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Ergonomic analysis of work in an eyeglasses store

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Abstract

Ergonomics is a science of work that directly endorses the creation of machinery and gadgets to be used safely and efficiently, as well as the conception and assessment of workplaces. This research aims to point the activities that take place in an eyeglass store located in the city of João Pessoa - PB - Brazil, as well as to analyze the ergonomic problems that happen in that environment. The adopted methodology was a field research with direct observation, where were applied surveys with the clients, as well as physical and photographic data collection. This work used the parameters of the Workplace Ergonomic Assessment (WEA), which helped the diagnosis and the suggestions for achieving the necessary adjustments for the ergonomic comfort. For the theoretical basis, there were used works from Pronk [10], Iida [4], Moraes & Pequini [9], Tilley [8], Dul & Weerdmeester [1] and Motta [5], as well as the NR-17 [3], NBR-9050 [6] and virtual sources of research. The results showed deficiencies in the physical and functional aspects of the environment, where the difficulties in the customers' adaption to the place do not favor a good performance to the realization of the developed activities, evidencing the relevance of having more researches like this. That being said, designers address the wide theme of Ergonomics in their investigations and absorb it in their projects.

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1. Introduction

According to Dul & Weerdmeester [1], it can be said that Ergonomics is a science that is applied to the design of machines, equipment, systems and jobs, with the aim of improve the safety, health, comfort and efficiency during the work. “Ergonomics (or human factors) is a scientific subject that studies the interactions of mankind with other elements of the system, making applications of the theory, principles and Project methods, with the aim of improve the human well-being and the global performance of the system” [1]. In the projects of work and daily situations, Ergonomics focus the men. The unsafe conditions, insalubrity, discomfort and inefficiency are eliminated by their adaptation to the physical and psychological capacities of men.

The proposed work was developed in an eyeglass store in the city of João Pessoa - Brazil, which is an environment with flow and limited space problems. The research occurred, a priori, by studies related to the meaning and application of the word “ótica” (Portuguese for “eyeglass store” and its synonyms), with researches, surveys and assessment of the selected environment.

According to the page OPTO [2], the term “opto” comes from “óptico” (Portuguese for “optics”), from optometry. However, it is common, in Portuguese, to mistake *óptica* by *ótica*, which are words with complete different meanings. *Óptica* comes from the Greek *optkós* (or *optiké*) and from the Latin *optica*, which refers to vision and its phenomena, study of light and perspective, etc. *Ótica*, without the “p”, refers to the ear or to the hearing system. Its origin is also Greek, but from the word *otikós* (or *ótos*).

The studied built environment is a company that sells and mounts eyeglasses with the using of specific machinery to the storage of parts. The equipment needed for the realization of the company’s basic tasks was designed aiming the ergonomic comfort of the users that handle it, but the research showed that the ergonomics of this machinery stills not enough, since the work stations of the place are not following the NR-17 [3], which governs the work place ergonomics, nor are they following other regulations. The ergonomic problems found in the environment were exposed and discussed, based on local visitation, direct observation of the realized tasks, surveys and photographic data, with a sketch of the establishment.

This research also has the aim of evaluate the difficulties of both customers and employees, making possible the making of proposals and solutions to achieve the ergonomic comfort.

2. Work assessment

According to Iida [4], in order to reach its objective, Ergonomics studies various aspects of the human behavior in the workplace, as well as other important project factors, such as:

- The men – physical, physiological and social characteristics of the employee; influence of gender, age, training and motivation;
- Machinery – all the help with material received and used by the men in the work, covering all the equipment, tools, furniture and facilities;
- Environment – the study of the characteristics of the physical environment that surrounds the worker during the work, such as temperature, noise, vibration, light, colors, gases etc.;
- Information – refers to the existent communications between the elements of a system, the sharing of information, the processing and the decision-making;
- Organization – is the conjugation of the elements cited above in the productive system, studying aspects such as timetable, work shifts and team formation;
- Work consequences – here enters the control of information such as inspection tasks, studies of errors and accidents, of the money spent with energy, fatigue and stress.

According to the survey applied to the owner of the place and his employee, there is no work shift, but they share the tasks, which are the customer services, store organization and money accountancy.

The actions that are not predicted or not programmed do not happen in the company. The main functions realized by the workers are selling and mounting the glasses. The movement of the workers within the store is basically from

the customer services area to the machinery room, i.e. there is a flow between the area of selling and negotiation and the zone of the mounting of the products.

In the analysis of the adopted stances in the work place, it can be perceived that the worker makes its activities standing, such as the mounting of the lens, with the respective machines in the side tables with the height of the worker, and the verification of the height of the customer's pupils. For Iida [4], the correct dimensioning of a workstation is fundamental for the good performance in the activities. It is important to note that it is possible that people spend many hours per day standing or sitting in that workstation. So, any dimensioning mistake can submit them to long periods of pain.

The registered number of working hours for the case study is from 8am until 6pm, Monday to Friday, with an interval of 1h for lunch, and from 8am to 12pm on Saturdays. However, the exact time of the ending of the shift depends on the number of customers to be attended.

According to Iida [4], the human body is more able to work in determined days and hours. In addition to the fact that the efficiency is higher in these periods, there is a lower risk of accidents. Many factors condition this favorable state for work. The more important are the circadian rhythm, which is intrinsic to nature itself, and the training process prior to the work. The human organism presents oscillations in almost every physiological function with a cycle of approximately 24 hours. This is the reason for the name circadian. From these functions, the more significant one and the easiest to be measured is the body temperature.

3. Characteristics of the employees

The eyeglass store has two persons in its staff: both of them most of times do the same functions, being the mounting of the glasses a task only for the optician, which, in this case, is the owner. The establishment is in the market for 9 years, and, during this time, 4 people have worked as its second employee, but none of the substitutions were due to pathological reasons. Regarding pain or musculoskeletal discomfort, just one claim due to a pain in the lumbar region in the last 7 days prior to the interview was presented by the oldest employee in the company.

“The monotony, the fatigue and motivation are three very important aspects that must be observed in the worker productivity. Monotony and fatigue are present in all the jobs and, when they cannot be eliminated; they can be controlled and replaced by more interesting and motivating environments” [5].

4. Characteristics of the workplace

The store has an area of 11,55 m², and this space does not present accessibility, and even though it has a ramp in the main entrance, its inclination is not according with the NBR – 9050 [6], making it inaccessible to people with special needs, as well as to elderly people. The area for receiving the clients, which has the highest flow of people, is 9,15m² wide (Figure 01 - yellow area); the workplace of the employee (green area in Figure 01) is where the customers register for the services and receive the final product. It is also the place where the cashier machine stays. The area destined to the machines of lens adjustment, mounting and storage is 2,40 m² wide (blue area of Figure 01), and in there the flow is minimum, since just the company's employees have access to it.

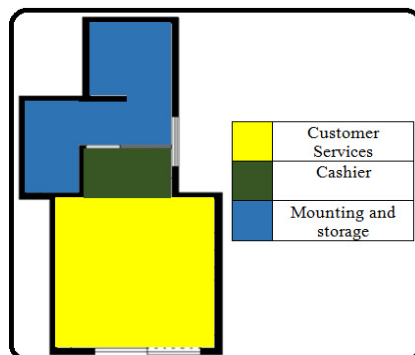


Fig. 1. Sketch I – Eyeglass store.

5. Tasks analysis

The theoretical principles of the approach proposed in this work are defined based on the Workplace Ergonomic Assessment (WEA). This method of analysis of work is divided in two different approaches: the traditional approach, which is based in the study of the human body movements, which are needed to do a specific task and in the measurement of the time spent to do each one of these movements, and the ergonomic approach, which is more narrow and limits the study case to an aspect of the workplace situation: the decomposition in a man-task system.

To analyze the tasks performed within the store, it is necessary to understand the layout and disposition of work items in the environment, as shown in Figure 02.

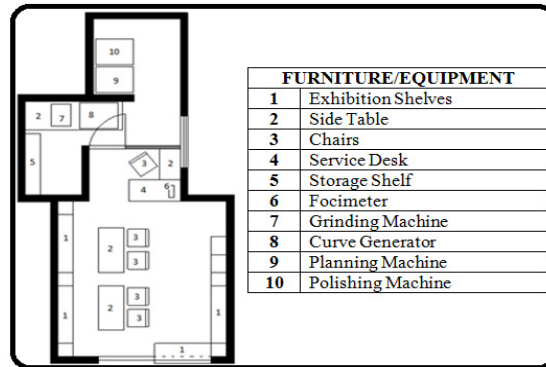


Fig. 2. Sketch II – Eyeglass store.

In this context, amongst the observed activities, the following are highlighted: customer services, product presentation such as the frames (Figure 03 - a); verification of the customer's height of the pupils (Figure 03 - b); handling, cutting and grinding of the lens; and, finally, the mounting of the lens in the frames.



Fig. 3. (a) Introducing the product to the clientele; (b) Verifying the height of the pupil.

The main process made by the company is the production of the lens. The workplace 1 is the space within the store for selling the products. The store has its own furniture for exhibition of the glasses, desks and chairs to attending the clientele and a service desk, where is a computer for registering the new customers, receiving payments and delivering the orders.

The workplace 2 is the local where the machinery for the lens confection, such as curve generator, polishing machine, focimeter, planning machine and pupilometer are stored.

6. Diagnosis

By having a small area to the storage of equipment, manufacturing and maintenance of the lens, and by being a place with an average flow of people, the store presents some problems.

The place used for the machinery corresponds to a small space, with an impaired access by a badly installed door (Figure 04 - a). This area is reserved not just for the storage of lenses, but for their manufacturing and maintenance as well. Since it does not have a proper ventilation system, the worker is exposed to a great quantity of toxic materials that are liberated when the machines are turned on, which is the case of the grinding machine used for the cutting and grinding of the lenses.

These residues are known as glass wool (Figure 04 - b), material made from glass fiber, that aggregate by the application of resins, silicones, phenols and other compounds that are soluble in organic solvent.

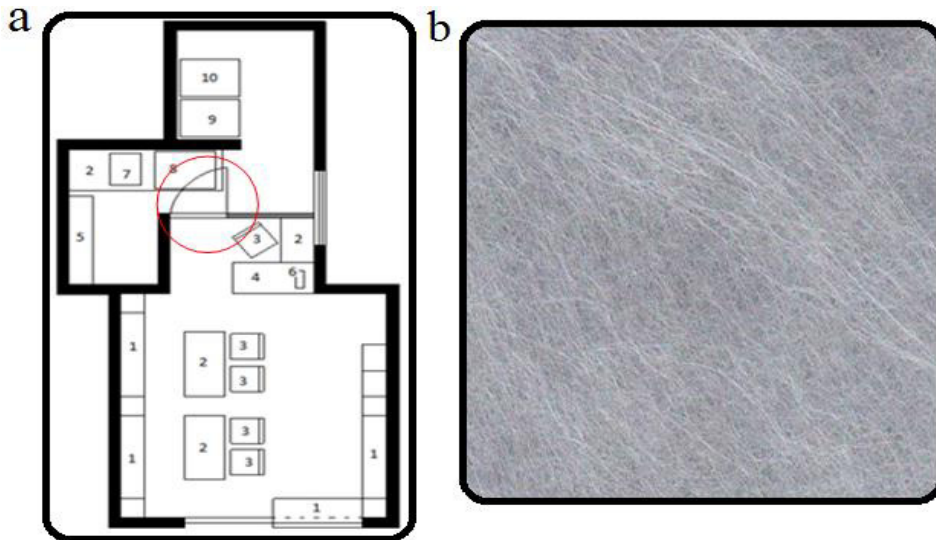


Fig. 4. (a) Sketch with the door highlighted; (b) Glass wool.

The internet page Ecycle [7] said that, according to The New York City Department of Health and Mental Hygiene, this fiber is toxic for it has metals that are harmful for both human health and environment. The use of glass wool can be more dangerous by the fact that, in its chemical composition, it is used a resin commonly used with styrene (residue that can cause effects such as tiredness, slowness, concentration problems and equilibrium problems). When the optician enters in contact with this material, its fragments can cause eye, skin, nose and throat irritations. High levels of exposition to glass wool fragments can cause asthmas and bronchitis.

Another ergonomic problem generated by the sharpener machine (Figure 05) is the height of the eye and arms positioning. According to the NR-17 [3], about the Ergonomics in the workplace, the standing workstations must “[...] have height and surface work characteristics that are compatible with the kind of activity developed in it, with the right distance from the worker’s eyes to the field of work and with proper height for the seat [...]”. This regulation also states that it is necessary “[...] to have an easily reachable and perceptible working area [...] and [...] adequate motion of the body movements [...]”.



Fig. 5. Grinding machine.

In addition to the grinding machine, in the same place are the polishing machine, which polishes the lenses (Figure 06 - a); planning machine, that adjusts the lenses made in the lens generator machine (Figure 06 - b); and the curve generator machine, that creates the curves of the lenses (Figure 06 - c).

These machines, when turned on, generate loads of noise, bringing discomfort to the person who is handling them. The exposition to this noise can cause future hearing loss, since the Personal Protective Equipment (PPE) is not being adequately used. Besides, people that are outside the machinery room feel uncomfortable as well, since the environment is not acoustically treated. According to Tilley [8], “the more intense the vibrations, the more distraction, nausea, irritation and discomfort they can cause and, under continuous exposure, trauma and injury”. It is proved, then, that the risks to which the workers of this machinery are daily exposed in their workplace is real, as well as the discomfort felt by the other users of this space.

It is important to highlight that, according to the classical model of the man-machine system (Figure 07), proposed by Grandjean and Kroemer & Grandjean *apud* Moraes & Pequini [9], the machinery must provide proper standing positions so that the manufacturing process can be efficient:



Fig. 6. (a) Polishing machine; (b) Planning machine; (c) Lens generator machine.

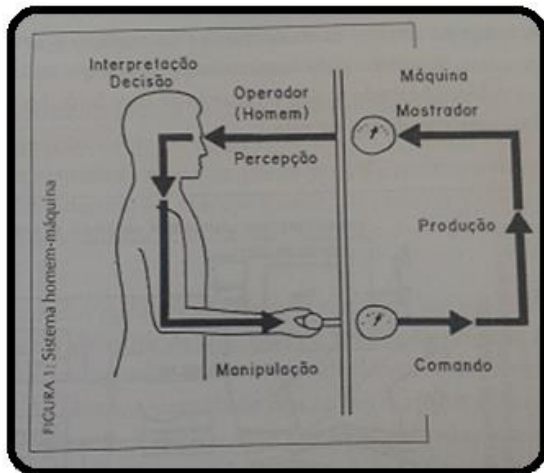


Fig. 7. (a) Polishing machine; (b) Planning machine; (c) Lens generator machine.

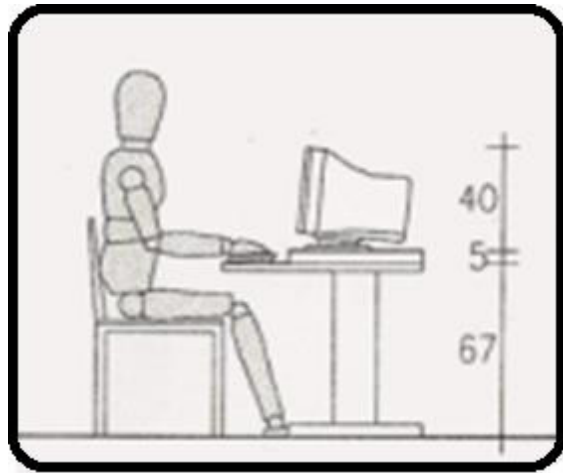


Fig. 8. Computer desk dimensioning.

Yet, in the machinery environment there are lighting problems, since the lights are placed in the center of the room and, for this category of environments, the regulations say that they must have focal lights as well, since the activities made within the space need high precision. Consequently, there are shadows generated by the machinery. There is no natural light.

According to Moraes & Pequini [9], a workplace must project a light that avoids the creation of shadow zones, by using artificial lights, even though there is natural light in that place.

7. Some recommendations

To diminish or avoid the damages and injuries cited by this work, the optician should use wide clothes, with long sleeves and gloves; use a filtering mask, avoiding the inhalation of any glass wool fragment; and the eyes must be protected with safety eyewear.

The standing positions that the professionals must adopt in order to fulfill their activities and their discomfort in doing them cause late damages to their health. Moreover, the muscular and joint pain can cause great wear throughout the years.

The side desk that is close to the customer services desk, used by both members of the company, which is occupied by the computer, is not indicated to these users, for it has an improper height, considered small in relation to the chair and the user, and, by this, can cause pains and damages in the user's back. In this case, the minimum that should be done by the company was to offer furniture that is regulated in the standard height, amongst a chair regulated for the user's height. However, even this minimum requisites, which are demonstrated by Pronk [10], is given:

It is essential to be aware for the parameters addressed by Iida [4], regarding the workstation:

“The ergonomics focus tends to develop workplaces that reduce the biomechanical and cognitive requirements, looking forward to putting the worker in a good stance. The objects to be manipulated must be within the body movement's range. The information is put in places that highlights its position.”

“The correct dimensioning of the workplace is a fundamental phase to the good performance of the person that will occupy the spot. It is possible that this person will spend many hours in a day, during years, sitting or standing in that place. Any mistake made in this dimensioning can, then, submit then to suffering for years. In some cases, when the arrangements involve desks or stands, the correction can be made in a relatively simple and economical way. For example, you can cut the legs of the table or chair, to reduce the height, or, differently, put stages or other methods to set the height higher.”

Following this way of thinking, it is perceptible that the machines, tools and materials must as well be adapted to the workplace conditions. By being so, they will promote a biomechanical balance, reducing the damages to health and assuring the safety and satisfaction in the workplace.

Another point to be highlighted is the stance that each customer needs to adopt in the place studied in this work, for the side desks for customer attending were wrongly dimensioned. A discomfort is caused due to their frontal part being closed, setting the customers farer from the desk, when they were supposed to have a design with open sides, providing comfort to the person seated there, putting this person closer to the attendant and the products to be chosen.

8. Conclusion

According to the ergonomic analysis that was made, some deficiencies of the place must be emphasized: the lack of space, almost no area for circulation of people and no accessibility. It was also perceived that there is no adequate space for welcoming the customers, for they make payments, register, receive information, try the glasses and place and gather their orders all in the same area.

These deficiencies fit in the problem of the flow, which also covers the location of the toilet, since the user has to walk through all the areas of the store to use it, for the toilet is not inside the store, but in an external annex of it. Therefore, environments with this flow problem are subject to turmoil and discomfort.

A practical point to mention is the intention of the owner in projecting a space for the machinery that serves the workers' needs, although the space has some dimensioning mistakes. So, for the adaptation to the workplace to be possible it would be necessary direct observation in specific parameters.

Despite the owner's intentions in having adequate workplaces, the machinery is handled in an improper way regarding safety equipment, since for all the PPE that were supposed to be available for the workers, just the safety eyewear is, and it is not used in all the recommended situations. Indeed, not having body safety equipment the workers' health is compromised, because, in addition to the noise and heat within the machinery room and its lightning conditions and forced positions, the optician handles the machines with the skin exposed, being susceptible to contamination caused by the residues leaving the lenses. Also, there is no civil safety equipment, such as fire extinguisher, even though the regulation institutes state that it is mandatory.

Finally, for a more productive, comfortable and inclusive eyeglass store, regarding people with special needs, as well as for the increase in the profits, there should be: awareness about the importance of the use of PPE's; investment into the resizing of the workplaces; enlargement of the physical place with environmental comfort parameters, designed by a interior design professional with experience in the area of architectural interior design.

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