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ERGONOMIC RISK ANALYSIS WITH THE USE OF ERGONOMIC GUIDES

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Abstract: This project was developed in a harness manufacturing company. Its objective was to identify the level of risk and the factors that were causing musculoskeletal problems in the 7 production lines. The movements, postures and activities of each operator in their work areas were observed, analyzing 453 workstations and prioritizing them with ergonomic evaluation techniques such as visual analysis and Ergonomic Risk Factor Checklist (RFC). A total of 439 stations were found within limits or without ergonomic risk, while 11 were found in risk limits and 3 out of limits. The 14 stations at ergonomic risk were evaluated using the Rapid Upper Limb Assessment (RULA) method and the company's official ergonomic guidelines to identify and correct the problems that were present. In the most critical station it was concluded that the operator had poor posture and did not follow the work method, correcting with retraining and training, reducing safety and production problems on the line, increasing the welfare of workers and creating a culture of validation of workstation designs according to the company's ergonomic guidelines.
Keywords: Ergonomics, Ergonomic risk, Ergonomic guidelines, RULA, RFC, RFC

INTRODUCTION

Ergonomics etymologically comes from the Greek "ergo" which means work, activity and from "novos" which means rules, it can be said that ergonomics is the study of work, being in charge of elaborating the rules or principles by which it should be governed. Some of the objectives of ergonomics is to analyze the working conditions related to the physical work space, thermal environment, noise, lighting, vibrations, working postures, energy wear, mental workload, nervous fatigue, workload and any situation or condition that endangers the health and welfare of the worker (González Maestre. 2007).

Ergonomics presents major challenges, mainly in mass production companies such as the automotive industry. One of them has been the study of human interaction with respect to the physical requirements of work such as posture, strength and movement. Once the work requirements are beyond the worker's capacity to respond, the worker does not recover physically and/or biologically, this is when these requirements are associated with the presence of work-related musculoskeletal injuries representing a health problem (Miroljub.) 2002).

Work-related musculoskeletal disorders are disorders of body structures such as muscles, joints, tendons, ligaments, nerves, bones and the circulatory system, caused or aggravated mainly by work and the effects of the environment in which they occur. Most are cumulative disorders resulting from repeated exposure to more or less heavy loads over a prolonged period of time (European OSHA, 2007). Both cumulative trauma and work-related repetitive movements are the cause of multivariate pathologies that have their seat in the neck, shoulder, elbow, arm, forearm and hand (Serrano, 2004).

Osteomuscular injuries of occupational origin are considered one of the most frequent diseases that affect workers of all sectors and all trades, depending on the condition in which the worker is, they can cause permanent or temporary disabilities. It has been evidenced over the years through various studies that musculoskeletal injuries are problems caused and/or aggravated by a series of occupational factors such as force activities, repetitive movements, static muscle load, inadequate posture of the body. In general, these are associated with overuse of different parts of the body and can also be associated with non-occupational and environmental factors (Alfonso Vargas et al 2017).

The company seeks to increase the safety and well-being of workers by improving the ergonomic process, workstation design and work methods. The process improvement should be able to create a culture of validation of workstation designs following ergonomics guidelines, and using techniques such as RULA and RFC. A correct application of techniques and the implementation of improvements avoid diseases and occupational hazards, greater comfort in the work area, reducing disabilities, fatigue, resignations, achieving greater safety, productivity and product quality. Its use is based on specific needs and conditions of the activity being developed and evaluated, where specific and relevant work factors are chosen.

Checklists, commonly known as "checklists", are the first and most common tool used to review the ergonomic risk conditions to which a user is subjected while performing an activity. They have the advantage of being quick and easy to use, and provide preliminary information that allows the identification of the main areas or risk conditions to which a user is subjected when performing an activity. They have the advantage of being quick and easy to use, and provide preliminary information that allows identifying the main risk areas or conditions to be evaluated in greater detail.

RULA was developed in 1993 by McAtamney and Corlett of the Institute of Occupational Ergonomics in England and the University of Nottingham. The RULA assessment method is based on observation and uses diagrams of body postures to which it assigns a score that reflects exposure to the risk factors assessed by the method; the classification and scoring of each assessed part is based on studies by various authors, as well as health guidelines and standards. It is mainly focused on the analysis of tasks performed with the upper limbs of the body, although later corrections to the initial version include some very basic evaluation points of the support and form of weight distribution on the legs of the person performing the task (Martínez de la Teja, G. 1996).

DESCRIPTION OF THE METHOD

PROBLEM *STATEMENT*

Taking into account that in the company under study, there have been some qualified occupational diseases and an increase in the symptoms associated with muscular ailments, related to ergonomic risk factors, it was considered necessary to conduct an ergonomic assessment to determine the level of specific risk and identify the hazards to which the company's workers are exposed, considering how they perform the functions in charge and the design of jobs that allow establishing a prevention of occupational diseases associated with ergonomic risk, encouraging self-care and informing about the importance of certain work habits. The ergonomic evaluation will be carried out by means of methodological techniques, in this case ergonomic evaluation methods such as visual analysis, RFC, RULA, which allow identifying problems in the practices and proposing corrective actions that benefit the company and its employees.

MATERIALS AND METHODS USED

Programs Used

- Gom Media Player® 2.2.57.5189 (2014), is a program that allowed to split videos into frames, this is useful when performing the task analysis. Since it allows you to enter the time interval in which you want to obtain the frames.

ERGONOMIC EVALUATION PROCEDURE

The people in the study were chosen by a convenience sample. The movements, postures and activities of each operator in their work area were observed, analyzing the risks based on the different ergonomic guidelines in force and a visual analysis. Once the task was analyzed, they were classified according to the type of risk present in the station in order to prioritize those with the highest risk, determining the level of risk of musculoskeletal disorders and the factors that are causing problems in the line through an analysis with ergonomics techniques, developing an ergonomic risk map in module 1, Table 1 shows the initial results of the visual analysis.

Workstation	Within limits	In limit	Out of bounds	Total
Corolla 150 L2	60	2	2	64
Floor 1 RAV4	79	2	1	82
Floor 2 RAV4	63	2	0	65
Corolla 150 L1	59	2	0	61
Corolla Miscellaneous	100	1	0	101
RAV4 Miscellaneous	8	1	0	9
SLP	70	1	0	71
Totals	439	11	3	453

Table 1. Results of visual analysis

The visual analysis of station 29 is shown in Table 2, for which all the steps performed by the operator during her work were observed and it was determined that she had bad posture when taping the back of the board because she was leaning too much, which determined that the station was out of guides.

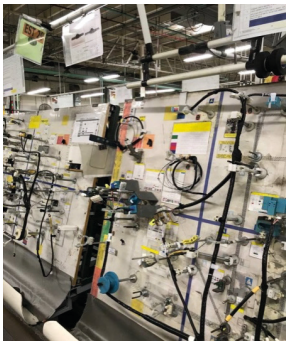

Figure 1.
Station 29

Figure 2.
Station 29

The analysis of the tasks of station 29 is the core of the study, it was performed by taking a video of a minimum duration of 10 minutes taken from several different angles, the video was decomposed into 200 frames using a program called GomPlayer, for this it is necessary to transform the duration of the video in seconds and divide it by 200 to obtain the interval for each frame, A random sample of 100 frames was taken from the 200 frames obtained, this sample will be divided into subtasks, the subtasks with a percentage greater than 10% to the duration of the frame, will be applied an ergonomic evaluation, with the RFC and RULA method.. Figure 3 and 4 shows a back and leg angle of 49° and 216° respectively. The RFC analysis of the back and leg postures of station 29, shift A, is shown in Table 3.

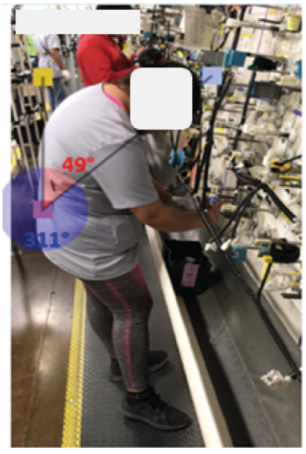

Figure 3. Back measurement

Figure 4. Leg measurement

CHECKLIST DE POSTURA

ID del trabajo

POSTURA CORPORAL GENERAL/PIERNAS		No	Menos de 1/3 Ciclo	Más de 1/3 Ciclo	Tarea(s)
1a.	De Pie Estático	○	○	✓	
1b.	De Pie Estatico Sin Tapete	○	○	✓	
2.	Usando pedal mientras está de pie	○	✓	*	
3.	Tendido en parte posterior o lateral	○	✓	*	
4.	Arrodillado	○	✓	*	
5.	Rodillas dobladas o en cuclillas	○	✓	*	

POSTURA DEL TRONCO		No	Menos de 1/3 Ciclo	Más de 1/3 Ciclo	Tarea(s)
6.	Flexión hacia adelante suave >20°	○	✓	*	
7.	Flexión hacia adelante severa >45°	○	*	*	
8.	Flexión hacia atrás > 20°	○	✓	*	
9.	Torsión o flexión lateral > 20°	○	✓	*	

Table 3. RFC analysis legs and trunk Station 29

The neck and forearm postures of shift A were also analyzed (Figures 5 and 6), showing an angle of 70° in the neck and 120° in the forearm. Table 4 shows the RFC analysis for neck and forearm.

Figure 5. Neck Station 29

Figure 6. Forearm Station 29

POSTURA DEL CUELLO		No	Menos de 1/3 Ciclo	Más de 1/3 Ciclo	Tarea(s)
10.	Flexión hacia adelante suave >20°	○	○	✓	
11.	Flexión hacia adelante severa >45°	○	✓	*	
12.	Flexión hacia atrás > 20°	○	○	✓	
13.	Torsión o flexión lateral > 20°	○	✓	*	

CHECKLIST DE EXTREMIDADES SUPERIORES Job ID
(Continuación)

POSTURA		MANO IZQUIERDA No	MANO IZQUIERDA Menos de 1/3 Ciclo	MANO IZQUIERDA Más de 1/3 Ciclo	MANO DERECHA No	MANO DERECHA Menos de 1/3 Ciclo	MANO DERECHA Más de 1/3 Ciclo	
10.	Se usa una pinza?	○	✓	*	○	✓	*	
11.	Hay desviación en la muñeca?	○	✓	*	○	✓	*	
12.	Hay torcedura, rotación o aprietamiento del antebrazo?	○	✓	*	○	✓	*	

Table 4. RFC analysis neck and forearm Station 29

After analyzing by the RFC method, it was determined that there is a high ergonomic risk index in the operator's neck and lower extremities posture. The arm, wrist, trunk, trunk, neck and leg postures were also analyzed using the RULA method. The analysis with the RULA method is presented in Table 5.

CONCLUDING REMARKS

SUMMARY OF RESULTS

Station 29 resulted in a final score of 5 (medium to high potential risk) according to the RULA method, indicating that it should be further studied and modified soon. In the most critical station, it was concluded that the operator presented poor posture and did not follow the work method, correcting with retraining and training, reducing safety and production problems on the line, increasing the welfare of workers and creating a culture of validation of workstation designs according to the company's ergonomic guidelines. After the study, the ergonomic guidelines were applied in station 29, remaining in yellow (Table 6). Figure 7 shows the modification of postures in station 29 after the implemented changes.

Y	Cuando este en el limite superior de la guia y tiende a salirse de control
R	Fuera de guia
G	OK

	NOMBRE DEL PROCESO	NUMERO DE ESTACIONES	STATUS				
			VISUAL	GUIAS	PUNTOS FUERA DE GUIAS	REANALISIS	COMENTARIOS
	EST 29	1	R				MALAS POSTURAS

Table 2. Visual Analysis Station 29

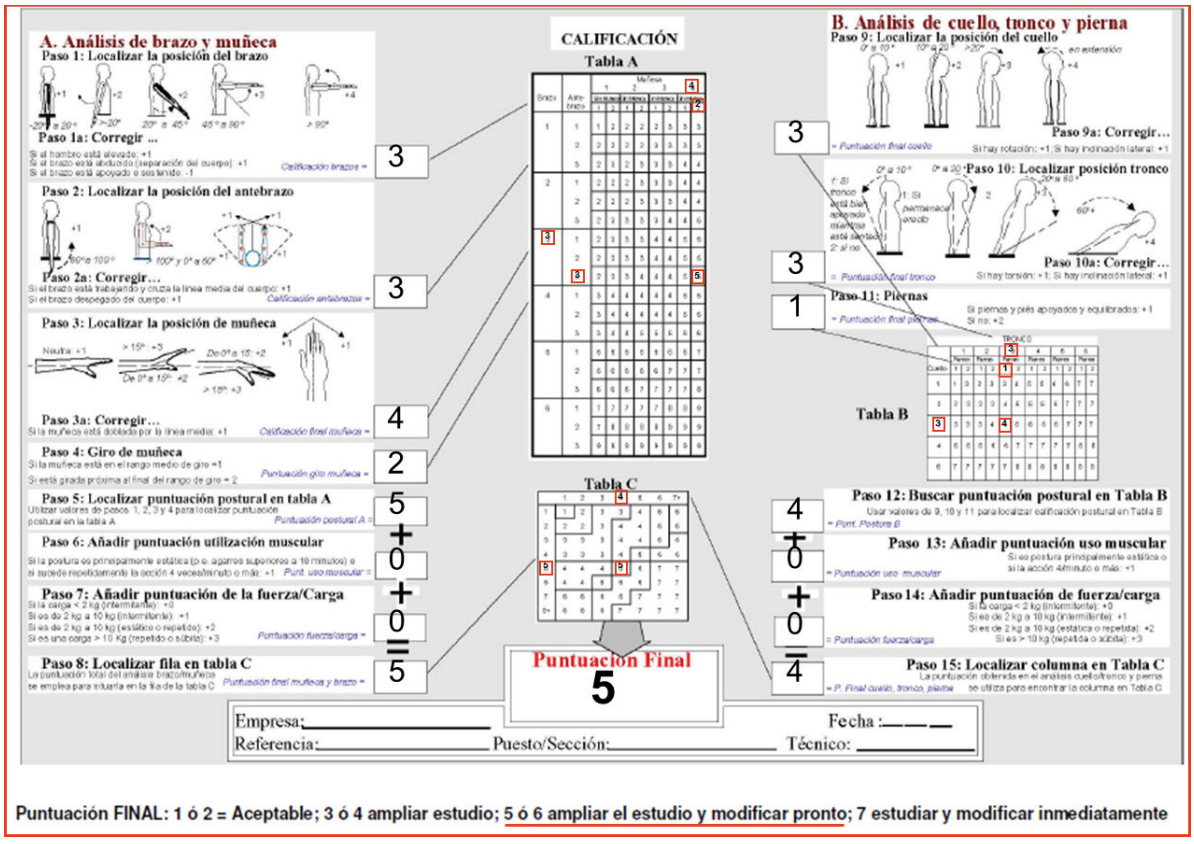

Table 5. Analysis with the RULA method

Y	Cuando este en el limite superior de la guia y tiende a salirse de control
R	Fuera de guia
G	OK

	NOMBRE DEL PROCESO	NUMERO DE ESTACIONES	STATUS				
			VISUAL	GUIAS	PUNTOS FUERA DE GUIAS	REANALISIS	COMENTARIOS
	EST 29	1	R	Y			MALAS POSTURAS

Table 6. Analysis Ergonomic guides station 29

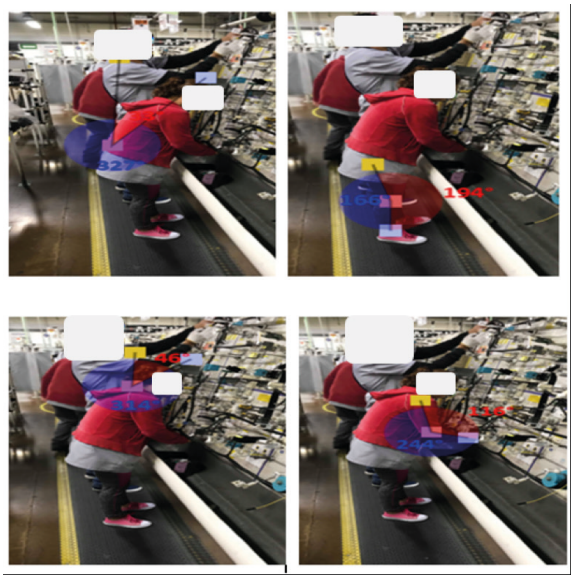

Figure 7. New positions Station 29

Table 7 shows a comparative measurement of trunk, leg, neck and forearm angles before the ergonomic analysis and after the improvements made, as well as the reductions in angles of the selected positions.

	Angle measurement			
	Trunk	**Legs**	**Collar**	**Forearm**
Before changes	49°	216°	70°	120°
After changes	33°	194°	46°	116°
Reduction degrees	16°	22°	24°	4°

Table7. Reduction in selected positions

CONCLUSIONS

The risk factors associated with the present study show that maintaining forced postures of bending and muscle tension, as well as reaching for objects in distant places in the workstation represent a greater risk of musculoskeletal injuries during the activity. The use of ergonomic techniques and guidelines allows the detection of real and potential risks to be corrected and improved. The results of the study show that musculoskeletal injuries are related to work overloads. This justifies the use of surveillance and prevention programs to maintain and/or increase labor productivity as a result of ergonomic improvements to perform repetitive tasks, in addition to reducing lost time in the workday, temporary or permanent disability, considerably reducing health costs and workers' compensation, making organizations more profitable.

WORK IN PROGRESS

It is recommended to extend the analysis to the two modules of the plant, preparing a risk map indicating critical work stations and their respective correction, as well as including risk factors related to human behavior such as smoking, alcoholism, physical activity and anthropometry, among others.

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