Ergonomic evaluation in driveshaft manufacturing, tool room area.

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Abstract

In GKN Inc. Celaya, exists the tool room, there the equipment that is used by the maintenance is reviewed and fixed; the ergonomics evaluation was directed to this area. The activities more commons are the milling and lathing, these activities show the highest incidence of muscle-skeletal injuries, such as low back pain, neck and shoulder. In order to realize the ergonomics diagnosis in the tool room, it was applied the LEST method; to get the ergonomic physics evaluation in the activities of milling and lathing it was applied the RULA method considering the significant postural changes of the activity progress. The results of LEST method shown that static load, dynamic load and noise had 10 points, time demands 8.5 points, lighting and relation with the head 7 points and the thermal environment with 6 points. The RULA method show final punctuations of 6 and actuation level of 3, for both activities evaluated. According with the results, it was determinate in both activities has a poor design and show a lack of process document, and both are generating muscle-skeletal injuries to the workers.

Keywords: work place, muscle-skeletal injuries, lathing, milling.

Resumen

En la empresa GNK Celaya, existe el área de maquinas-herramientas, ahí el equipo que es usado por las cuadrillas de mantenimiento es revisado y reparado; la evaluación ergonómica fue centrada en esta área de la empresa. Las actividades más comunes son el torneado y el fresado, estas actividades presentan la más alta incidencia de lesiones musculo-esquelética, tales como dolor de espalda, cuello y hombros. Para realizar el diagnostico ergonómico en el área de maquinas-herramientas fue aplicado el método LEST, y para realizar la evaluación física de las actividades fue aplicado el método RULA considerando los cambios importantes de posturas durante el desarrollo de las actividades de fresado y torneado. Los resultados del método LEST mostraron que la carga estática, carga dinámica y el rudo obtuvieron puntuación de 10, el tiempo de

trabajo obtuvo 8.5, la iluminación y la relación con el mando obtuvieron valores de 7, y el ambiente térmico obtuvo 6 puntos. El método RULA obtuvo puntuaciones finales de 6 y niveles de actuación de 3 para ambas actividades evaluadas. De acuerdo con los resultados, se puede concluir que en ambas actividades no se diseñó la estación de trabajo, muestran falta de documentación en sus procesos y ambas actividades están generando molestias musculo-esqueléticas en los trabajadores.

Palabras clave: estación de trabajo, lesiones musculo-esqueléticas, torneado, fresado.

1. INTRODUCTION

Company GKN Driveline is a factory of the area metallurgical industry/, automotive branch, which makes driveshafts, the facrory is located in Pan-American highway km 284, in Celaya, Gto. It is supplier of the following cars manufactures: Toyota, Honda, Wolkswagen, GM, Ford, Chrysler, Renault, among others. At the moment it has 1.700 employees and it includes an approximated area of 30 hectares.
This investigation concentrates in the area of forge, specifically in the area of machine-tools, where punches and matrixes are elaborated.

The evaluated activities were turned and milled. The aims were directed towards the obtaining risk index in the positions that the workers adopt when they doing the mentioned activities. The description of the positions that the workers realize shows in the following images:

Figure 1. Lathing operation

The piece that handles in the turning and the milled is a punches and its weight oscillates between 10 and 15 kg. The punch is showed the following image.

Figure 2. Punches

The methods of ergonomic evaluation LEST and RULA were applied. The obtained results were considered for the improvement of the work methods and the design of devices that help the diminution of the ergonomic risk index, such as: aids for load and unloading of tools and modification of height of work tables and machines.

2. MATERIAL Y METHODS

2.1 Activities evaluated

In the tool room there are 10 workers, all of them male, the rank of ages is 22 to 38 years, the rank of statures of 1,60 to 1,74 meters, the average of antiquity is 15 years in the factory, where 5 of them realize the turning and the other 5 milling.

Some of the positions realized during the operations are the following.

Figure 3. Lathing and milling activities.

2.2 LEST method

The method Lest was developed by F. Guélaud, M.N. Beauchesne, J. Gautrat and G. Roustang, members of the Laboratoire d'Economie et Sociologie du Travail (L.E.S.T.), of the C.N.R.S., in Aix-in-Provence in 1978 and it carries out the evaluation of the conditions of work in the possible more objective and more global way, a final diagnosis that indicates if each one of the situations considered in the position is satisfactory, bothersome or noxious.

The method is of global character considering each aspect of the position of work in a general way. It is not deepened in each one of those aspects, a first valuation is only obtained to determine if a deeper analysis is required with specific methods. The objective is, according to Guelaud (1977), to evaluate the group of relative factors to the content of the work that it can have repercussion so much about the health as envelope the personal life of the workers. Before the application of the method they should have been considered and resolved the relating labor risks to the Security and Hygiene in the Work because they are not contemplated by the method.

The information that is necessary to pick up to apply the method has a double objective-subjective character. On one hand quantitative variables they are used as the temperature or the sound level, and for other, it is necessary to pick up the worker's opinion regarding the work that he/she carries out in the position to value the mental load or the aspects psychosocial. Guelaud, 1997.

The valuation given and dimensions and factors considered by the method LEST is shown in the following charts.

Table 1. Valuation and Meaning in LEST method

Color and punctuation	Meaning
0, 1, 2	Satisfactory situation
3, 4, 5	Weak annoyances
6, 7	Average annoyances. Risk of fatigue exists.
8, 9	Strong nuisances. Fatigue exists
10	Harmfulness

Table 2. Dimensions and factors in LEST method

	DIMENSIONS				
	PHYSICAL LOAD	PHYSICAL ENVIRONMENT	MENTAL DEMANDS	PSYCOSOCIAL DEMANDS	TIME DEMANDS
FACTORS	Static load	Thermal environment	Time pressure	Iniatitive	Time demands
	Dynamic load	Noise	Complexity	Social Status	
		Ilumination	Attention	Communication	
		Vibrations		Relation with the head	

2.3 RULA method

To get the evaluation of the positions adopted by the workers when they doing its work, it was decided to apply the method of ergonomic evaluation RULA, because this one allows to evaluate the exhibition of the workers to risk factors that can cause muscle-skeletal injuries in the members superiors of the body.

Some of the factors analyzed within this method were the positions, the repetitively in the movements, the applied forces, the static activity of the system skeletal muscle, among others (Corlett, 1993).

Method RULA divides the body in two groups, the group A that it includes the members superiors (arms, forearms and wrists) and the group B, that includes the legs, the trunk and the neck. By means of the tables associated to the method, a score is assigned to each corporal zone (legs, wrists, arms, trunk…) for, based on these scores, to assign global values to each one of the groups A and to B.

The key for the allocation of scores to the members is the measurement of the angles that include different from the body of the worker. The method determines for each member the form of measurement of the angle. Later, the global scores of the groups A and B are modified based on the type of developed muscular activity, as well as of the force applied during the accomplishment of the task. Finally, the final score from these modified global values is obtained.

The final value provided by method RULA is proportional to the risk that entails the accomplishment of the task, so that high values indicate a greater risk of appearance of muscle-skeletal injuries. The method organizes the final scores in action levels that orient the analyst one on the decisions to take after the analysis. The proposed levels of action start of the level 1, this meaning that the evaluated

position is acceptable, the highest level is 4, which indicates the urgent necessity of changes in the activity.

The possible results offered by RULA are divided in four levels, which depend directly on the risks reached about the developed activity. The following chart shows the different levels and the action need for each level.

Table 3. Levels and meaning in RULA method

Level	Meaning
1	When the final score is 1 or 2, the posture is acceptable
2	When the final score is 3 or 4, changes in the task are necessaries; is convenient to do a deeper analysis.
3	The final score is 5 or 6. A redesign in the task or method work is necessary.
4	The final score is 7. Changes in the task or work station are urgent.

Fuente: http://www.ergonautas.upv.es/metodos/rula/rula-ayuda.php

The obtained data was processed by means of web page developed by the Polytechnic University of Valencia, Spain; it can be consulted in Internet web page www.ergonautas.com for RULA and LEST methods.

3. RESULTS

Next, the graphics of the application of LEST and RULA methods in tool room are showed is separated sections.

3.1 LEST method application

With respect to the analysis of the workstation by means of the diagnosis conducted by method LEST the following graph was obtained, considering the operations of turning and milling is in the same work area, reason why this diagnosis is applicable for both operations:

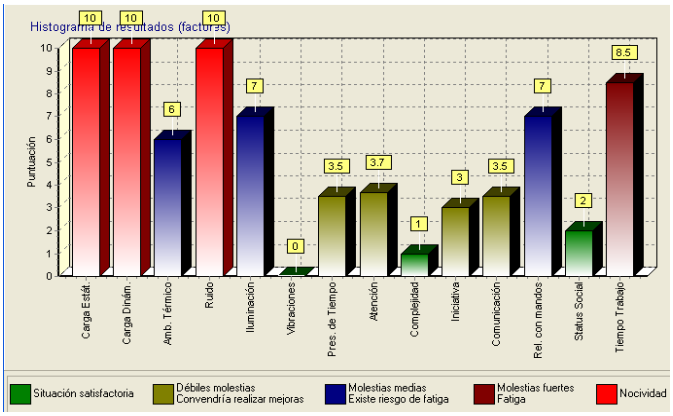

Figure 4. LEST method results. Factors.

It is possible to observe that the static and dynamic load are factors considered with high risk, due to the workers must to maintain a weight approximated of 15 kg., between load and unloading, which represents that at the end of the labor day, the operator has loaded an accumulated gross weight of 1200 kg.

Also, the noise got the highest score (10 points), this due to the level of noise oscillates between 85 and 95 dB among the labor day, this can be equivalent to the noise generated by a dryer of hair in her maximum scale or by the alarm-clock in a continuous time of 8 to 12 hours.

The time demands is a risk factor, obtained a score of 8.5 points which is considered like fatigue, a typical duration is almost 12 hours in a common labor day, obviously this situation can cause a chronic fatigue in the workers.

The following chart, show results of the dimensions considered by the LEST method.

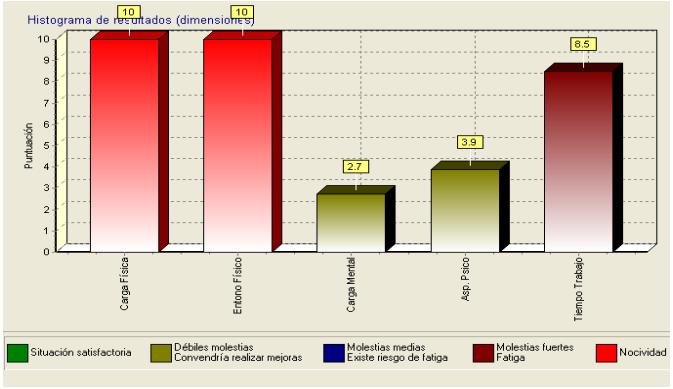

Figure 5. LEST method results. Dimensions

3.2 RULA method application

The following chart shows the results for milling operation in the RULA method application.

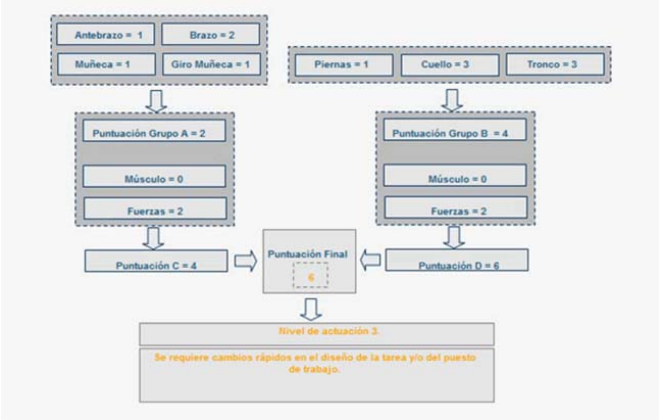

Figure 5. RULA results. Milling operation

The following chart shows the results for lathing operation in the RULA method application.

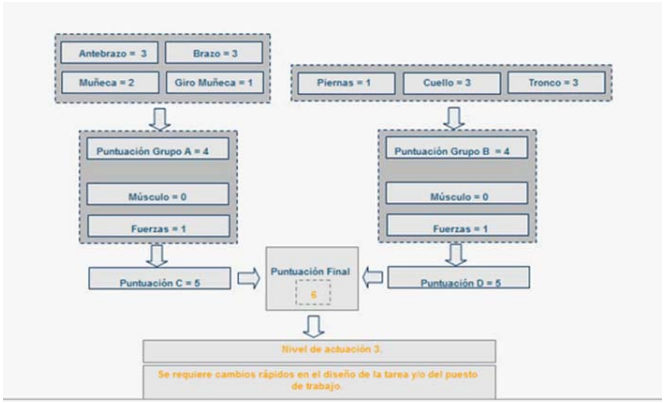

Figure 6. RULA results. Lathing operations.

4. DISCUSSION AND CONCLUTIONS

The factors that showed a higher index, according to the LEST graph, were: static load, dynamic load, noise and time demands. The factors that showed an intermediate index were: thermal environment, illumination and the relation with the head. On the contrary, the factors of smaller index were: vibrations, complexity and social status.

Referring us to the factors of greater index of ergonomic harmfulness, it is possible to said that, due to the weight of the tools (12 to 16 kg.) and the frequency of load and unloading (for turning, each half an hour; milling, every 4 hours), in both options, static and dynamic load, resulted with the highest risk index, in this case 10 points of score in the LEST method which is considered like injurious.

Too, the noise got the highest score of risk (10 points), this due to the combination of two important radiant bodies: the machines in the tool room and the presses of the forging area which is next to the tool room. Finally, time demands were factor of injurious risk because regularly they must work overtime, which cause an excessive extension of the labor day, typically until of 12 hours.

The graphic resultants of the application of method RULA show a 6 final score and an action level of 3 for both evaluated activities. In the case of the milling, the parts of the body with greater score was the arm, neck and trunk with scores of 2, 3, and 3 respectively; in turning, the parts with greater score were the forearm, arm, neck and trunk, all of them with scores of 3.

Para mejorar las condiciones de trabajo en las actividades evaluadas, se realizaron las siguientes propuestas para modificar las estaciones de trabajo.

En la actividad de torneado, se propone la siguiente modificación:

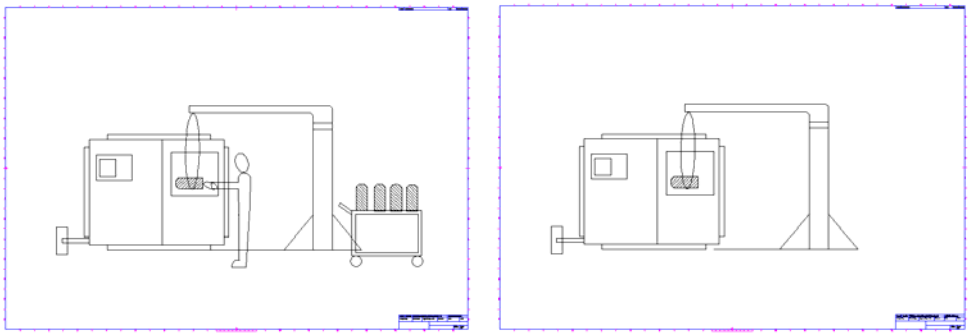

Figure 7. Modification of work station for lathing operation.

With this modification, the weight that loads the worker at the time of realizing the lathing of the punches will be reduced significantly.

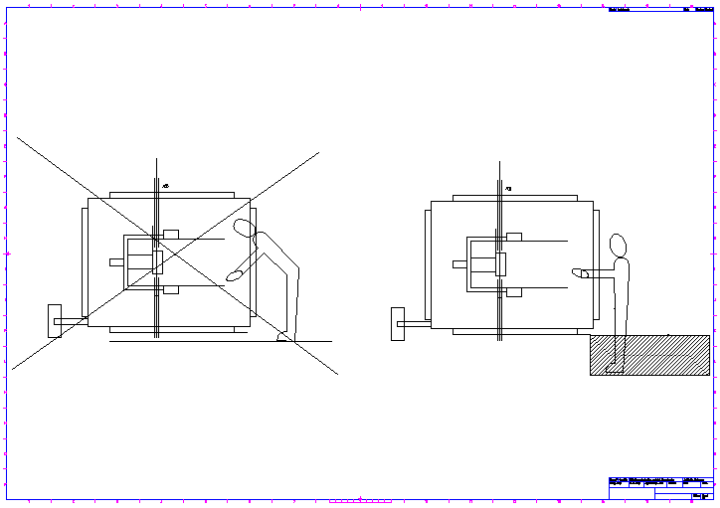

Figure 8. Modification of work station for milling operation

With this modification in the work station, the inclination that the worker realize at the time of doing the milling operation will be reduced and with that the incidences of injuries in the back will be able to be reduced.

5. REFERENCES

McAtamney, L. Y Corlett, E. N., 1993, RULA: A survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics*, 24, pp. 91-99.

NTP 175: Evaluación de las condiciones de trabajo: el método L.E.S.T. Instituto Nacional de Seguridad e Higiene en el Trabajo. Ministerio de Trabajo y Asuntos Sociales. España.

RULA method online: http://www.ergonautas.upv.es/metodos/rula/rula-ayuda.php

LEST method online :
http://www.ergonautas.upv.es/metodos/lest/LEST_online.php