

ERGONOMIC RESEARCH OF PROTECTIVE GOGGLES and EARPIECE COMBINED

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Abstract

This paper is focused on improving an ergonomic ear coupled with goggles, to meet the needs of operators working in areas where noise is excessive, above 100 to 114 dB (A), as Norm NR-15 and also require goggles. The main function is to give comfort to the workers of operational areas where the use of protective eyewear and ear shell type is essential to perform their daily functions. The coupling to the ear of the glasses is composed of rod adjustable with a quick release pin. Research ergonomic case with the development of a virtual representation and propose a different stakeholder groups to evaluate the new model in the degree of acceptability.

Key-words

Ergonomics, Epi, safety.

Initially, according to Iida (2005), applications of ergonomics were restricted to militaristic connotations, and industrial space. Later, it expanded around the world: education institutions, research, national and international events; specific studies on women, elderly, disabled, mining, agriculture, services sector (health, education, transport and leisure). In Brazil the largest Ergonomics presents indications for practical than theoretical aspects. The professions of the future will be characterized by scientific and artistic creativity, for the mechanical work tends to disappear with automation is to redistribute tasks. Therefore, the ideal is to combine quality of life, work, study and fun.

1.1 Personal Protective Equipment

According to Cunha (2006) and provided in the standard NR-6, Personal Protective Equipment (PPE) is equipment for personal use, with the aim of neutralizing certain accidents and protect against possible diseases caused by working conditions. It should be used as a last resort or in specific situations and legally provided, as the case in which collective protective measures are not feasible, or as an emergency measure for the collective protection are being implemented (Lopes Neto; Barreto, 1996). The reality shows the opposite of what is stated in the law, which many use the PPE as a first option for worker safety, without considering the overall context of the work environment. For Montenegro and Santana (2012) the employee will be more receptive to the EPI when it is more comfortable and more pleasant to wear. For this, the equipment must be practical, protect well, be easy to maintain, strong and durable.

The equipment used can be separated by parts of the body. The protection for the head is the helmets with protective front flap, flap or full front flap with visors. Safety glasses colorless or dark shades are used for eye protection. Hearing protection requires the hearing protector type shell or the insertion type (plug). We have air-purifying respirator with disposable filter on the respirator. The protection of the upper is made by protective gloves, rubber or calfskin model. The legs are protected by protective footwear like leather boots or tall rubber boots. For fall protection with level difference, no seatbelt harness, safety lanyard adjustable type, type Y with energy absorber and fall arrest device. The safety garments are jackets and pants in waterproof fabric (Personal Protective Equipment, 2012). Due to the amount of equipment and the different usage environments, there is a great need for assessment of PPE used by employees, so you can protect it without losing productivity (Vendrame, 2012)

1.2 Ergonomics

The human being must perform their activities as long as it is not prejudicial to it by this factor must stress the importance of ergonomics in the design process, taking the human being as its starting point.

Ergonomics aims to interact with the machine and the environment that surrounds it, but in many cases, products such as agricultural equipment not suited to man and still are sold freely, without respecting the rules and ergonomic principles, and according to Iida (2005), it is the study of the adaptation of work to man. The term work has a slightly broader sense, not only regarding machinery and equipment, but also covering the interaction between man and his work, its interface with the machinery and equipment, by means of controls and dials.

According to Grandjean (1998), the practice of Ergonomics aims to change the working system by adjusting the existing activity characteristics, abilities and limitations of man in relation to the execution, performance, effectiveness, convenience and freedom from danger.

With the use of ergonomics in civil activity Iida (2005), comments that ergonomics should be focused on those aspects of human behavior and other factors such as: human, environment, information, organization, consequences at work: control issues tasks such as inspections, studies of errors and accidents, in addition to studies on energy expenditure, fatigue and stress.

The Ergonomics aims, through the study of the human being, the increase of the efficiency of their work, providing data so that it can be scaled according to the actual capabilities and limitations of the body.

Ergonomics helps design machines suitable for human use, reduces fatigue and physical discomfort for workers, and reduces the rate of accidents at work and absence. In other words, it increases efficiency, reduces costs and provides more comfort and welfare to humans (Iida, 2005).

The definition of Ergonomics is mentioned as a derivation from the Greek words *ergon* (work) and *nomos* (rules), ie, Ergonomics can be considered as the study of labor laws. In the United States also used as a synonymous of human factor (human factors) (Dull; Weerdmeester, 1995).

In Brazil, the Brazilian Association of Ergonomics - ABERGO (www.abergo.org.br) adopts the classification of Ergonomics as the study of the interactions of people with technology, organization and environment, projects and interventions, aiming to improve, seamlessly and non-dissociative, safety, comfort, well-being and effectiveness of human activities (ABERGO, 2012). Internationally, the International Ergonomics Association (International Ergonomics Association) (www.iea.org.br) conceptualizes Ergonomics and their specializations.

For the Association, Ergonomics is the scientific discipline that studies the interactions among humans and other elements of the system, and the profession that applies theory, principles, data and methods, the projects aimed at improving the well-being and overall performance of systems (Iea, 2011).

Through interactions with the human machine, it involves other attributes of human knowledge that is usability meaning the user experience with the equipment.

In the late '80s, early approaches developed methods, techniques and tools to support the construction of interfaces which were intuitive, easy to use and productive. The usability engineering coming out of the labs of universities and research institutes began to be implemented as a function in interactive software development companies. Among them, especially the ISO 9241 series as Cybis, Holtz and Faust (2010).

One can understand the ergonomics as the body of knowledge about man into activity, necessary for designing instruments, machines and devices that can be used with maximum efficiency, comfort and safety.

This knowledge must also be used by those responsible for organizing work, in order to define journeys, cadences, pauses, hierarchies and other elements that contribute to the welfare of workers and labor productivity.

According to Pires and Rio (2001), in Greece and ancient Rome the job was reserved for slaves, considered unworthy for free human beings. Among the Hebrews, the work was seen in a less unworthy way, but it maintained a predominantly negative connotation.

It was seen as a sacred mission to view the original sin. Only in the Renaissance, a process of valuing work began, alongside an appreciation of earthly, material life. In recent years, within the context of economic globalization, it has been approached in a paradoxical way.

On the one hand, it is extremely valued and rewarded. On the other hand, probably due to the imbalance between supply and demand that has generated crowds of unemployed, it has been drastically devalued.

Many work situations and everyday life are harmful to health. The diseases of the musculoskeletal system (especially back pain) and those psychological (stress) are the most important causes of absenteeism and of disability to work. The probability of the occurrence of accidents can be reduced when you adequately consider human capabilities and limitations during the project work and its environment. Ergonomics can help reduce these problems (Dul; Weerdmeester, 1995). For Iida (2005), our environment consists of people, humidity, lighting, temperature, pressure, vibration, furniture, equipment, buildings, etc., where the combination of these elements leads to the creation of products and services. But when these conditions are unfavorable, tensions arise and they increase the risk of accidents, discomfort and can cause considerable damage to health.

When it is not technically possible to control noise at its source or in its transmission, then the solution to protect individuals from the harmful effects of noise is the use of personal protective equipment - PPE basically earplugs with a cap or shell. This type of control has practical problems of implementation, since individuals exposed to noise must be aware of the problems which they may have when not using the PPE. Hearing protection - cap - inserted into the ear canal - used properly, can reduce up to 30 dB sound pressure level inside the ear.

Earplugs - shell - responsible for covering the entire outer ear - More efficient than the first, can reduce noise up to 40 dB.

A helmet that covers the entire head, including the ears. This type of equipment, according to workers, has some disadvantages, because besides the discomfort, the sound insulation can result in loss of important information in the environment. To solve this problem, currently, the technology provides an active protection device, that when identifying an unwanted sound, it produces a sound wave with the same amplitude but opposite to the noise in order to eliminate it. Moreover, it amplifies the sound of speech of other workers, through a selection process, and may also convey important messages or music (Grandjean 1998).

1.3 Hearing protection: advantages and disadvantages

Santos et al. (1996) stated that common sense suggests always using earplugs to avoid the effects of noise. In daily discussions between workers and employers and the actions of services that assess work environments, the main point is the discussion between collective measures versus individual measures, they are always preferred by companies, although refer to noncompliance of workers.

The individual control of noise exposure by using protective device involves a number of advantages and disadvantages, however the constant use of hearing protectors during the workday is very important, Vieira (2003).

Nudemann et al. (1997), mentioned by Vieira (2003), classified the extra-protective shell type earphones being formed by two shells attenuating noise, placed around the ears and interconnected through an arc tensor. These shells:

- ✓ Must have rimmed soft material to allow for a good fit in the ear region;
- ✓ The rod can be positioned over the head, behind the head or under the chin;
- ✓ Must have attenuation average of 20 to 40 dB, concentrated in the mid-high frequencies.

This type of shield is inappropriate for continuous exposure due to the pressure on the whole ear area and it presents great discomfort and it is highly unlikely they will use the shield during the whole journey.

1.3.1 The extra-protective shell type headphones have advantages.

- ✓ Eliminate complex adjustments when put on and may be used on any person;
- ✓ Its size can be viewed at a distance, allowing preparation to perform oral communication;
- ✓ For the same reason, it becomes easy to control its correct use;
- ✓ Can be adjusted even utilizing gloves;
- ✓ They are comfortable in cold environments;
- ✓ In case of helmets or face shields, they should be assembled together by the manufacturer;
- ✓ Initial cost of implementation is greater than the in-ear models, but its life is long and there are spares available;
- ✓ Easy to remove if you walk around in areas with frequent changes in sound pressure level;

1.3.2 The disadvantages include

- ✓ Depending on the model, it may interfere with wearing glasses and welding masks;
- ✓ They carry space problems in small or confined places;
- ✓ Very uncomfortable in hot environments;
- ✓ The weight of the shield also generates discomfort.

Nudemann et al (1997), mentioned by Vieira (2003) also describes the in-ear protectors or caps as these are positioned within the outer ear canal and should be manufactured by elastic material, nontoxic and, if pre-molded in various sizes, with smooth surface, without recesses, allowing cleaning with mild soap and water.

They are divided into three types:

1. Premolded (rubber, silicone, plastic, etc.).
2. Self moldable (foam plastic, waxed cotton, fiberglass);
3. Moldable (silicone rubber), individually molded in the external environment of the worker.

These protectors have advantages as:

- ✓ Easy to carry;
- ✓ Allow the use of glasses and other PPE (helmet, face shield, welding mask, etc.).
- ✓ Initial cost of implementation is low, although life is short;
- ✓ Its use is not affected by temperature.

They have drawbacks such as:

- ✓ Easy to lose and forget;
- ✓ Not being seen, difficult to check their use;
- ✓ Must be cleaned and sanitized frequently;
- ✓ Depending on the type, requires the availability of various sizes according to the external auditory canal;
- ✓ Difficult to manipulate with gloves or with dirty hands;
- ✓ Can cause injury to the ear canal.

The semi-insertion protectors consist of two auditory canal shutters (without penetration) and a plastic rod sleeve, which offers a compression of the shutters on the auditory canal. This type of protector is very little used. The protective shell type and insertion are the most used.

The ergonomic contribution, according to the time it is made, is classified in ergonomic design, repair and awareness (Wisner, 1987). According to Iida (2005) ergonomics design occurs when the contribution is made during the initial phase of the project, the machine or the environment, and ergonomics correction occurs when the contribution ergonomics is applied in real situations, to solve problems that are seen in security, excessive fatigue, diseases of the worker or the quantity and quality of production. And lastly, ergonomics awareness does not often solve ergonomic problems, neither at the design stage and nor at the stage of correction, only then does the awareness of workers take place, they are precautionary about the problems with the ear protectors.

2. Method

This paper used a qualitative approach by applying exploratory techniques in order to investigate, clarify and develop concepts and modifying the manifestation of interpreting users (Gaya, 2008; Gil, 2009).

The use of this methodological representation is to obtain informative data as a way of capturing the characteristics of a particular group.

This field study was conducted in a mechanical metal company in the period of 2 months with weekly meetings QCC with different groups of subjects always consist of 10 users. Steps of the methodology used:

- a) Preparation of the survey;
- b) Application of the survey;
- c) Analysis of data collected;
- d) Interpretation.

The survey presented a user evaluation comparing the proposed virtual example to the current model used by the company, identifying the approval or not. After the survey, collected data are analyzed providing a survey percentage of users and their possible interpretations.

The graphical representation of the researched ergonomic product. The proposed configuration of this new research model consists of a hearing protector, shell type, with an outer engineering plastic, rod support stainless steel, anti-noise foam and a removable pad for a perfect fit on the head.

The safety glasses are made of plastic material arc with a center pin and two slits at the ends, which are used for engagement with a display polycarbonate colorless, yellow (amber), gray or green. These rods spatula type are made with adjustment of adjustable same material as the arch and articulated through these metal screws.

Further details and configuration of the equipment can be seen in the graphical representation by the figures that are shown below:

- a) Figure 01 - Adjustable rod;
- b) Figure 02 - Spinning pin;
- c) Figure 03 - Exploded view of the product;
- d) Figure 04 - Assembly drawing.

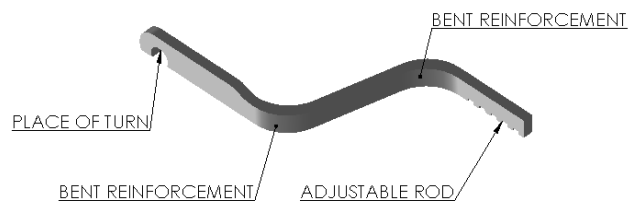


Figure 1: Ajustable rod – The authors

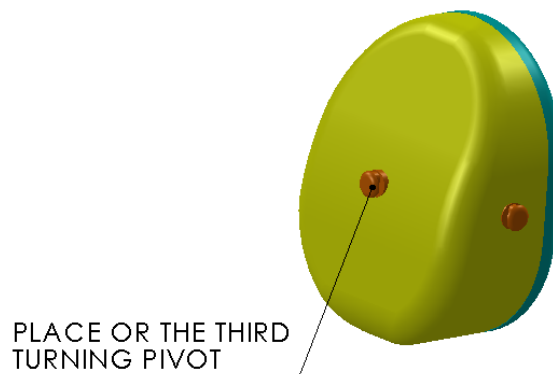


Figure 2: Spinning pin – The authors

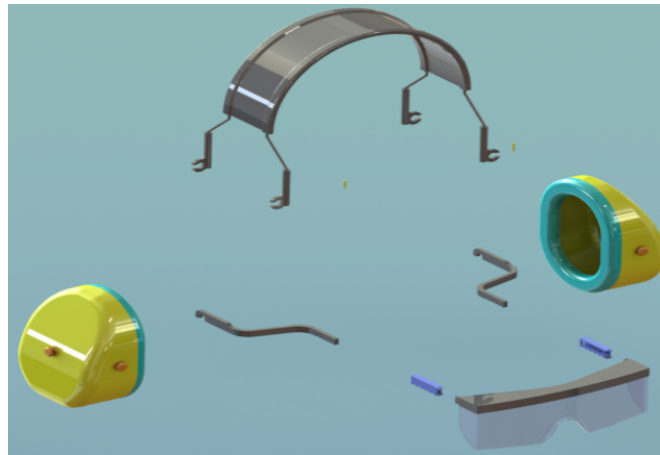


Figure 3: Explode view of the product – The authors

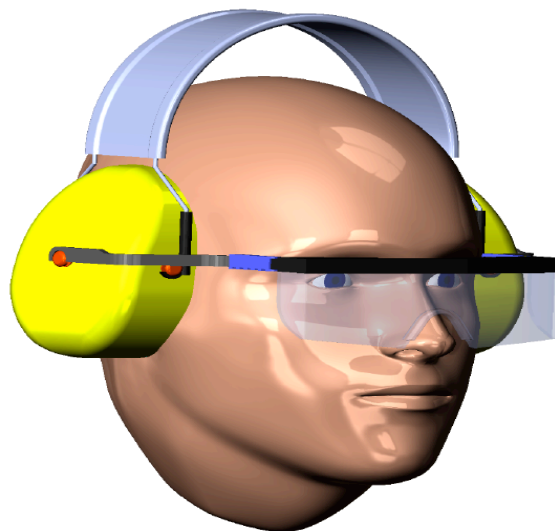


Figure 4: Assembly Drawing – The authors

3. Results

After the weekly meetings of stakeholder groups, ergonomic improvements in the evaluation of proposals for comfort and satisfaction compared with current models of PPE used by the company, we came up with the following results

CCQ	Sample	Approval (%)	Rejection (%)
1	10	72	38
2	10	85	15
3	10	91	8
4	10	90	10
5	10	97	3
6	10	100	0
7	10	98	2
8	10	96	4
Total	80	Average	91 %
			9 %

4. Conclusion

With this proposal, it can be concluded that the efficiency of an ergonomic intervention is very significant 91% approval compared to 9% rejection. From the point of view of the user, the justification of the use of the new proposal is likely to improve the productivity of the company, in both social and professional. The new device shows great potential for earnings improvement, but still requires the construction of a physical prototype for future studies extending further evaluation, particularly the requirement of acoustic muffling.

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