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Ergonomic Analysis and Application OWAS Method in a Mechanical Maintenance Shop of Thermoelectric Plant

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***Abstract* — *The present work aims to develop an ergonomic analysis of the safety aspects of the mechanical maintenance workshop of the thermoelectric plant, located in the city of Campos dos Goytacazes. Note that it may serve as a support tool for company employees and other organizations that have maintenance workshops. It was envisioned a focus on safety issues for the development of work activities, seeking to identify irregularities in the ergonomic aspects in the execution of activities in the work environment and to propose alternatives to reduce and / or eliminate irregularities and, consequently, to improve the working conditions of employees of this sector. Thus, after a brief description of work safety, the importance and importance of ergonomics and the OWAS method (Ovako Working Posture Analysis System) are emphasized, the importance of furnas in the Brazilian electrical sector. safety engineering and ergonomics and its importance, as already commented, ending with an analysis of the safety in the sector of maintenance of furnas, applications of the method OWAS and the final considerations. The results of the environmental analyzes and proposed, contributed to a reduction of the index of work accidents in the mechanical maintenance workshop.*

Keywords* — *Safety. OWAS Method. Thermoelectric.

I. INTRODUCTION

For many years, companies neglected safety, hygiene and comfort issues for workers. The central objective was profit, obtained through the increase of production promoted by the exploitation of the labor force. According to the Nucleus of Research in Engineering Sciences (SEGRAC), this negligence resulted in consequences that eventually "forced" the competent bodies of the Ministry of Labor to create standards linked to this issue. Among the consequences referred to above, we can mention the increase in the number of work accidents that would result in a reduction in productivity, including in the Brazilian electric sector, the frequency of occurrence of accidents with and without leave, due to the high hazard index of the labor activities (ABRAO & PINHO, 1999).

The activities performed and services rendered by the electric sector are essential for the entire population, which is a very important element for the development of a country. Currently, the national electric sector is composed of dozens of companies that through the action in the most different states and regions, manage to serve a large part of the national territory. As is well known, the activities developed in the electric sector are of great danger, due to the complexity and high risk inherent to the process. Therefore, this is one of the sectors that present the most work accidents, showing the need to seek prevention measures that minimize the occurrence of these events.

This article aims to analyze a thermoelectric plant sector located in the northern region of the State of Rio de Janeiro, where proposals for improvements in the ergonomic and safety aspects of the mechanical maintenance workshop will be presented. For the development of the work will be used a methodology not known in the northwest of Rio de Janeiro: the Ovako Working Posture Analyzing System (OWAS) method, in addition, a diagnostic of the organizational, safety and ergonomic aspects will be performed, in order to propose quantitative and qualitative improvements in the ergonomic, social and organizational areas and the development of biomechanical and job analysis proposals. Focus will be given to safety issues for the development of work activities, in order to show some abnormalities or points that can be improved, as a way to optimize the process and ensure the welfare of workers. The following are some comments on the importance of engineering work safety, ergonomics, OWAS method and the electrical sector and Furnas. Finally, an analysis of work safety engineering is presented, prioritizing the ergonomic applications in the maintenance sector, followed by the final considerations.

II. WORK'S SECURITY ENGINEER

The analysis of the history of the emergence of work safety in companies is confronted with a context created by the man himself who has managed through history to ensure its existence on the planet. This history encompasses from the beginning of the labor relationship, where man begins his labor activities through predatory activity, evolves to agriculture and herding, until the period in which the transfer of the handicraft phase to the industrial age occurs. The latter was initiated by the industrial revolution in England, marking the beginning of modern industrialization, which originated with the appearance of the first spinning machine, denoting a process of evolution and the potentialization of the means of production (DE CICCO, FANTAZZINI, 1993; BORG, 1998).

The capitalist world lived its moment of glory, when those who owned the capital came to dominate the means of production, the high costs of the machines no longer allowed the artisans to own them. Thus, the capitalists, gave rise to the first fabric factories, composed of own machines and people employed to manipulate them (TORREIRA, 1997).

However, the industrial revolution, as far as work safety was concerned, proved to be the main cause of major health problems in this period, since it showed a significant increase in production to the detriment of living and working conditions to which the worker was exposed (SEGRAC, 2010).

Thus, in order to fully cover the security needs of the various work activities carried out within companies, it adds that work safety is linked to several areas such as introduction to safety, hygiene and occupational medicine, prevention and control of risks in machinery, equipment and facilities, psychology in security engineering, communication and training, administration applied to safety engineering, work environment and diseases, work hygiene, research methodology, legislation, technical standards, civil and criminal liability, skills, environmental protection, lighting, fire and explosion protection, risk management and ergonomics (RODRIGUES, 2003).

III. ERGONOMICS AND THEIR IMPORTANCE WORK CONTEXT

At the beginning of its formation, ergonomics was linked to the study of military activities and industrial production, however, it is possible to notice a greater mobilization focused on ergonomics in the industrial circles (COUTO, 1995).

Unlike other sciences that had their origins in the pre-twentieth-century, such as physics, chemistry, among others, ergonomics has an "official" date of birth: July 12, 1949. However, in 1857, that term had been used by the Polish Wojciech Jastrzebowski, who published the article "Essays on ergonomics or work sciences, based on the objective laws of science on nature." However, it was only with the founding of the Ergonomics Reach Society in the 1950s in England that ergonomics acquired the status of a more formalized discipline (IIDA, 2002; HIGNETT, 2000).

Ergonomics was born of a group of scientists and researchers who had an interest in developing an interdisciplinary science. However, there have been studies on these characteristics since Taylorism, where the workers had the aspect of suffering linked to work. In the era of artisanal, non-mechanized production, for example, there has always been a concern to adapt activities to human needs, always seeking the comfort of the worker. However, it was from the industrial

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revolution that issues concerning the worker's suffering aspects became more dramatic. The factories that first emerged bore no resemblance to modern factories, being dirty, dark, noisy, and dangerous. In addition, working hours were up to 16 hours a day, without holidays, and in a semi-slavery regime (MOORE, 1995; GUERIN et al., 2001).

Ergonomics aims at improving the performance of the productive system and seeks to reduce its harmful consequences on the worker. Thus, it seeks to reduce fatigue, stress, errors and accidents, providing workers with safety, satisfaction and health during their relationship with this productive system (IIDA, 2002, HIGNETT & MCATAMNEY, 2000).

Based on this premise the basic objectives of ergonomics are: safety, health and consumer satisfaction, associated with the efficiency of the whole process. For this to happen in fact, it becomes necessary that the whole productive system is intertwined and in tune. Figure 1 shows a schematic that shows how the interrelationships between systems should be, also showing the various factors that influence the productive system (IIDA, 2002):

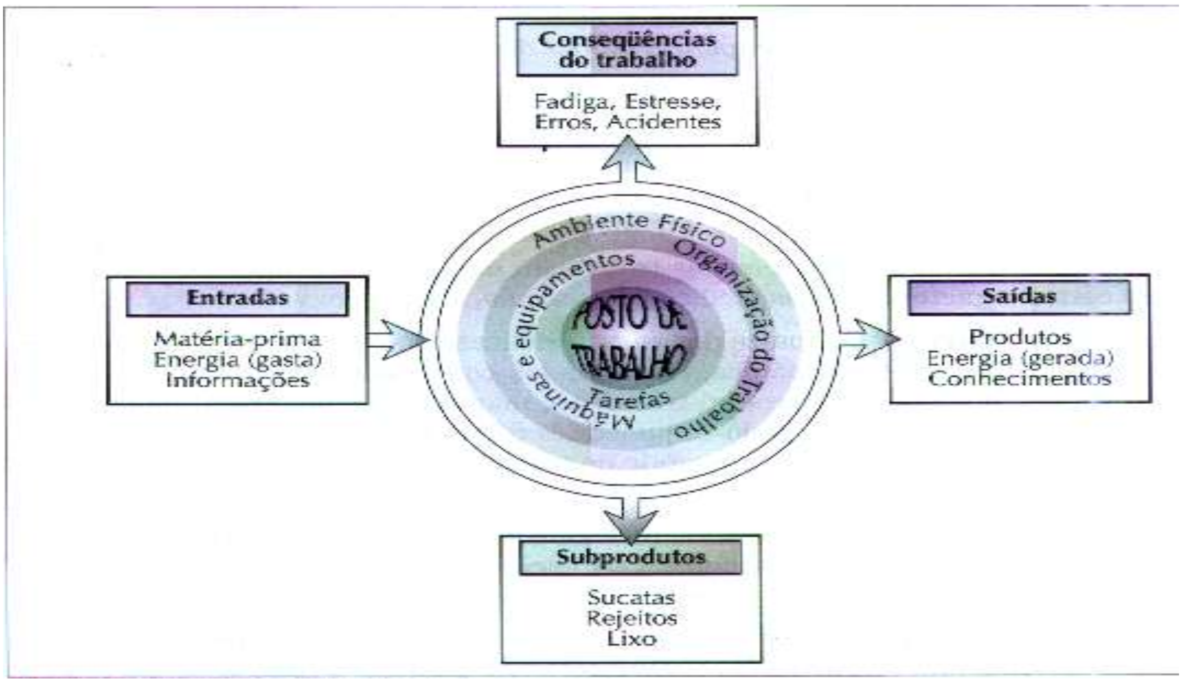


Fig. 1: Several factors that influence the productive system. Source: IIDA, 2002

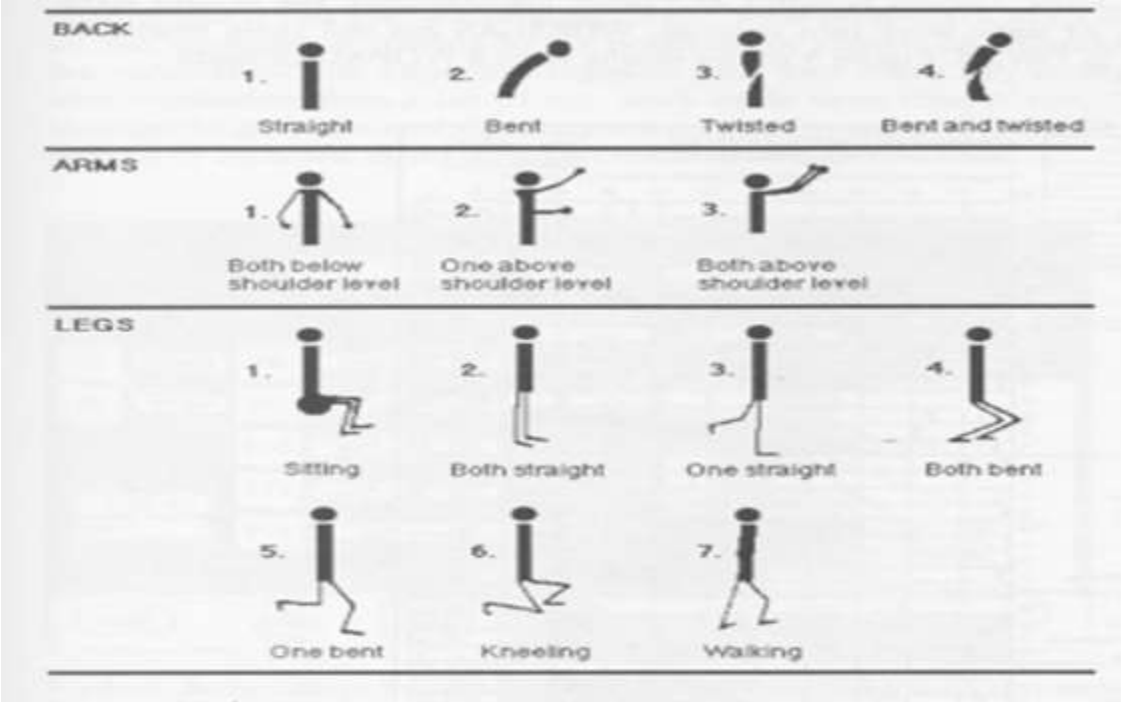
IV. POSTURAL EVALUATION METHODOLOGY OVAKO WORKING POSTURE ANALYZING SYSTEM (OWAS)

The OWAS method was developed by OVAKO OY in conjunction with the Finnish Institute of Occupational Health in Finland, with the aim of analyzing work positions in the steel industry (KARHU et al., 1977a; KARHU et al., 1977b).

In the OWAS method the activity can be subdivided in several phases and later categorized for the analysis of the postures at work. In the analysis of activities, those requiring manual lifting of loads are identified and categorized according to the sacrifice imposed on the worker, although this is not the main focus of the method. Aspects such as vibration and energy expenditure are not considered. Subsequently the postures are analyzed and mapped by observing the photographic records and filming of the individual in a work situation (JOODE; VERSPUY; BURDOF, 2010).

The system is based on analyzing certain activities in variable or constant intervals, observing the frequency and time spent in each posture. Registration can be done through video accompanied by direct observations. In cyclical activities the whole cycle must be observed and in non-cyclical activities a period (CHAFFIN, 2001).

Thus, to register the postures the procedure is to look at the work in general, checking the posture, strength and phase of the work, then look away and perform the recording. It can, therefore, make estimates of the proportion of the time during which the forces are exerted and assumed postures, according to Figure 2 (COLOMBINI, 2005).



Fig, 2: Positions of the back, arms and legs. Source: IIDA, 2005

The combination of the positions of the back, arms, legs and use of force in the OWAS method receives a score that can be included in the Win-OWAS analysis system, which allows to categorize action levels for corrective measures aimed at the promotion of occupational health.

Despite the positions of the back, arms and legs, they should be analyzed and postulated in the Win-OWAS analysis system as shown in Figure 3 (GUIMARÃES & PORTICH, 2002).

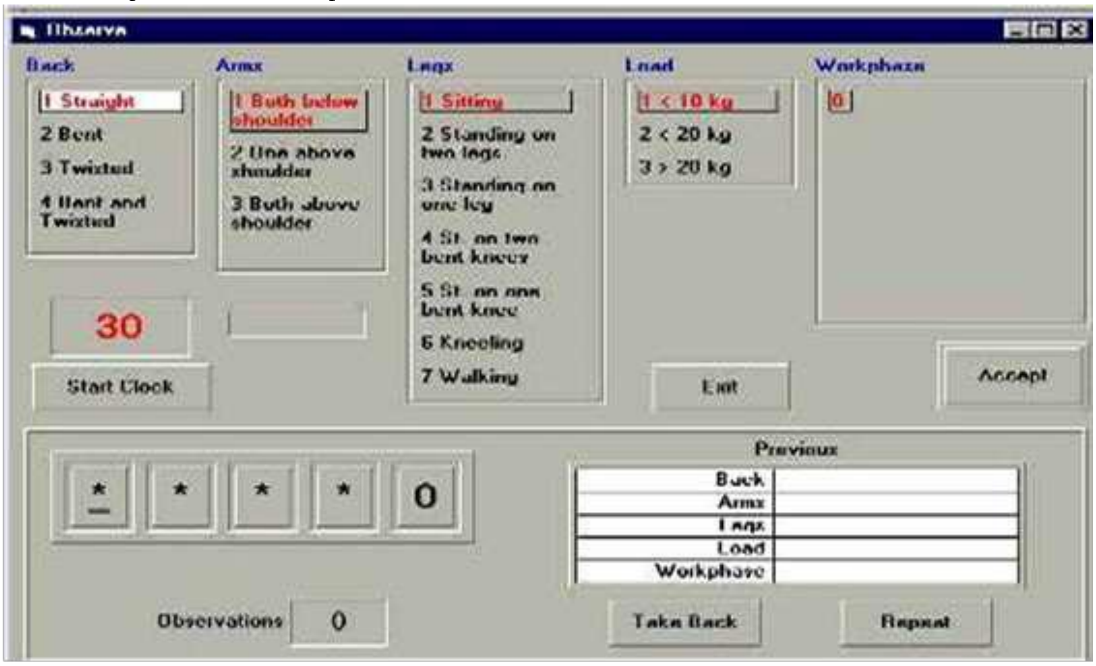


Fig. 3: Win-OWAS analysis system.

V. ANALYSIS OF THE CASE STUDY

The company under study has a historical context of similar emergence to that occurred with the state-owned company Petrolífera do Brasil. Both emerged in the 1950s with the objective of healing the energy crisis that compromised the supply of the three main socio-economic centers in Brazil (São Paulo, Rio de Janeiro and Belo Horizonte, OLIVEIRA, 2007).

At the end of the 50s, the company showed signs of the transformations that would occur from its construction: it started the works of dams and tunnels of diversion of the study plant, acquired equipment for the construction of

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transmission lines and already had fronts of work in full activity (OLIVEIRA, 2007).

Today, the thermoelectric plants present the success of their trajectory and are present in the main Brazilian states:. In addition, it comprises a complex of eleven hydroelectric and two thermoelectric plants, totaling a power of 9919 MW, and also with 19277.5 km of transmission lines and 46 substations, guaranteeing the supply of electric energy in a region where they are located 51% of the Brazilian households and accounting for 65% of the Brazilian GDP (OLIVEIRA, 2007).

The present study was carried out in the mechanical maintenance workshop at the Thermoelectric Plant in the north of the State of Rio de Janeiro. In this environment are developed various risk activities, where are found several heavy industry equipment, such as: an inductive heater, two lathes, a planer, three radial drills, a donut, a band saw, two grinders, a welding machine and three walruses, as shown in Figure 4.

Fig. 4: Furnas mechanical workshop equipment.

The aforementioned equipments, assist the employees of the sector in the development of their work activities. Every day the workshop workers receive a schedule, which includes all the activities they must perform. Among the main activities performed within the workshop, we highlight: repair services in equipment, component welding, replacement of bearings, manufacture of parts for machines, among other activities.

VI. THE IMPROVEMENTS AND IMPLEMENTATION OF THE OWAS METHOD FINAL CONSIDERATIONS

Among the aspects related to the safety of the workers in their workplace, the following irregularities were found in the environment under analysis: excessive noise, poor lighting, excessive heat and inadequate postures.

• Noise - to measure the noise level of the mechanical maintenance workshop, a decibelimeter model ETB-142 was used. Measurement was performed at various points in the workshop, where noise level variations were identified, however, all values found were above 85 decibels. Figure 5 shows one of the measurements.

Fig. 5: Measuring the noise level of the lathe.

The improvement proposed in this aspect for the reduction of the noise level of the environment, caused by the lathes was the replacement of the same ones by more

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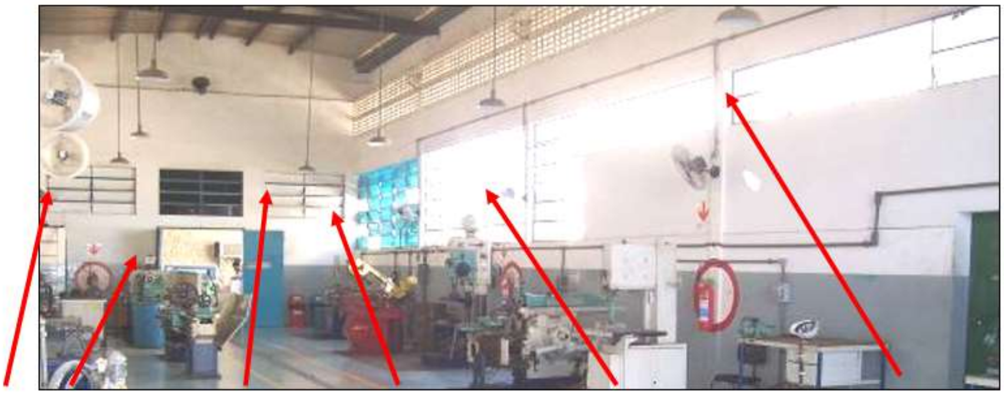

Fig. 7: Ventilation points of Furnas mechanical maintenance workshop

effective modern models. Regardless of the brand to be acquired, during the purchasing process, the responsible person must pay attention to the following characteristics of the lathe:

• Luminosity - for the verification of the luminosity of the environment, a model LD 200 (Digital Lux Meter) was used, as shown in Figure 6. The measurement was made in several points of the workshop, where it was verified places with light deficiency.

Fig. 6: Measuring the brightness near the grinder

ABNT, through Brazilian Standards of Regulation (BSR), establishes minimum illuminance values for activities that require artificial lighting. As for the noise of the machines, it becomes a bit more complicated, given the difficulty and often impossibility of reducing the noise of a machine.

The improvements implemented in relation to the low luminosity detected in some points of the workshop, so that new reflectors are installed in the environment, replacing the lamps with other ones of greater power,that would allow a greater illumination of the environment.

• Heat - Due to the unavailability of an appropriate instrument, it was not possible to measure the temperature of the mechanical maintenance workshop. However, it can be observed that the environment under analysis is too hot, thus compromising the comfort of the employees who need to work in this sector. Two factors were detected as being the preponderant factors for the thermal discomfort situation of this site. They are: reduced points for air intake and low efficiency fans. Figure 7 illustrates the ventilation points of the workshop and the installed fans.

NR-17 establishes in one of its subitems the interval considered as acceptable for the temperature of a working environment (20 and 23 degrees Celsius), which would provide a greater sense of comfort for the workers (MINISTRY OF WORK 2002).

Thus, in order to increase the ventilation of the environment, promoting a more pleasant climatic condition for the employees of the sector and passers of the same, an alternative would be the installation of new extractors in the workshop.

Among the aspects related to the ergonomics of the workers in their work place, it was found irregularity in the environment under analysis with regard to the posture of the workers when carrying out their work activities. It was found that these assume inadequate postures resulting from improper design of construction of some machines and accessories present in the workshop. Figure 8 demonstrates some erroneous positions taken by workers.

Fig. 8: Incorrect worker posture.

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By assuming inadequate postures for a long period of time, employees are at serious risk of suffering from severe localized pains in the muscles that are required to maintain these postures.

Through the application of the Ovako Working Posture Analyzing System (OWAS) and the Nordic questionnaire, it was possible to identify the main postures assumed during the development of the activities, as shown in Figure 9 (a) and (b).

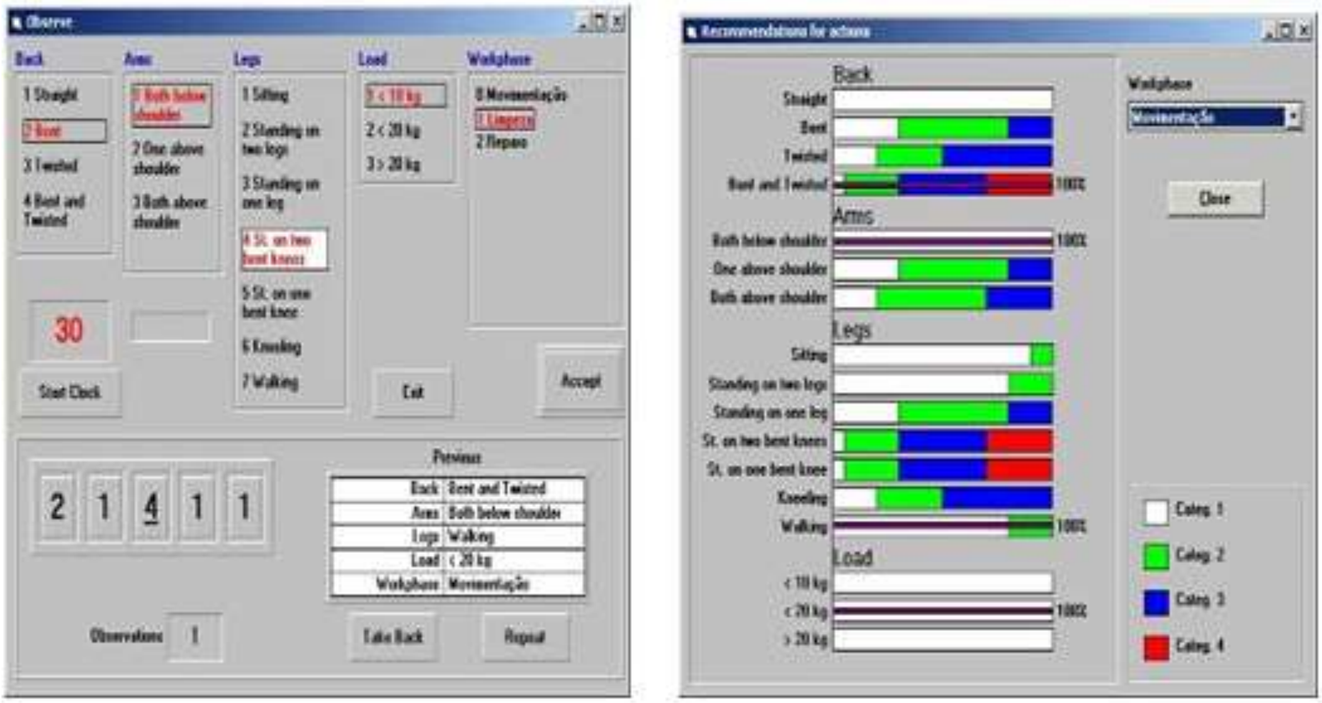

Fig. 9 (a) and (b): Analysis of the posture of the grinder worker.

Legend:

Valuation of positions by the OWAS method

- Class 1 - Normal posture dispenses care, except in exceptional cases.
- Class 2 - Posture that should be verified in the next revision of working methods.
- Class 3 - Posture that should merit attention in the short term.
- Class 4 - Posture that should receive immediate attention.

The graphs above show that during the movement of the equipment the backs of the platform auxiliaries are subject to an excessive effort that deserve attention in the very short term, since it falls into category 4. This situation may require interruption of the work immediately.

In this way, it is essential to verify the relation of cost and benefit of the new projects. From this analysis, it was possible to analyze the investments needed to implement the changes and the other the tangible and intangible benefits that it will provide.

Also, in the characterization of the organization of the work tasks were divided according to the area of specialization, in the case studied the organization was made by specialties that focused on the mechanics team and fit the theory of Taylorism. Communication takes place in a direct (verbal) and indirect way through service or electronic mail.

VII. FINAL CONSIDERATIONS

Thus, after applying several analyzes in the thermoelectric power plant, it is believed that the attention to the results by the company will allow a higher return than the investment, given that through the proposals presented, it is possible to know where the problems are and to act in order to minimize work accidents, thus avoiding the loss of time in operations, promoting greater employee satisfaction and commitment, all of this through a relatively low investment. However, two aspects related to cost / benefit analysis must be considered: investment risks and intangible factors. Investment risks are related to uncertainties that occur unexpectedly and produce unforeseen results. The intangible factors would be those that are not quantifiable in monetary terms.

Once the environmental analyzes have been carried out and the new implementations have been proposed, it is hoped that there will be a reduction in the rate of accidents at work in this workshop. In this way, it can be concluded that by putting in practice the implements proposed in this work, several improvements in the mechanical maintenance workshop can be glimpsed, promoting greater satisfaction, comfort and, above all, safety of workers.

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