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Ergonomic Risk Reduction with Automation of the Motorcycle Rear Lantern Mounting Process: Case Study in the PIM – AMAZONAS-BRAZIL

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Abstract*— *The present work deals with the use of pneumatic devices, applied in productive processes to improve an ergonomic problem. An easy-to-use automation system was implemented and evaluated for the assembly process of the motorcycle rear lantern product, since it was in high levels of absenteeism and rejection due to ergonomic effort. The case study was carried out in a motorcycle company, through the collection of data regarding the operation on the line and technical report records containing performance indicators. The results obtained were the reduction of ergonomic risks, thus guaranteeing safety standards, quality and ergonomics. The process of continuous improvement and of great relevance for both the company and the employees involved.

***Keywords*— *Automation, Pneumatics, Ergonomics and Quality*.**

I. INTRODUCTION

Automation is a fundamental element that enables companies to meet the market demands. With the purpose of improving time and resources, providing higher quality and productivity for the most diverse processes in which it remains linked, in addition to promoting greater safety and quality of life for its employees [1]. Automation means the organized dynamics of automatisms, that is, their associations in an optimized way and directed towards the attainment of the objectives of the human program [2].

The search for the automation in the industrial sector manifests when the company understands the greater need to be productive, pretending to the greater speed, reliability, versatility and production flow [3]. The involvement of compliance with specific methods, software and tools establishing the machine or industrial process, has several objectives, stressing the improvement of efficiency through optimization of resources, repetitiveness in execution, reduction of time and process costs.

The aim of this work was ergonomic risk reduction with automation of the motorcycle rear lantern mounting process, for this purpose it had specific objectives: to raise variables of the manufacture process; Establish the mechanism that leads to the creation of the device in order to automate the assembly process in order to reduce ergonomic risks; Aim solutions for the mechanism in the motorcycle rear lantern mounting process.

II. LITERATURE SURVEY

2.1 PNEUMATIC, ELETROPNEUMATIC AND INDUSTRIAL AUTOMATION

Pneumatics refers to the use of gases, which gives the automation process a great possibility of functionality for machines and equipment. The many features offered by it make it paramount for automation methods.

According to [2], "Pneumatic comes from the Greek root PNEUMA, which means breath, wind, blow. Therefore, pneumatics is conceptualized as being the matter that deals with the movements and phenomena of gases."

For [4], electropneumatic is the branch of pneumatics that starts using DC or AC electrical energy as a source of energy for the activation of directional valves, thus composing the so-called electrovalves and proportional valves, also energizing magnetic positioning sensors, pressure switches, micro-switches, etc.

Automation can be established as the technology through a process or procedure is obtained without human assistance. Despite being done in many areas, automation is immediately added to the production industries. In that circumstance, the term was originally developed in 1946 by a Ford Motor Company engineer to reproduce the variety of automatic transfer devices and power mechanisms that had been installed in the company's production plants.

Automation is a definition and an aggregation of techniques by means of which active systems prepared to act with optimum efficiency are incorporated by the use of information acquired from the environment in which they act. Regarding the information, the system calculates the most favorable corrective action for the execution of the action and this is a closed-loop pattern, known as feedback systems [6].

2.2 ERGONOMICS

Ergonomics involves a set of knowledge where it is based on responses to different demands. The purpose of ergonomics is to help meet human needs in the workplace, integrating the promotion of health and well-being. In a thorough and methodological investigation of work situations, ergonomics intends to reorganize them in such a way as to exclude sources of loss, that is, to abolish notable aggressors that may lead to partial or total impairment of any vital function, in short, medium or long term [7].

Ergonomics is the set of scientific knowledge relating to the human being and necessary for the design of tools, machines and devices that can be used with maximum comfort, safety and efficiency. " [8]. A software is presented by [9], to assist in the application of ergonomic tools.

2.3 QUALITY

From the point of view of production, quality is associated with the design and production of a product, in order to satisfy the needs of the customer and, from the point of view of the customer, quality is associated with the value and utility that it recognized on the product.

The principle underlying this view of total quality is that in order to achieve real effectiveness, control must begin with product design and only end when a product has reached the hands of a customer who is satisfied [10].

For Marshall [11], "quality is a term that has become part of the jargon of organizations, regardless of their field of activity and scope of action, public or private."

In order for a company to always guarantee quality in its products, investments in machines and equipment are necessary, because through them it is possible to increase the level of reliability, guarantee higher quality and avoid reworking due to production failures.

"Quality is the suitability for use" [12].

"Quality is the degree of adjustment of a product to the demand it intends to satisfy" [13].

Quality management is a good management process. In any area. The involvement of the article in the expression quality management modifies it into something specific. Quality management is, however, the management of something well indicated, called quality. Quality management is something general; Quality management is a technical area of the organization [14].

Quality tools are tools that facilitate the execution of the method, dealing with information, its collection and processing. By analyzing the results and determining their causes, it is possible to identify control and improvement actions and their priority, assisting in decision-making and problem-solving processes.

III. MATERIALS AND METHODS

An analysis was carried out in one of the processes developed in a motorcycle assembly company, where the sector indicators of absenteeism, quality and productivity were studied. It was highlighted the process of assembling the lock of the right and left rear signs, in which it presented high index of absenteeism, which was causing high defect rates, due to incorrect assembly, besides the difficulty of the collaborator to perform the assembly, bringing risks to his health.

Given the difficulties, an easy-to-install device with the best cost-benefit for the company was developed. This device used a simplified pneumatic system whose function reduces the impact of force caused by the process collaborator, promoting agility and efficiency in execution, reducing quality problems and increasing productivity and reducing ergonomic risks.

IV. ANALYSIS OF RESULTS

4.1 HISTORY OF THE PROBLEM

The indicators for the definition of the work station in which improvement is needed were following the quality, production, personnel and safety data.

Historical indicators during the period of the 12 months of 2018,

Regarding the item quality, rejection goal 0.011, real 0.010, positive difference of 0.001; goal zero locks, real 1 blocking and production suspension.

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Regarding the item Production, target efficiency 70%, real 65.57%, negative difference of 4.43%; line stop 24, real 28, negative difference of 4 stops in the assembly of components.

Regarding the personal item, absenteeism goal 2.1%, real 6.8%, negative difference 4.7% of absenteeism in the assembly of components in the period; accidents zero goal, zero real accidents registered in the component assembly sector.

With the analysis of these indicators, a GUT quality tool was used that uses the severity, urgency and tendency to define the area to be chosen for the improvement theme. One of the alarming items to be studied was the quality, but there was an improvement work being implemented to reduce this indicator with that, the urgency factor was reduced, thus highlighting the personal item by the amount of absenteeism with 58%, much higher of the stipulated sectorial target, of these absences, the medical licenses that were responsible for 86% of this item stand out. Collecting the data in the item medical licenses was possible to indicate the main reasons for these licenses that were ergonomic problems, which corresponded to 38% of the total medical licenses.

Stratifying the ergonomic problems in the works of the Assembly of Components sector, we obtained prominence for the assembly of the rear markers with 43% of the total, which justifies the reason for choosing the theme of this project.

It is also highlighted in the indicator of quality problems in the sector that is responsible for approximately 33% of the quality problems in the assembly of components.

4.2 ANALYSIS OF THE MECHANICAL CHARACTERISTICS OF THE COMPONENTS

4.2.1 Components Analysis

The assembly of the flags involves three pieces to be studied in order to find the cause of the occurrence of the ergonomic problems that occurred in this work station. The rear stop (figure 1a) is the item where the Right and Left Rear Signals are attached (figure 1b). The Latch Lock (figure 1c) is intended to secure the rear flags to the correct position on the rear bumper.

With the availability of the parts to be studied, item analysis and analysis were performed to determine if the hardness (figure 4) of the material was as specified in drawing, in order to certify that the parts were within the parameters required for their manufacture.

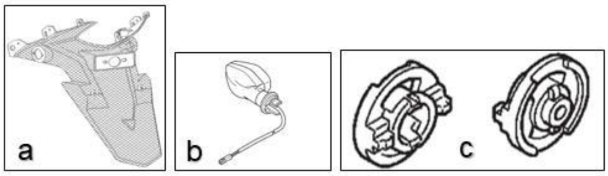

Fig. 1: assembly components

An analysis was performed and a report was issued on the measurement of the hardness of the components, attesting that the item is as specified in drawing.

4.2.2 Component Assembly Analysis

With the confirmation that the parts were as specified, an assembly test was performed to verify the conditions and interferences in the items studied. Manual assembly was carried out according to the conditions of the production process (figure 2). and with the dimensioning data of the parts of the assembly the interference of 4 mm between the flag stem and the lock was verified (figure 3).

Fig. 2: manual assembly

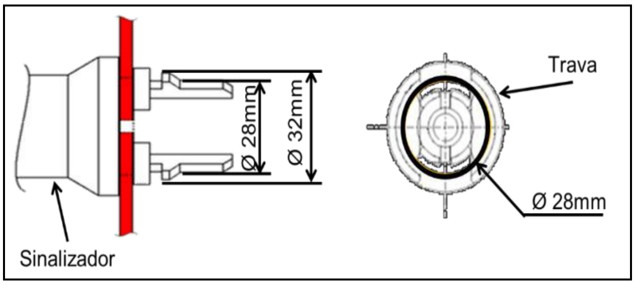

Fig. 3: Interference Illustration

With the aid of the digital dynamometer of the brand Instrutemp, model ITFG-5005 with capacity of measurement up to 150 kg, the force required for the assembly of the flag in 10 samples was verified and concluded that the greatest force applied was of 16,5 kgf.

The effort to mount the latch lock far beyond that allowed by the ergonomic analysis tools. The maximum

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allowed for the application of manual force in productive processes is 0,6 kgf.

4.3 RESULTS CONCERNING THE DEVELOPMENT OF THE DEVICE PROJECT

4.3.1 Pneumatic circuit design

4.3.1.1 Pneumatic Actuator Specification

According to the results on the mechanical characteristics of the components for the execution of the locking assembly it is necessary to apply a force between 9.3 kgf and 16.5 kgf. For the application of this force calculation is necessary for the definition of this Pneumatic Actuator, this calculation is defined by the Force (F) in kgf, equal to the Compressed Air Pressure (p) in bar, multiplied by the area of the cylinder piston in cm2 (A) according to equation 1.

$$F = p \; x \; A \qquad \text{EQ (01)}$$

With the application of data in equation 1 we verified that to reach the force of 16.5 kgf a pneumatic actuator with piston of diameter 18.6 mm is required. After defining the piston diameter it is necessary to specify the stroke length. With the analysis of the paralama dimension, a cylinder with a stroke of 100 mm was specified.

4.3.1.2 Elaboration of the Pneumatic Scheme

After defining the actuator to be used, for its correct operation it is necessary to draw up the pneumatic scheme to determine the items to be used in the system.

FluidSIM software distributed by Festo was used to create pneumatic and electrical systems. This software enables the drawing of electro-pneumatic diagrams in a simple and fast way, besides demonstrating the realistic simulation of the drawing based on the physical models of the components, making it an excellent tool for the creation of these circuits (figure 4).

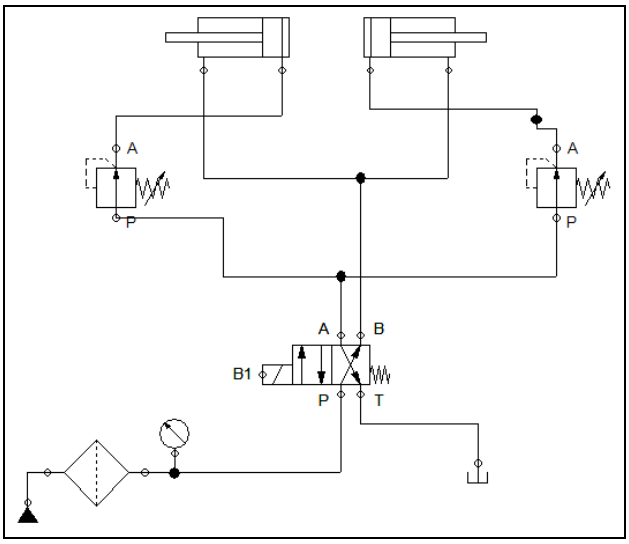

Fig. 4: Simplified Pneumatic Circuit

Figure 4 shows the simplified pneumatic design of the design, where a valve actuates two pneumatic actuators for the execution of the flag latch assembly.

4.3.2 Electrical Circuit project

With the creation of the pneumatic circuit, it has enough information to create the electrical system of the project. In order to comply with the safety regulations of NR10 and NR 12, it is necessary to install photocells and bimanual pushbuttons, thus complying with safety regulations. The electrical circuit was also created using FluidSIM software (Figure 5).

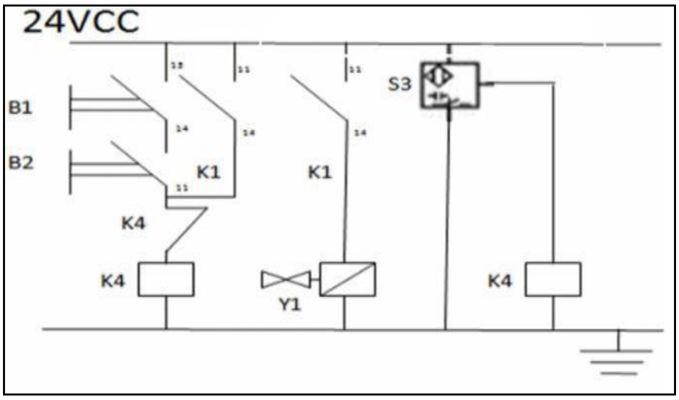

Fig.5: Simplified Electrical Circuit

4.3.3 Mechanical Design project

Defined cylinder to be used in the preparation of the project was drawn the design of the mechanical structure of the device that aims to ensure the fixation of the assembly for its assembly. For the creation of this design was used Solid Edge software distributed by Siemens,

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CAD software that began its creation in the 90's and presents a simple and practical way to create projects.

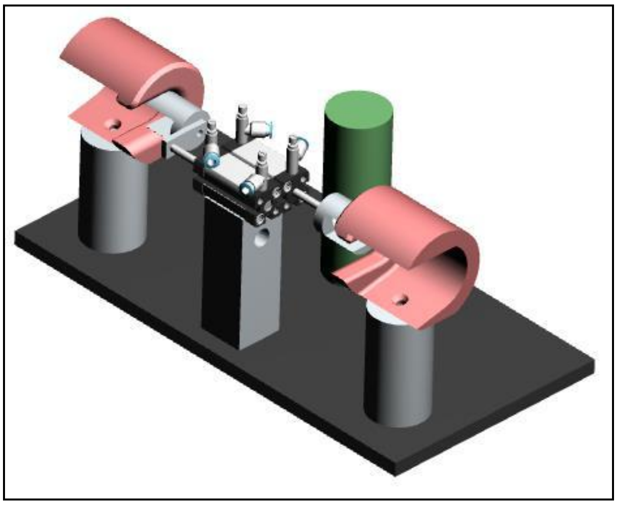

Fig.6: Mounting device

Figure 6 shows the 3D design of the assembly device.

4.4 RESULTS REGARDING THE MANUFACTURE OF THE DEVICE

For the construction of the device were used machines and tools of machining, materials available in the sector Technical Group of the company Alfa. An aluminum plate with the thickness 12mm and dimensions 400mm x 200mm was used as the base of the device and using a drill of column and drills was made drilling according to the drawing of the item. For the manufacture of the supports, Nylon and Polyurethane billets were used as feedstock, and the machining operations were performed using Lathe and Milling Machine.

For the fixation of the items was used allen screws with cylindrical head with metric thread Ø 6mm, m6, and metric thread Ø5mm, m5. As results we have the device (figure 7). After the device was built and the pneumatic actuators were installed a simple system was set up for testing the device. Once the device has been tested, the complete equipment has been assembled.

In order to comply with the Brazilian safety standard on machinery and equipment NR12, Annex 8 Item 2.1, the safety systems in the acceptable pressing or working zones must be the enclosure of the pressing zone.

To conform to this standard, the structure of a deactivated and adjusted equipment for the use of the device was reused.

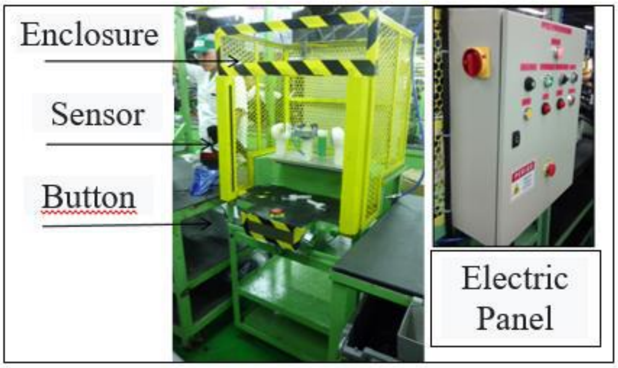

Fig.7: Final device

After the implantation of the device is expected to eliminate the ergonomic problems related to the assembly process, transferring the application of the necessary force of the locking to the pneumatic actuator, thus reducing the absenteeism index of the component assembly sector.

With the implantation of the device is also expected to reduce 33% of quality problems related to the assembly process.

V. CONCLUSION

The implementation of equipment and device for ergonomic risk reduction are of great importance, as well as reducing risks to the health of the worker, reduces costs and increases production through the improvement of the process, through increased efficiency and reduction of human fatigue.

This project allowed a broad knowledge in the area of project development, with the studies carried out, in the classroom, in the study place and in the bibliographic reference, attributing quality to the student for the job market. Through it also was obtained experience in the productive processes, providing better perception for the resolution of problems related to the engineering area. Although this work was based on a negative point of production, there was no problem for the data collection, nor in the development of the project. The positive aspects were the availability of the material, the tools and software used, and the analysis of the jobs.

The project of developing a pneumatic device based on a case study of ergonomic methods in productive processes, with the aid of bibliographical references, established the elaboration and implementation of an efficient and effective project. The objectives of this study were duly achieved.

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