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Ergonomics analysis of the productive environment of fashion clothing firm in Belo Horizonte- MG

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Abstract. A company making women's clothing, located in Belo Horizonte, Minas Gerais was studied in its ergonomic aspects with regard to the layout. With this study it was possible to establish the best positioning of machines and jobs of employees. The analysis criteria used were: frequency of use, functional grouping, sequence of use, flow and intensity of preferred connections. An ideal arrangement in the workplace provides improved manufacturing quality and employee performance and consequently higher production yields.

Keywords: company, ergonomics, work

1- Introduction

The environment of a production company with regard to their physical arrangement *(layout)* is a factor that influences the flow of work which in turn increased demand displacement of the employee and consequent physical wear. An overview of the production flow of a company manufacturing women's clothing allows to establish a direct relationship between the level of production of parts and the worker income. The environment is analyzed as a workplace with a *Taylorist* approach where body movement is minimized and the time spent to perform a job [2]. For this analysis are proposed three steps: developing the preferred method, the standard method to prepare and determine the time pattern. [1]

The physical layout of the workplace presented by the company is analyzed according to the criteria of importance, frequency of use, functional grouping, sequence of use, flow and intensity of connections preferred. For each criterion is identified a problem to be solved using ergonomic tools aimed at a better arrangement for the physical plant of the company. The analysis is of great importance to the company as it improves the work environment for employees that will have greater motivation, less absenteeism and fewer illnesses, reflecting on their productive output.

2. The clothing industry in Brazil

Brazil has great participation in the economy through the fashion industry. According to the Brazilian Association of textile and clothing (ABIT), an organization that supports the development of the textile industry, the country is the sixth largest textile producer in the world, second largest producer of *denim* in the world and is among the five producing countries confection. It has about 30 000 companies that generate 1.65 million employees. It also represents 17.5% of GDP of manufacturing industry and about 3.5% of total Brazilian GDP.

2.1. A manufacturing industry and ergonomics

The company studied here is a micro-company that was founded in 1995 and is located in Belo Horizonte, Minas Gerais state. The state has a very significant participation in the global economy. According to research of ExportaMinas and FIEMG (Federation of Industries of Minas Gerais), the traditional sector of

Minas Gerais accounted for 10% of national production, with 5.7% of companies dedicated to making clothing. It is the third exporter of textiles and garments in the country and occupies the 3rd position in the national ranking of GDP textiles, with 12.3% share or U.S. $ 4 billion. Cotton is used as main raw material. The company under study is inserted in this current economic scenario in the fashion market and produces its own brand, whose products are sold in three stores located in different regions of the city. But it also offers services faction to other brands of clothes. It has a staff composed of 16 women distributed according to function performed: four seamstresses, a modeler, a designer, a manager, a charwoman and a sales lady.

The relationship of interface between human, machine and environment is an object of study in this case, in order to analysis of potential problems and suggestions for correction. Murrel (1995) defines the relationship between ergonomics and human factors as:

> *... The scientific study of the relationship between man and his environment. In this sense, the term environment is taken to cover not only the environment in which it can work, but your tools and materials, its working methods and organization of work, either as individuals or within an environment of teamwork. All these are related to nature of man himself; of its skills, abilities and limitations.* (MURREL, 1995)

3. Research methodology

According Karwowski (2001), research methods provides a structured approach to ergonomics analysis and assessment of the problems. Therefore, it is the responsibility of the ergonomist:

- Testing the theoretical human-machine performance.
- Develop hypothesis
- Questioning
- Utilize rigorous data collection and analysis of technical data
- Ensure the repeatability of results
- Disclose-finding study

The research methodology consists of three steps:
1) Step 1 - Analysis of the ergonomic work station, through a focus chosen for the case study develops a standard to be applied to the company.
2) Step 2 - Project of workplace job: overall planning *layout* consists of a station of work;
3) Step 3 - Physical arrangement of the workplace: how the equipment will be willing and various elements that compose the job.

3.1. Step 1 - Analysis of workplace ergonomic

According to Iida (2005), the worksation is the physical configuration of the relationship between human-machine- environment. It is a complex that involves human and the equipment he uses to do the work, as well as the surrounding environment. In this case study (a garment factory) is a group formed by several stations of work. There are basically two types of approaches to analysis of the job: 1) *Taylor* approach, which is based on the principles of economy of motion, 2) ergonomic approach, which is based mainly on the analysis of posture and biomechanics in the interactions between human, system and environment. The diagnosis ergonomic allows prioritized problems deepen and test predictions. It is a time of systematic observations of the activities of tasks, records of behavior in a real work situation [4].

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The environment in study is an clothing company whose staff is composed by women (only the director and owner is male). In an interview, the owner says it all employees are registered under the CLT, receive vouchers carrier, guarantee fund and health plan. The company has documented all the planes determined by the occupational medicine such as the PPRA, which consists of the Program Prevention Program, known as NR9, which aims to raise the conditions of the work environment and recommend preventive procedures.

When interviewed, the director of the company tells us that while the work is repetitive and noisy, the company has not had cases of dismissal of employees due to health problems of ergonomic order. As attendance incentive to work by employees of the company created an award with a staple food to any employee who does not produce or absence from work and resulting delays during the month.

3.2. Taylorist focus of the job

It is based on a series of empirical knowledge accumulated since the time of its creator, Taylor (1856-1915). They are studies of the bodily movements necessary to perform a work and time spent on each of these movements. This study is composed according to Iida (2005) cited by Barnes (1977) in three steps:

3.2.1. Develop the preferred method:

What starts this step is necessary:
a) to define the purpose of the operation;
b) to describe the various alternative methods for achieving the goal;
c) to test all these alternative;
d) to select the method that best meets the goal.

Aim of the operation we can cite the rearrangement of the layout of the factory of the company seeking economy of movement of employees, less wear, less

fatigue, and consequently more production. The alternatives for achieving the objectives consist of survey data, analyze the physical arrangement of the company as a whole and planning for new physical arrangement.

3.2.2. Prepare the standard method

Must be registered the preferred method for this is converted to standard to be deployed throughout the factory. For this step should be followed tasks: a) perform detailed description of the method b) schematic drawing to the job with the placement of the machines and their dimensions, c) list environmental conditions such as lighting, gas, dust, and other factors that affect performance in the workplace. In Figure 1 can be observed that the plant has a good daylighting and ventilation, artificial lighting is put into one central light. For the individual workplace (sewing machines) would be ideal if there were more lights focused on the machines.

3.2.3. Determine the time standard

This is the time required, a labor expert, to perform the work using the standard method being included tolerances expected, inefficiencies in the production process, and tolerance to fatigue (dependent on workload and environmental conditions).

4. Survey data

The information on the environment, equipment, posture and nature of the task can be raised through questionnaires, filming. In this case study was done through a registration questionnaire and photographs.

5. Design job

It is part of a more global planning of production facilities and can also be called, as in the case of factory *layout.* It consists of three levels:

5.1. Level 1 - Design of the macro-space:

It is a study of the total space of the company, defining the dimensions of each department, including ancillary areas such as inventory and maintenance. At this level you can determine the flow of input and output of raw material to output of finished products. Sets here the work team for each stage of the process.

- Layout of the company:
  - Administrative Area: 30 square meters, divided into the waiting room, toilet, kitchen and office.
  - Manufacturing plant: 150 square meters, divided into the shipping area, cutting area and manufacturing, warehouse, bathroom and dining room, as shown in Figure 1. Distributed in this area are manufacturing a cutting table, six sewing machines, table to iron the clothes, shelves to stock and support tissues.

Figure 1.
Factory making clothes (Source: company)

5.1.1. Flowchart of production:

I. Modeling - performed by the modeler who is also responsible for cutting the pieces.

II. Cut the pieces - is done manually, because the factory does not have laser cutting. Search is the most of the tissue.

III. Separation of the pieces already cut - is made by the modeler / cutter that separates the pieces shaped rolls and ties, placing them in a cardboard box or PVC, which is transported to *overlock* machine to begin the closing of the piece.

IV. Closing the piece - is done by machine *overlock.* Machine (1)

V. Placement of lining - is done by the machine line (machine 6)

VI. Placement Preparation for placement of the elastic piece. (Machine 2)

VII. Elastic - is placed in the 3rd row machined. (Machine 3)

VIII. Finish-machine is made in the last machine of the right of the room. (Machine 4)

IX. Conclusion- is done on the machine (5). At this stage the seams are checked, and are nailed labels and silicone composition. This machine has finished the pieces go for the expedition.

X. Shipping: takes place at a table in front of the finishing machine, where they will be labeled and packaged, going, later, to the store. There is an accurate record of sales which is computerized.

Figure 2 illustrates the *layout* of the company as a whole and details the flowchart described above.

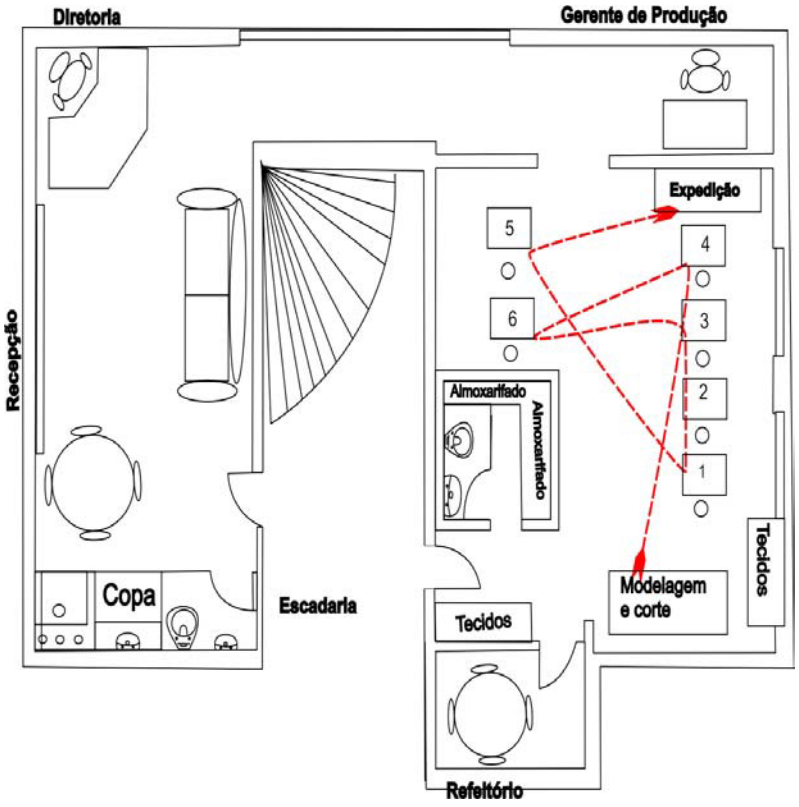

Figura 2. Physical arrangement (layout) of the company under study
Legend: 1-Machine Overloock 6 - 2-machine line machine bias
3-4-elastic Machine Finishing 5-cap - coverstitch sewing machines
6 - Expedition

5.2. Level 2 - Project of the micro-space

Attention is focused on each workstation or production unit, covering the worker and the equipment he uses. In an analysis of the micro-space was studied each job, study the work and its relationship with the equipment he uses to perform its task. Each seamstress was observed for a long time. The image in *Figure 3* shows the work at his place of work during the execution of its task.

Fig. 3 - seamstress working position (source: company)

What could be seen was the poor posture due to inadequacy of the chair, and there was the need of placing a cushion to adjust the height of the machine to work.

5.3. Level 3 - Detailed design

Establishes the characteristics of the interface created between man, machine and work environment so that these interactions are appropriate. This detailed analysis of the job of every seamstress was not performed, since the major focus is the macro-space, which comprises the environment in general, the organization of work, teamwork, and other transportation systems.

6. Arrangement of the workplace

According to Iida (2005), the physical arrangement (layout) is the study of spatial distribution or the relative positioning of the various elements that compounds the workstation. The criteria for this arrangement are: the importance, frequency of use, functional grouping, sequence of use, flow and intensity of connections preferred. The criteria that had focus in this study were sequence of use, flow and intensity of preferred links, which are detailed below:

6.1. Sequence of use:

It concerns a planning or operational links between the temporal elements, their relative positions in space must follow the same sequence.

6.2. Intensity of flow

It aims to bring closer together the elements, among which there is greater intensity of flow. This flow is represented by a given variable that should be chosen, for example, materials, information or body movements. The study of the physical arrangement of the plant allowed the company a check of the production flow. It was observed that this cycle was uncoordinated because they are not close together work stations (machines) that perform sequential functions.

The flow in this case is measured by the variable material and body movements. By observing a day's work in making it was found that there was a large displacement shift on the part of employees to get to the machine that would sequence the last executed task.

According to Iida (2005), there may be some restrictions on the project as: technological, financial and schedule. In the company studied the restriction is the limitation of space, it is necessary to accommodate the ergonomic needs of workers, with this restriction. Therefore, the redesign of the company's manufacturing unit is shown in Figure 4.

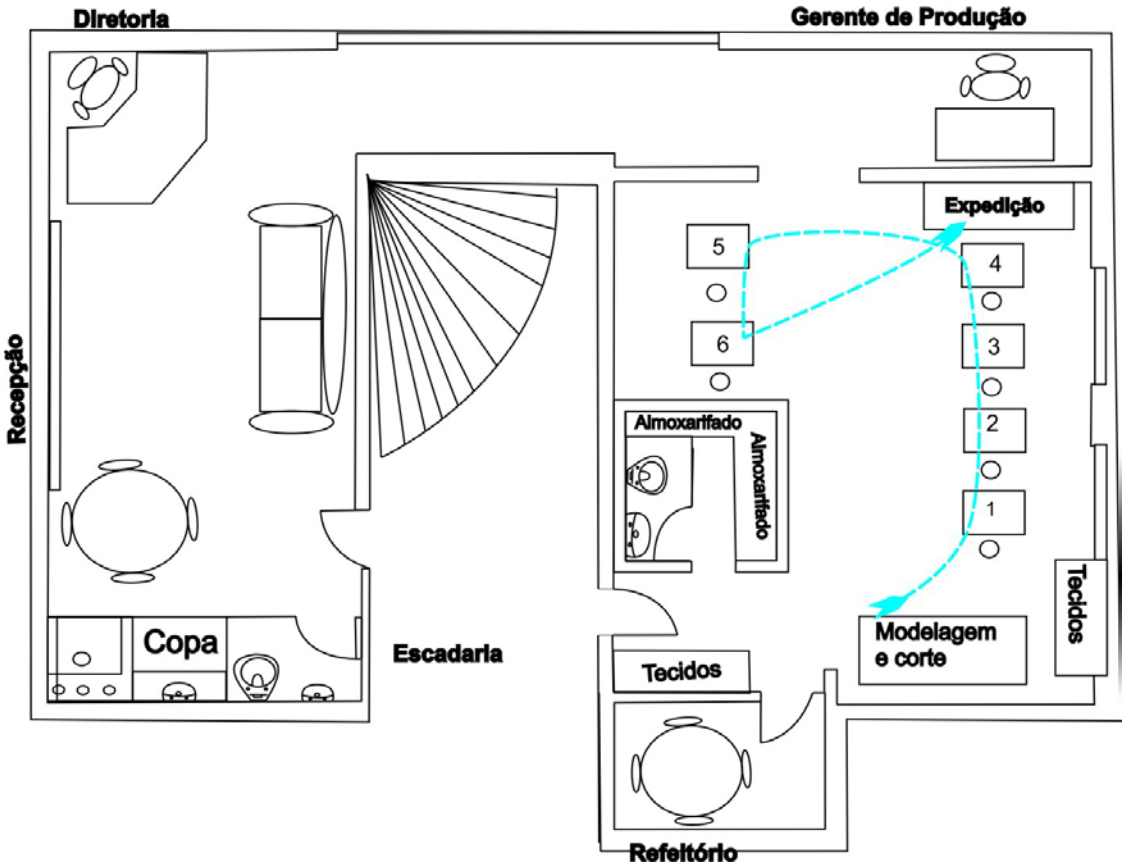

Figura 4 - Arrangement of the proposed job
Legend: 1-Machine Overloock 6 - 2-machine line machine bias
3-4-elastic Machine Finish 5 - Machine coverstitch sewing machines 6 - Expedition

An ideal arrangement would require more physical space and perhaps some interventions in architectural space, and this would lead to more spending and financial reforms. As the owner of the company was unwilling to new spending, the new ergonomic intervention consisted of a rearrangement of the *layout* of the factory. Changing the position of the sewing machines according to the function performed. This task was made easier by the fact that the production is based on only one product form (female underwear). Thus, the sequence always follows use the same operating order. Is observed in Figure 4 that the machine number (1) was deployed near the cutting table, where the flow begins production of a play. In the initial *layout*, a cutter across the factory to take up the other end. The machine number (6) in the initial *layout* came to occupy the position of the machine number (2), continuing the first task in the making.

The flow became more functional, faster, because the time-pattern could be found that there was a decrease of 3 minutes the time required to complete the preparation of a piece. For a company that has an output of 200 pieces/day, this reduction in the standard time is very telling. In addition to arranging the *layout* of the machines was made an analysis of storage and inventory of fabrics and thread, buttons, etc. The warehouse is located next to the bathroom, and it is not very suitable.

The storage of tissue is segmented in different places because there is insufficient space in the factory of the company. There is no organization of the raw material as shown in Figure 5 and Figure 6:

Figure 5
Storage of parts and tissues (Source: company)

There is no inventory control of parts or a pilot and organization of tissues. Figure 6 shows the stock lines that should be arranged by similar colors, facilitating the work of the employees.

Figure 6
Storage of parts and tissues (Source: company)

As for the modeling of parts was found that the molds are made by hand in paper *craft,* are stored in drawers without any form of registration by codes. This complicates the work if a part has performed in past collections will be used again.

Figure 7
Storage mold parts (Source: company)

It has been suggested that this case be provided a closet with shelves for these molds were stored in folders and in turn were separated by date and Registration Code.

The transport of parts between modeling/cutting table and machines up to shipping and then was found that it is done through cardboard boxes, as shown in Figure 7.

Figure 8
Transportation of parts between machines (source: company)

It was suggested in this case the acquisition of Box wired and shelves with casters, so that the already cut pieces are arranged in order of size: small, medium and large.

7. Results and discussion

The results were very positive because the firm was very capable of making changes in their physical arrangement in the plant. After an ergonomic work analysis (AET), for a few days it was found that the *layout* of the plant needed more time to the execution of a production cycle of a piece. In addition, the manner of storage and inventory of raw materials was unsatisfactory. The transport of parts of a job to another (machinery) was carried out in cardboard

boxes to inadequate function. Therefore, the ergonomic changes listed were:

- Proposed new arrangement for the location of machines to improve the intensity of flow between them, as well as the sequence of use. This change led to a decrease in the standard time for the execution of a production cycle of a piece in 3 minutes from the old *layout* of the company.
- Buy wired carts with wheels for transportation of parts between workstations (machines), organized on shelves in order of size pieces (small, medium and large).
- Store the molds made in the form of paper record with codes. Place them in folders with numbers and date collection to which they belonged. This facilitates the search if they are used again.
- Improve the lighting of the plant with more centralized focus on sewing machines.

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