are widely presented in the specialized literature [18; 19].

3.2. Key competences of certified professional ergonomist

The Board of Certification in Professional Ergonomics (*BCPE*) has become the *first certification organization* approved and supported by the International Association of Ergonomics (*IAE*) in accordance with certain criteria established by it [20] In other words, the IEA does not act as a certification association or authority, but develops *a set of criteria and procedures* for evaluating and supporting professional certification bodies.

Similarly, in *Europe*, the *Center for Registration of European Ergonomists - CREE* collaborates with ergonomics companies or associations in EU member countries for the evaluation and registration of *European Ergonomists* (*Eur. Erg*). CREE *has agreements or understandings* based on reciprocity with BCPE because, as stated by E. N. Corlett, former *President of CREE*, the *center's policy* is to have a *unique body* in each country. As a result, CREE must meet certain requirements formulated and set out in *European Standard 45013* to which *CREE* has also adhered [20].

The *title of European ergonomist* represents professional certification according to *the training criteria defined at European level*. The *first objective* of the title of *European ergonomist* is *the opportunity to practice in all the countries of the European Union*. The acceptance of an ergonomist by the *CREE* means *strengthening his national credibility* [21].

At the same time, *BCPE defines the main competencies and attributions of the certified professional ergonomist (CPE)* which are widely presented in the specialized literature [22], but which are not always covered and taken into account, for example:

- Works with system design models;
- Establishes the design criteria and specifications;
- Designs and develops evaluation tools;
- Conducts pilot studies and simulations, verification of change;
- Uses advanced methodologies, mathematical models and simulations;

- Analyzes the structure of work systems and socio-technical systems;
- Identifies origin of the causes of the damage and of the decreased performance;
- Analysis of organizational and management processes;
- Performs complex basic analyses, including cost-benefit analyses.

Therefore, by understanding the main *competencies and responsibilities* of the professional ergonomist, as well as the *change management techniques*, BCPE can help to identify opportunities for organizational development, sustainable including the improvement of ergonomic education and culture.

3.3. The ergonomics body of knowledge

"*Ergonomics* is a *body of knowledge* about human abilities, human boundaries and other human characteristics that are *relevant to design*" [23].

Ergonomists integrate knowledge about human functions, structure and behavior for their practical use in the design process. In other words, ergonomic design is the application of information about human factors to the design of tools, machines, systems, tasks, jobs and work environments in order to improve the human condition [23]. Therefore, there is the possibility of disseminating knowledge or *exchanging information*, as well as specific formal education in ergonomics.

The literature in this field recommends *broadening the objectives of ergonomic* education in as many scientific fields as possible, assuming the basic concepts or knowledge of the particular fields and *accepting and respecting the point of view of each domain* regarding the *common object of study*. *The primacy of ergonomics* starts from the unitary, *integrative and holistic vision*, organically structured with a view to the problematic of design of socio-technical systems.

The unique knowledge base of ergonomics derives from the methods and techniques that researchers and practitioners have adapted and developed to distinguish the technology of ergonomics, as a knowledge system, from the other scientific fields, which contributes to the process of designing socio-technical systems.

The body of ergonomic knowledge is finally focused on the integrated human design that involves the application of the natural and human sciences in their complementarity [17; 18], In other words, the body of knowledge of ergonomics is represented by human skills (capabilities), human boundaries and other features that are relevant to the design .

Therefore, *the body of knowledge of ergonomics* is determined by the *different incidences of analysis*, design or evaluation of the sociotechnical systems that do not belong and can never be exhausted by a single field of research.

3.4. Professional practice in ergonomics: macroergonomic approach

"More research is needed into the *role of ergonomists* and *their organizational activities*" [24]. "*In addressing problems of an ergonomic nature,* ergonomists engage in various forms of organizational activity" [25].

As it is known, the *IEA* describes ergonomics as a *scientific discipline* that deals with understanding the interactions between people and other elements of a system and as a *profession* that applies theory, principles, data and design methods to optimize the performance of the entire socio-technical system. From this perspective, researchers are experts in certain fields of research while *professional ergonomists* must acquire the relevant knowledge from all the sciences participating in ergonomics [17; 18; 19].

Therefore, *ergonomists* use the knowledge and skills from various human sciences and engineering sciences to adapt socio-technical systems and working environments, jobs and products to people's capabilities and limits [18; 19]. Ergonomics (professionals *apply the technology of the human-system or human-organization interface* to the analysis, design and evaluation of socio-technical systems to improve human performance and systems as well as the comfort and quality of professional life [19].

Practice in the field of ergonomics and band experience entails *other relevant aspects*, which are widely presented in reference works in the specialized literature [25]:

- *Improving the understanding of professional practice in ergonomics*, the attitude of ergonomists;
- The extent to which *ergonomists are aware of their activity* in the organizational context;
- identifying *the challenges* and *opportunities* faced by ergonomists, as well as the strategies they use;
- *Examining the professional practice* of ergonomists, including their experience from the *perspective of good practices*, as well as how their structure facilitates or influences the integration of ergonomics in the organizational processes or in the overall strategy of the organization;
- Evaluation of the *proactive role* of ergonomists in supporting the implementation of ergonomics;
- Understanding the *variety of interactions* and *collaborations* of ergonomists;
- Analysis of the degree of involvement of ergonomists in participatory ergonomics programs;
- *Identifying the factors* that can influence the practice of ergonomists;
- The need for an *expanded conception*, regarding the professional practice;
- Enhancing the *relevance of ergonomic practice* by gradually integrating ergonomics into organizational processes in general and work systems in particular [25].

3.5. Credibility of ergonomists

"Gaining credibility *is a specific form of organizational activity that in the case of ergonomics acquires* a particular interest" [25]. A *key element* in supporting their philosophy as well as in the success of their organizational activity is *the credibility of ergonomists*, an aspect identified in [24] and widely presented in [25]. During their professional practice, ergonomists are involved in a variety of activities, in a variety of interactions and collaborations that ultimately lead to a type of activity that some authors [25] have called an *organizational activity* in which ergonomists use different strategies for implementing ergonomics. The *credibility of ergonomists has different bases*, which depend on their experience or the recognition of their contribution at the organizational level.

An important feature of the need for ergonomic practice is the *enhancement of the interaction between the stakeholders (stakeholders)* participating in the efforts of organizational change. This need has recently been recognized by supporters of participatory ergonomics and brought to the fore by [25]. Concern for the credibility of the ergonomists also *requires the achievement of a balance or a full agreement* between the *interests of the internal and external stakeholders* of the organization, as any imbalance or misunderstanding of them can lead to the suboptimization of the organizational system.

Gaining the confidence of ergonomists for a macroergonomic approach to socio-technical systems, as well as for an efficient professional practice is also *a process that starts with microergonomic interventions*. This is because a *macroergonomist gains credibility* when he first makes macroergonomic changes and achieves results, and then suggests microergonomic changes [26; 27].

From this perspective, we recall that, although macroergonomics and microergonomics are of the same nature, *macroergonomic implies the extension of microergonomics* to the area or level where dysfunctions, inconsistencies, imbalances or failures occur. In other words, *macroergonomic creates a useful context for successful microergonomic interventions* [27; 28]. Therefore, *micro- and macroergonomic integration in organizational management* is a fundamental activity that requires *a paradigm shift* that allows organizations to increase the efficiency and competitiveness of businesses without neglecting the increase of human well-being [29].

For a better *understanding of the importance of education and training* in the field of ergonomics, in the opinion of the specialists it is necessary to know both *the concerns about the*

professional practice in ergonomics in relation to the other scientific fields as well [27] and the experiences gained as well as many particularly *relevant aspects for the field of ergonomics* presented widely in reference works [25] in the specialized literature.

The aspects presented in the paper were *considered* through a team effort and an interdisciplinary and holistic approach in the content of the elaboration of the *occupational standard for education and vocational training for the occupation of Ergonomist,* COR code 226309 approved by the *National Authority for Qualifications* in Romania [30]. We mention that the Occupational Standard was *approved* by the most important research institutes operating in occupational filed, as well as by the most representative professional associations in the field in Romania.

4. CONCLUSIONS

In the article, the scientific discourse focused on two major topics: education and certification in the field of ergonomics (and human factors). Thus, we set out and made an overview of current issues and an inventory of elements of interest for the two topics.

The purpose of the research approach was to demonstrate the dynamics and timeliness of training and certification in the field of ergonomics (and human factors). As a result of the study carried out based on bibliographic research and by investigating the web pages of some organizations and bodies in the field, it can be stated that:

- Professional training in the field of ergonomics is intense and widespread among universities (bachelor's, master's and doctoral programs) and consulting firms in the field. So, the accessibility to the ergonomic field of knowledge is high;
- The implications of professional training at the level of macroergonomics are still little explored and exploited;
- Certification in the field of ergonomics is well developed and defined by key competencies. at European level CREE plays an important role in this respect and operating in consensus with BCPE;
- The community of certified ergonomists is growing, because of the implications they have on the conception and organization of jobs, work systems, means of work and the creation of well-being at work.

Ergonomics, Occupational Risk Management and Occupational Health and Safety can create a body of knowledge to support comfort, safety and health working environment to achieve simultaneously highest productivity and occupational well-being. Therefore, they are mandatory to be implemented in any type of work processes or workplaces without exception. Their *knowledge in action* effort is expected to prevent and reduce the risk of accidents and occupational diseases; are important aspect as supporting welfare and increased productivity.

In future studies, the implications and extension of ergonomics knowledge in the field of sustainable development will be investigated. This research will be based on the set of six values for ergonomics in the context of sustainability challenges [31] which are:

- Respect for human rights;
- Respect for the Earth;
- Appreciation of complexity;
- Respect for diversity;
- Respect for transparency and openness; and
- Respect for ethical decision-making.

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Educația și formarea în ergonomie - o provocare permanentă

Rezumat: În cadrul articolului se prezintă principalele obiective ale educației în ergonomie, cât și principalele standarde asociate acesteia. Procesul de formarea în domeniul ergonomie este prezentat ca funcție, ca proces organizațional și din perspectiva macroergonomiei. Un aspect important asociat formării este certificarea profesională în domeniul ergonomie, în cazul căreia sunt prezentate criteriile de certificare, competențele cheie, corpul de cunoștințe profesionale, practica profesională în ergonomie și credibilitatea ergonomiștilor.

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