APPLICATION OF RULA METHOD FOR THE REDESIGN OF A HANDTOOL

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INTRODUCCIÓN. Este proyecto se elaboró en una panadería, en donde se elaboran panes, como donas, conchas, bollos, entre otros. Para la elaboración de la dona se utiliza una herramienta de mano de con lámina galvanizada, en forma de dona, con un diámetro de 10 centímetros; la utilizan los trabajadores, tomándola con la mano extendida, abarcando la forma del diseño, para poder golpear el molde sobre la masa y formar las donas. **OBJETIVOS:** Rediseñar una herramienta de mano, la cual será utilizada en la elaboración de donas, en una panadería establecida en la Ciudad de Los Mochis, Sinaloa. **METODOLOGÍA**: 1.- Se Identificaron 75 personas que participan en el área de producción (puestos rotativos). 2.- Se aplicó la evaluación del método RULA, se tomaron fotos y video de lo observado mientras se realizaba el trabajo. Se aplicó la evaluación, resultando un nivel 5 (5 o 6 investigación futura y cambio pronto); es necesario hacer una investigación y el rediseño.3.- Se toman las medidas antropométricas de los trabajadores y en base a esto se elabora el rediseño ergonómico.4.- Se elaboró el prototipo del rediseño, observando la reacción de los trabajadores al momento de su utilización. 5.- Se aplicó nuevamente el método RULA, para la mejora de resultados obtenidos por el rediseño, tomando fotos y video de lo observado. 6.- Se realizaron ajustes necesarios. Se ajustó la altura de la mesa a una medida estándar para mayor comodidad del trabajador. **RESULTADOS: S**e aplicó la evaluación RULA antes del rediseño, dando un resultado de 5. Fue necesario hacer una investigación y cambiar el rediseño de la herramienta. Una vez que se trabajó con el rediseño de la herramienta de mano, se evaluó el rediseño resultando un nivel de 2; siendo un nivel aceptable (1 o 2 Aceptable). **CONCLUSIONES:** Utilizando el método RULA, con fotos y videos, se logró rediseñar la herramienta de mano, la cual provocó una notable mejoría en los trabajadores al momento de su uso. La herramienta de mano para hacer donas, está rediseñada para cualquier persona, logrando que sea una herramienta de mano ergonómica.

Palabras claves: herramienta de mano, evaluación ergonómica, panadería,

INTRODUCTION. This project was developed for a bakery in Los Mochis city, Sinaloa, in which a variety of breads, are made as donuts, shells, rolls, among many others. Particularly for baking donuts is a tool of hand made from galvanized sheet, in the form of donuts and with a diameter of 4 in; This tool is used by workers taking it extended hand covering the shape of the design, to be able to hit the mold on the mass and to create donuts. **OBJECTIVES**: Redesign a hand tool, which will be used in the preparation of donuts, in a bakery established in Los Mochis city. **METHODOLOGY:** 1. Identified 75 participants in the area of production (which these posts are rotating). 2. Applied the evaluation of the method RULA, where first took photos and video of what is observed while they performed the work with the hand tool. And then applied the assessment, resulting in a 5 level. 3. Take the anthropometric measures of workers and against this background it is made the redesign. 4. Was the prototype of the redesign, observing the reaction of the workers at the time of its use. 5. Was applied again the method of RULA, improving results obtained by the redesign, taking photos and video of what is observed. 6. Finally were some adjustments, adjusted the height of the table to a standard measure for convenience in carrying out the work. **RESULTS.** First the evaluation before the redesign, giving a result of 5 (5 or 6 investigate further and change soon), so it is necessary to make an inquiry and change as soon as possible the redesign of the tool. Once worked with the redesign of the hand tool, it assessed the redesign resulting in a level of 2 (1 or 2 Acceptable). **CONCLUSIONS.** On the basis as the method RULA, photos and videos. This is seen to somewhat change the shape of things, in this case to the hand tools, can be achieved generating higher productivity, the better results, but gain, but always in a safe manner.

Keyword: hand tool, ergonomic evaluation, bakery.

1. - Introduction

1.1 Background

The company was founded in the City of Los Mochis, Sinaloa in 1994, with the concept of bakery and deli, the need was seen in the market for vendors to supply them with hot dogs, burgers and cakes. It was for this reason that we acquired a small equipment to produce bread, which consisted of an oven and a mixer, with a production area of 16 square meters.
In the development stage was noted that the detail or grocery market, was not operated with a product and service quality was when we decided to explore this market with fresh bread and bakery products.

Today has been very significant growth, currently serving in northern and central Sinaloa and southern part of the sound, with a production of more than 100 workers. The production area is divided into 4 different lines in the processing of products handled by this company. Being in the bakery where the donuts are made daily, according to orders. For the preparation, it requires a manual tool. The production staff consists of men and women, which have heights and characteristics of different complexion. The process is carried out as follows:

1. - Prepare the mass needed for the number of donuts that will be worked out according to the order. 2. - After mixing the dough is rolled, that is, lying on the table to advance to the next step that is cutting. 3. - Molds are cut using the hand tool for making donuts. And placed in trays in quantities of 15 donuts per tray, letting stand for 2 hours or so to as to achieve consistency. 4. - The next step is to fry, to finally be glazed.

The production is approximately 3500 donuts per working day 5 to 6 hrs.

1.2. - Problem

The hand tool used to make donuts, is used by workers of the bakery being this, of galvanized sheet, donut-shaped with a diameter of 10 centimeters. It is used by grasping the extended hand is covering the design, so you can bang the mold on the dough and go to form the donuts. Product of this movement, while causing tiredness, fatigue, muscle aches workers in this area. Thus arises the interest and the need for research and redesign the tool.

1.3. - General and Specific Objective

1.3.1. - General Purpose. Redesigning a hand tool based on the need to use and anthropometric design, which is used in the production of donuts in a bakery established in the City of Los Mochis, Sinaloa.

1.3.2 Specific Objectives.

- 75 people were identified (morning and afternoon).
- We applied RULA assessment, taking photos and video of what is observed while performing the job. Assessment was applied, resulting in a level 5 (5 or 6 Investigate Further and change soon), it was necessary to initiate an investigation and redesign.
- Anthropometric measurements are taken and is prepared ergonomic redesign.
- It developed the prototype of the redesign.
- We applied again RULA, taking photos and video from the observed.
- Adjust the table height to a standard size for convenience in carrying out the work.

1.4. - Justification

This redesign is warranted based on the reduction of fatigue and muscle aches that occur over time in workers, while reducing the number of workers with disabilities caused by such problems. It improves mental and physical performance of each person as well as the moral aspect, feeling that the company which is working really cares about their welfare. It increases the productivity of the

company, because it improves the performance of each of the persons performing this work, as well as improving production, since it is much faster or in more quantity due to the use of the new hand tool.

2.1 Ergonomics: comes from the Greek words ergon (work) and nomos (law or rules). Murrell defined ergonomics as "The study of human beings in their working environment"; Singlenton said "It is the study of the interaction between man and environmental conditions" Grandjean defined it as "the study of human behavior in workplace. "

2.2 Anthropometry: is defined as a discipline that describes the quantitative differences of human body measurements, considering the dimensions by reference to various anatomical structures and serves as a tool to ergonomics in order to adapt the environment to people.

2.3 RULA Method: evaluate specific positions, it is important to evaluate those that pose a higher postural load. Application of the method begins with the observation of the worker's activity for several cycles. From this observation should select the most significant tasks and positions, either on its duration, or for filing, a priori, greater postural load. These positions will be assessed.

If the work cycle is long assessments can be made at regular intervals. In this case we consider also the time spent by the worker in each position.

To perform measurements on the positions adopted are primarily angles (the angles formed by the different members of the body from certain references in the position studied). These measurements can be performed directly on the worker by protractors, electro goniometers, or any device for making angular data. However, it is possible to use photographs of work by adopting the posture study and measure the angles on them. If using pictures is necessary to make a sufficient number of shots, from different points of view (standard, profile, detail views ...), and make sure to measure the angles displayed in true scale in the images.

The method should be applied to the right and left side of the body separately. The expert reviewer can choose a priori the side that is apparently subject to greater postural load, but in case of doubt it is better to look at both sides.

The RULA method divides the body into two groups, group A which includes the upper limbs (arms, forearms and wrists) and group B, comprising the legs, trunk and neck. By the tables associated with the method assigns a score to each body part (legs, wrists, arms, trunk, ..) to, in terms of these scores, assign values to each of the groups A and B.

The key to the assignment of ratings to members is to measure the angles of different parts of the body of the worker. Method determines for each member in the form of angle measurement.

Subsequently, the overall scores of groups A and B are modified depending on the type of muscle activity developed and applied force during the performance of the task. Finally, we get the final score from these values changed.

The final value provided by the RULA method is proportional to the risk involved in performing the task, so that higher values indicate a higher risk of musculoskeletal injuries.

The method organizes the final scores on performance standards that guide the evaluator on the decisions to be taken after the analysis. The proposed performance levels ranging from level 1, which assessed that the position is acceptable, level 4, indicating the urgent need for changes in the activity.

Group A: Ratings of the upper limbs.

The method begins with the evaluation of the upper limbs (arms, forearms and wrists) organized in the so-called Group A.

Score arm.

Points	Position
1	from 20° extensión to 20° flexion
2	extension >20° or flexion between 20° and 45°
3	flexion between 45° and 90°
4	flexion >90°

Table 2.1. Score arm.

Points	Position
+1	If the shoulder is elevated or rotated arm.
+1	If the arms are abducted.
-1	If the arm has a foothold.

Table 2.2 Changes on the score of the arm.

Score Forearm.

Points	Position
1	flexion between 60°and 100°
2	Flexion < 60° ó > 100°

Table 2.3. Score of the forearm.

Points	Position
+1	If the vertical projection of the forearm is beyond the vertical projection of the elbow.
+1	If the forearm crosses the midline of the body.

Table 2.4. Modification of forearm score

Wrist score:

Points	Position
1	If you are in neutral position with respect to bending.
2	If you are bent or stretched between 0 º and 15 º.
3	To flexion or extension greater than 15 degrees.

Table 2.5. Wrist score.

Points	Position
+1	If radial or ulnar deviated.

Table 2.6. Changing the wrist score

Points	Position
1	If there is pronation or supination in midrange.
2	If there is pronation or supination in extreme range.

Table 2.7. Rating flick of the wrist

Group B: Ratings for the legs, trunk and neck.

Cervical score:

Points	Position
1	If there is flexion between 0 º and 10 º.
2	If you are bent between 10 º and 20 º.
3	For more than 20 º flexion.
4	If you are extended.

Table 2.8. Score neck.

Points	Position
+1	If the neck is rotated.
+1	If lateral tilt.

Table 2.9. Changing the scoring of the neck.

Trunk rating:

Points	Position
1	Sitting, well supported and with a trunk-hip angle> 90 °.
2	If you are flexed between 0 º and 20 º.
3	If you are bent between 20 º and 60 º.
4	If you are bent over 60 degrees.

Table 2.10. Score of the trunk.

Points	Position
+1	If the trunk torque.
+1	If the trunk lateral bending.

Table 2.11. Modification of the score of the trunk.

Leg score:

Points	Position
1	Sit with your feet and legs well supported
1	Stand with your weight distributed symmetrically and space to change position
2	If your feet are not supported, or if the weight is not distributed symmetrically

Table 2.12. Leg score.

Overall scores: after receiving scores of members of group A and group B individually, we proceed to the assignment of an overall score for both groups.

Overall rating for members of group A

Forearm Arm		Wrist							
		1 Wrist Spin		2 Wrist Spin		3 Wrist Spin		4 Wrist Spin	
		1	2	1	2	1	2	1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table 2.13. Overall score for Group A.

Overall rating for members of group B

	Trunk											
	1		2		3		4		5		6	
	Legs		Legs		Legs		Legs		Legs		Legs	
Neck	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Table 2.14. Overall score for group B.

Score type of muscular activity developed and applied force:

Points	Position
0	If the load or force is less than 2 kg and is carried out intermittently.
1	If the load or force is between 2 and 10 kg and stands up intermittently.
2	If the load or force is between 2 and 10 kg and is static or repetitive.
2	If the load or force is intermittent and more than 10 kg.
3	If the load or force is greater than 10 kg, and is static or repetitive.
3	If there are shocks or abrupt or sudden forces.

Table 2.15. Score for muscle activity and forces applied.

Final Score:

	Score D						
Score C	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7

7	5	5	6	6	7	7	7
8	5	5	6	7	7	7	7

Tabla 2.16. Final Score.

3.1 Methodology.

- 75 people were identified and applied RULA assessment, taking photos and video of what is observed while performing the job. Assessment was applied, resulting in a level 5 (5 or 6 Investigate Further and change soon), it was necessary to initiate an investigation and redesign.

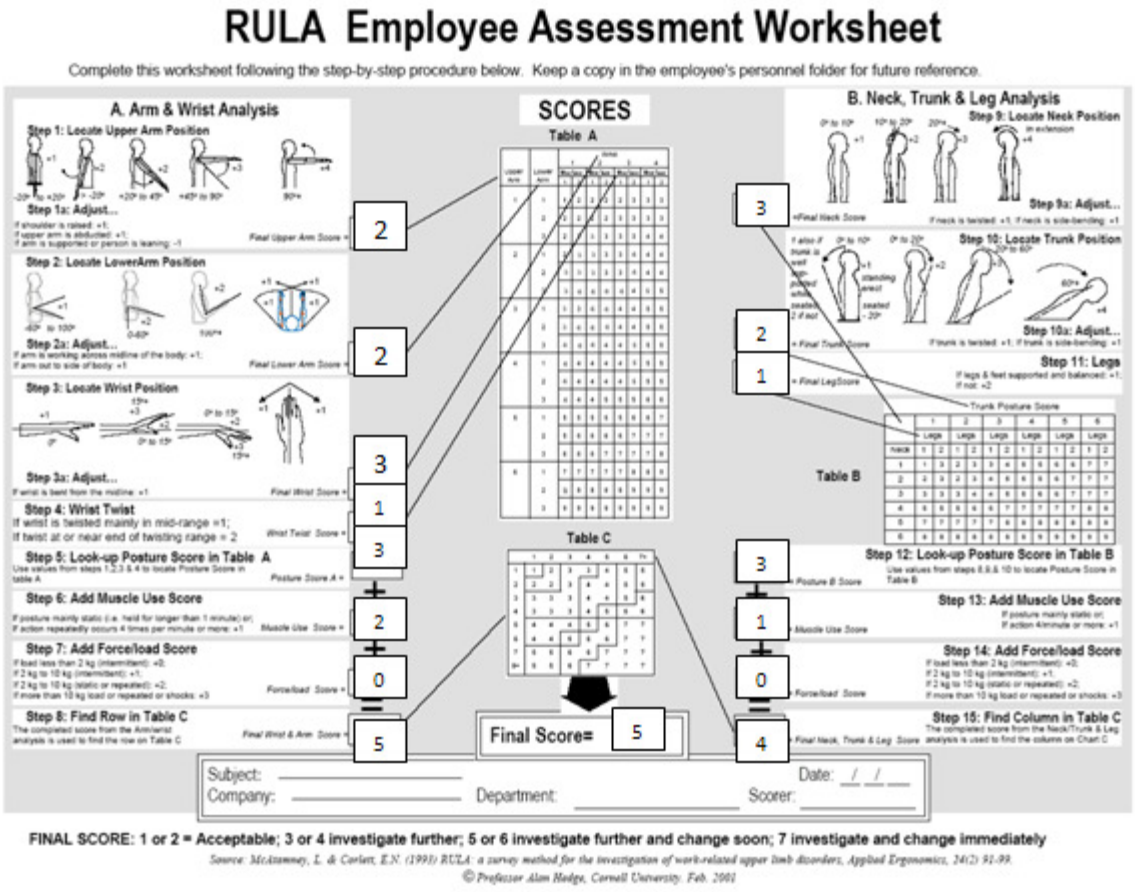

Figure 3.1. RULA application of the hand tool without redesign.

Figure 3.2. Tool Use

Figure 3.3. Original hand tool made of galvanized sheet metal

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It uses only 3 steps to develop this, which are
arm extended. Percentiles are determined according to each measure, to take with it a standard measure and develop an ergonomic redesign.

It listed the 75 measurements obtained in descending order, ie from largest to smallest (width of the palm grip and an outstretched arm).

Below is the table of measures, together with the equivalent percentiles to each value, taking only the 3 measures chosen for the development of the redesign.

	PERCENTILES	WIDTH OF HAND
1	100%	10.5 cm.
2	98.66%	10
3	97.33%	10
4	**96%**	**10**
5	**94.66%**	**10**
70	8	7.5
71	6.66	7.5
72	5.33	7.5
73	3.99	7.5

74	2.66	7.5
75	1.33	7

Table 3.6 Measures of the width of the hand and percentiles.

	PERCENTILES	GRIP
1	100%	5.2 cm,
2	98.66%	51
3	97.33%	51
4	**96%**	49
5	**94.66%**	49
70	8	36
71	6.66	36
72	5.33	35
73	3.99	35
74	2.66	33
75	1.33	33

Table 3.7 Measures of grip and percentiles.

	PERCENTILES	EXTENDED ARM
1	100%	81 cm
2	98.66%	80
3	97.33%	75
4	**96%**	77
5	**94.66%**	78
70	8	72
71	6.66	68
72	5.33	70
73	3.99	71
74	2.66	63
75	1.33	72

Table 3.8 Measures Extended arm and percentiles.

- Redesign of the hand tool was made.

Figure 3.4. Using the new tool

Figure 3.5 Hand tool (redesign) made of stainless steel

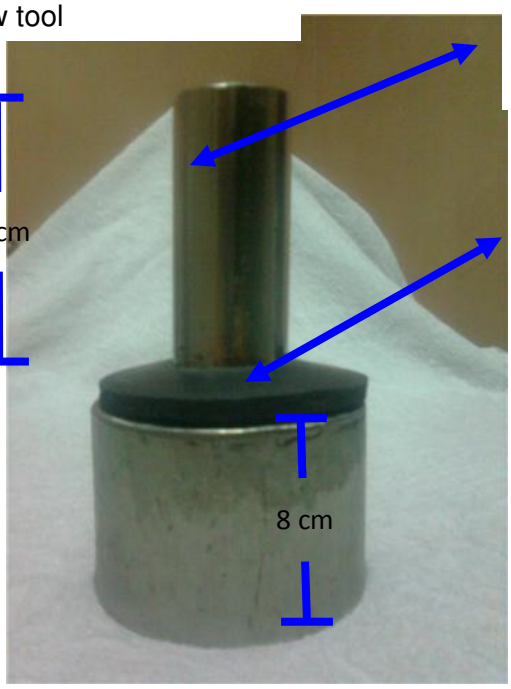

Figure 3.6 Redesign of the hand tool made of stainless steel.

- We applied again RULA, taking photos and video of what is observed and evaluated.

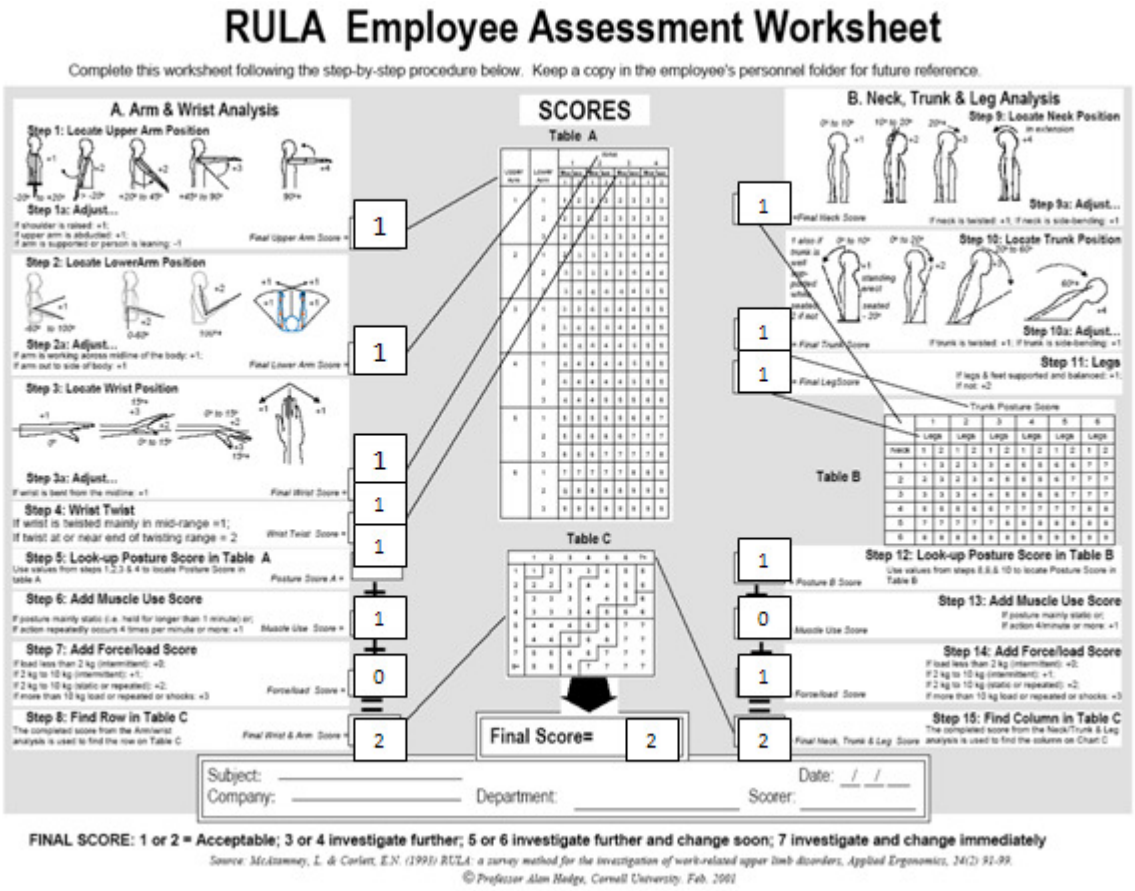

Figure 3.7 Method using the redesign RULA

- Adjust the table height to a standard size for convenience in carrying out the work.

CONCLUSIONS

Based on research conducted through surveys of a population of 75 employees of a bakery, and the use of tools such as the implementation of RULA, photos and videos, it was the redesign of this tool in hand, which resulted in a marked improvement in workers at the time of use.

RECOMMENDATIONS

That's why we recommend working on awareness training for staff to use hand tool, making do with this, the importance of this tool to use when creating awareness in them of both the risks of not using it and the benefits it will bring the use of this.

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