DESIGN AND IMPLEMENTATION OF MANUFACTURING CELL WITH ERGONOMIC SUPPORT ANALYSIS

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Resumen: Este estudio muestra el desarrollo del proyecto desde la perspectiva general del análisis de riesgo ergonómico utilizando el método RULA (Rapid Upper Limb Assessment). El análisis arrojo información para mejorar el ambiente de trabajo. Se desarrollo el Proyecto de evaluación ergonómica en una compañía metalmecánica con más de 16 años en Mexicali, con el propósito de enfocar esfuerzos en la prevención de riesgos ergonómicos.

El proyecto se apoyo en las características retrospectivas (5 años) de los registros médicos, evidenciando lesiones músculo tendinosas en muñecas en las áreas de trabajo de ensamble, específicamente en una estación en particular; los cuales fueron determinantes para definir el proyecto en las celdas de manufactura.

Objetivo: Reconocer evaluar y controlar los riesgos laborales por actividades repetitivas, posturas, y agentes del medio que por sus características puedan causar daños a la salud, considerado el análisis ergonómico aplicado al concepto de celdas de manufactura

Metodología empleada: Normas oficiales Mexicanas de STPS (Secretaria de Trabajo y Previsión Social) vigentes, Evaluación RULA/BRIEF, Mediciones antropométricas, Principios de celdas de manufactura

Resultados

Tabla 1 Resultados del proyecto

Mejora en Índice de frecuencia	
Tendinitis	95%
Dolor de cuello	100%
Espalda	90%
Beneficio	
Rotación de personal	0%
Desperdicio	-33%
Optimización de espacio	40%
Productividad	40%
Condiciones ambientales	
Iluminación	100%
Ruido	100%

Conclusiones: Con base a los datos obtenidos:

- Disminuyo el índice de frecuencia de lesiones por tendinitis, dolor de cuello y espalda; impactando de manera favorable la rotación
- Se considerarán para el diseño de las estaciones de trabajo, la media poblacional del estudio antropométrico
- Se comprobó que el costo beneficio de la aplicación de la ergonomía generó mejoras significativas en las condiciones laborales beneficiando a casi 500 empleados

Palabras Clave: Celdas de manufactura, RULA, Análisis Ergonómico

Abstract: This study shows the project's general perspective for ergonomic hazards using the RULA's (Rapid Upper Limb Assessment) method. Analysis shows information to improve the work environment. Project ergonomics was developed in a metalworking company with over 16 years in Mexicali, with the proposed of focusing efforts on preventing ergonomic risk.

The project was supported in retrospective characteristics (5 year) medical records, which showed muscle lesions in wrist tendon (CTD: Cumulative Trauma Disorder) areas specifically assembly work at a particular station, were decisive in defining the project in manufacturing cell.

Objectives: Recognize asses and control the labor risks for repetitive activities, postures, and environmental agents that have certain characteristics may cause damage to health, considered the ergonomic analysis applied to the concept of manufacturing cells.

Used methodology: Mexican official standards of existing STPS (Secretaria de Trabajo y Previsión Social), RULA Assessment, Anthropometric measurements and Principles of manufacturing cells.

Results:

Table 1 Project results

Improved Frequency index	
Tendinitis	95%
Neck pain	100%
Back and shoulders	90%
Benefits	
Absenteeism	0%
Waste	-33%
Space optimization	40%
Productivity	40%
Environmental conditions	
Ilumination	100%
Noise	100%

Conclusions: Based on the data:

- Reduce the frequency index of tendinitis injuries, neck and back pain, favorably impacting the absenteeism.
- Will be considered for the design of workstations, the population mean anthropometric study.
- It was found that the cost benefit of the application of ergonomics to yield significant improvements in working conditions, benefiting nearly 500 employees.

keywords. Manufacturing cells, RULA and Ergonomic Analysis

1.- INTRODUCTION

This study shows some of the environmental factors of process redesign in a metalworking company with over 16 years in Mexicali, initiating the development of the project from the overall

perspective of ergonomic risk analysis methods using RULA (Rapid Upper Limb Assessment) / BRIEF. The analysis yields information to improve the working environment, in order to focus efforts on preventing ergonomic hazards.

The project will support the features retrospectives (five years) of medical records, showing muscle tendon in wrist injuries in the assembly work areas, specifically in a particular season, which were crucial in defining the project in the cells manufacturing. Later it was necessary to implement each of the principles of manufacturing cells, which had as one of its aims to cut down injuries sustained when production lines were used and the advantages that the implementation of this system of manufacturing production in its approach . It was remarkable to observe that first applied the standards and principles Japanese and Mexican Americans than the standards established by federal labor law.

2.- Objective

Recognize evaluate and control occupational hazards by repetitive activities, postures, and environmental agents which by its nature could cause damage to health, considered the ergonomic analysis applied to the concept of manufacturing cells

3. Methodology

3.1. Factors and Design Techniques

To develop improvements as a project in newly created department was required to first determine the factors necessary in a process or product improvement, further weighting. Factors that were discussed and were weighted were: packaging, ergonomics, reliability, maintenance, manufacturing, environment, performance and safety. Of the above factors stood out in his group, ergonomics and manufacturing, which were diagnosed as other such systems and subsystems as corresponded in the following items on this article.

3.1.1 Weight and diagnostic medical. To be able to support the weight of the plant physician, was necessary to make a diagnosis of injuries in the last 5 years behavior which is shown in Figure 1.

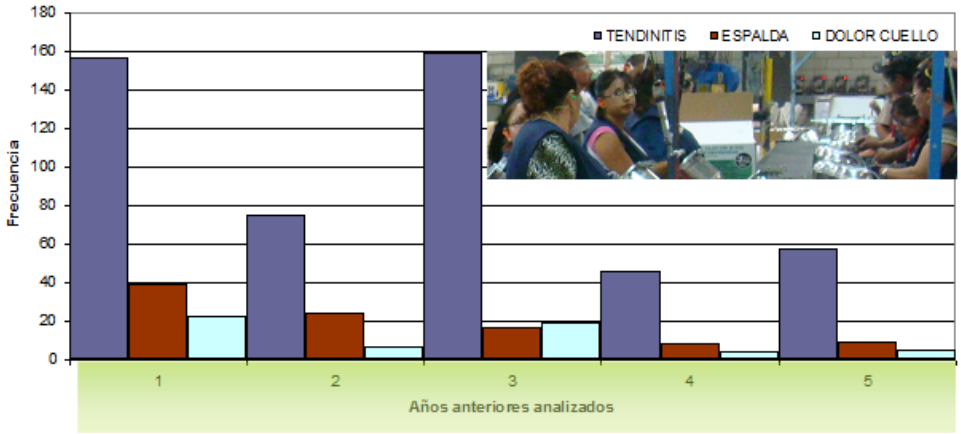

Figure 1. Injury graphic in the last five years in the production line

As can be seen from the graph in Figure 1, tendinitis injuries were the most frequently expressed, in analyzing the documents supporting the physician receives a particular station as the main carrier of the injury. It was decided to take a more precise analysis of the case which had previously been tested ergonomically down significantly, however, the cases have involved the previous year that operators avoid working in the station. The weighting is determined whether one could know if our proposals were significant in their environment, it was necessary for the same thermal analysis on a ship operated blade in a municipality that maintains extreme temperatures in the year. Realising the study as shown in Figure 2, the tendinitis was found increased in the months where the heat is great in Mexicali.

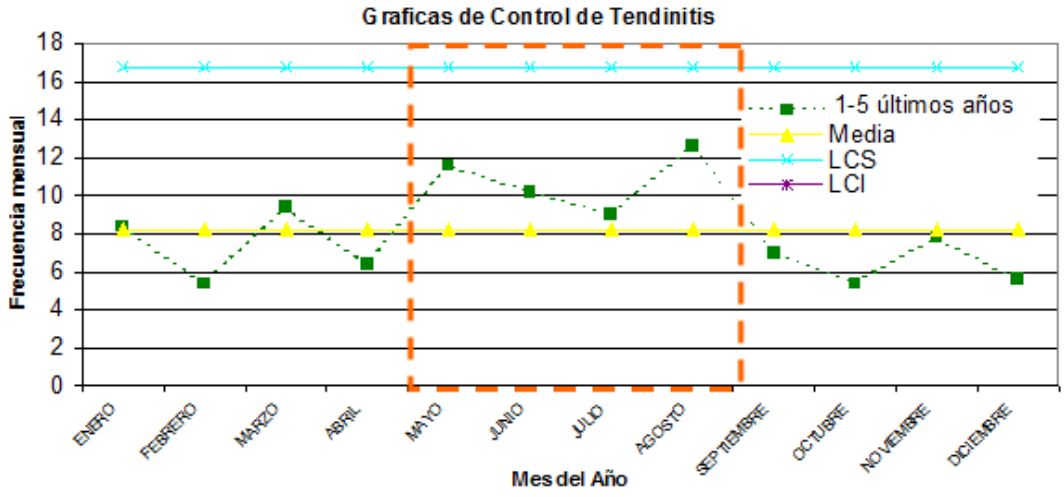

Figure 2. Tendinitis injury in the last five years

3.2. Mexican Official Standards of STPS (Secretary of Labor and Social Welfare) in force Federal Labor Law art. 132 Obligations of Employers Cap. X, Ergonomics art. 102. (Federal Regulation on Safety, Hygiene and Working Environment 1997)

The official Mexican standards determined by the Secretary of Labor and Social Welfare in effect allowed us to measure each of the parameters set by physical and chemical conditions, however, to labor issues in the area we focus on the chemical physics but also evaluated

3.2.1 Physical

Vibrations (NOM-024-STPS-2001),

Noise (NOM-011 - STPS-2001). Concentration equivalent dB (A): continuous, intermittent, fluctuating and Impact,

Lighting (NOM-025-STPS-1999)

a) Disposition: General, located, and auxiliary

b) Artificial: Incandescent, fluorescent, vapor and H

c) Natural

d) Combined

Radiation

a) Ionizing (NOM-012-STPS-1999) x-rays, radioisotope and other

b) Non-ionizing (NOM-013-STPS-1993), ultraviolet, infrared, radio frequency and other static Electricity (NOM-022-STPS-1999)

Thermal conditions (NOM-015-STPS-2001)

3.2.2 Chemicals

Substance (NOM-010 - 1999 STPS-)

3.3. Anthropometric measurements

Some anthropometric measurements of operators are working in the plant are shown in Table 1

Table 1 Some anthropometric measurements of line operators

Descripción de Medición	Mujer 44.4%		Hombre 55.6%	
	Prom	Desv	Prom	Desv
Extensión del brazo:				
10.Altura codo al suelo (brazo extendido hacia el frente)	130.0	7.0	143.8	7.9
11.Hacia el frente	63.3	6.4	70.5	4.2
14.Ancho hombro a hombro	44.5	4.4	46.8	2.9
15.Ancho codo a codo	48.8	6.4	51.2	3.1
16.Ancho pecho-espalda	29.0	4.5	25.4	2.9
19.Calzado	4.5	0.5	7.5	2.0

3.4. RULA Assessment / BRIEF

Poor posture is considered one that moves away from a neutral position or physiological, where they play an important role while maintaining the posture and the handling of heavy objects. (Kroemer 2000). Since the results were assessed at the station representing more problems in production lines using the method as the main tool right RULA showed results that could be considered in the design of new stations. First results were deciphered on the right of operators to both women and men as shown in Figure 3 where we obtained the results of urgent change of season.

3.5 Principles of manufacturing cells (Villaseñor 2009)

1. Place machines and workstations as close as possible to minimize the distance to be walking
2. Free from obstructions routes and install comfortable floor worker

   Increase the safety of workers

   Improved productivity

   Greater flexibility of work for each operator

2. Keep the cell width of 4 feet to allow flexibility, relocation and redistribution of work among team members

   Minimize distances of each operator

   Operators have access to both sides of the cell

   Increases the flexibility of the work cycle, so there may be operating on both sides of the cell U

Puntos	Análisis	Derecho	Izquierdo
Brazo (Tabla 1)	2-Extensión >20° o flexión 20° - 45°		2
	3-Flexión 45° - 90°	3	
Modifican (Tabla 2)	1-Hombro elevado o brazo rotado	2	
	1-Brazos abducidos		1
Antebrazo (Tabla 3)	1-Flexión 60° - 100°	1	
	2-Flexión < 60° o > 100°		2
Modifican (Tabla 4)	1-Si el antebrazo cruza la línea central de cuerpo	1	1
Muñeca (Tabla 5)	2-Flexionada o extendida entre 0° - 15°	2	2
Modifican (Tabla 6)	1-Desviada radial o cubitalmente	1	1
Giro (Tabla 7)	1-Pronación o supinación en rango medio		1
Giro (Tabla 7)	1-Pronación o supinación en rango extremo	2	
	Puntuación Global Grupo A	7	4
Postura	1-Estática, si se mantiene postura >1 minuto seguido repetitivo (si se repite > 4 veces/minuto)	1	1
Puntuación para actividad muscular y fuerza ejercida			
Posición (Tabla 15)	2-Si la carga o fuerza esta entre de 2 - 10 Kg. y es estática o repetitiva	2	2
Puntuación Global Grupo C		10	7
cuello (Tabla 8)	1-Flexión 0° - 10°	1	1
modifican (Tabla 9)	1-Cuello rotado	2	2
	1-Inclinación lateral		
tronco (Tabla 10)	2-Flexionado 0° - 20°	2	2
modifican (Tabla 11)	1-Torsión del tronco	1	1
Piernas (Tabla 12)	1-Sentado, con pies y piernas bien apoyados	1	1
	Puntuación Global Grupo B	3	3
Postura	1-Estática, si se mantiene postura >1minuto seguido repetitivo (si se repite > 4 veces/minuto)	1	1
Puntuación para actividad muscular y fuerza ejercida			
Posición (Tabla15)	2-Si la carga o fuerza esta entre de 2 - 10 Kg. y es estática o repetitiva	2	2
	Puntuación Global Grupo D	6	6
	Puntuación Final Derecha e Izquierda	7	7
Requiere cambios urgentes en el puesto o tarea			

Figure 3. RULA Evaluation for production line (belt)

4. Heights consistently maintain places of work and materials at the point of use
5. Locate the end of the line as close as possible to the next line.
6. Avoid carrying a piece of top-down and front-back

   Always avoid placing the parts manufactured in shelves, racks, boxes or any container that is out of the process
7. Where possible, use gravity to assist the operator in the placement and movement of materials

8. Design a system of two containers refill
9. Install flexible and movable equipment in the cell distribution to fit easily

Facilitates continuous improvement efforts, reduce time and costs for the relocation of production in cells

Improve response times to changes in products or processes

8. Manufacturing cell design for flexibility of volume
    a. Flexibility:
    b. Design assembly line layout to cellular manufacturing in a "U" or "U" open.
    c. Eliminate communication barriers and increase teamwork
9. Minimize the distance between operations transfer
10. Cycle times operator must be at or below the target time / takt
    a. Ensure that the cell meets the customer demand time
    b. Ensures that meets the capacity requirements
13. Design routes operating within the cell, making sure not cross
    a. Increases operator safety
    b. Facilitates flow of material
    c. Optimize productivity by removing obstacles from the path
    d. Ensures follow-up sequence of work
14. Design the cells for operators to work within it.
    a. Promotes communication and teamwork
    b. Improved response time and operating in several machines or workstations
    c. Optimize production space
    d. Reduce travel distances
15. Design the cells so that the rotation of the work is against clockwise
    a. Improved ergonomic design
    b. Facilitates milestone
    c. Standardize more material flow
    d. Eliminate wasted movement when moving the product of the hand that receives the working
16. Design the cells so that the operations are more than one piece among stations
    a. Minimize WIP

b. Pull Production System or milestone

17. Design the cells to ensure that all parties go through all seasons
18. Design the cells so that the operator can easily perform various operations.
    a. Helps to improve the ergonomic design by reducing repetitive movements
    b. Improves mobility and versatility of workers
    c. Allows greater flexibility
    d. Promotes "system thinking", continuous improvement
    e. Eliminate each operation specialists
    f. Improved response time
    g. Improved communication
    h. Improved teamwork
    i. Improving the skills of each to rotate the cell operations
19. Design the cells so that the operator never trapped
20. Better handling of material
    a. Improving the response time

4. Results

4.1 Medical conditions for improved stations applied in manufacturing cells

Measurements after the improvements implemented in the stations of the manufacturing cells reduce injuries allowed as shown in Figure 4

4.2. RULA assessment implemented in manufacturing cells. Improvements in manufacturing cell stations were significant as shown below. First results on the right of operators to both women and men shown in Figure 8 and Figure 9 where we obtained the results to changes in tasks

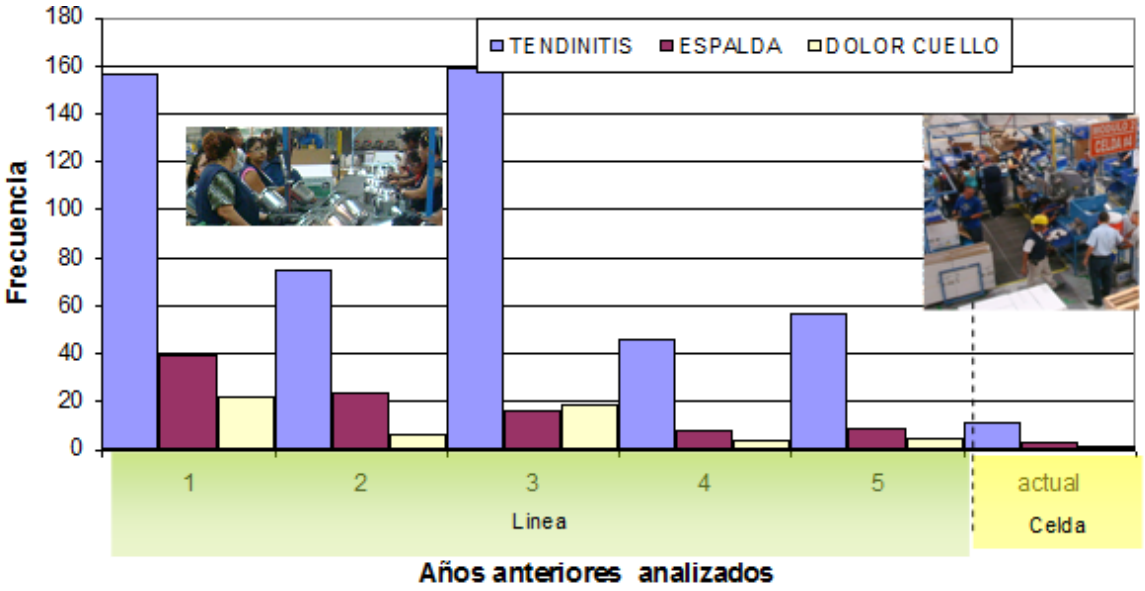

Figure 4 raph of injuries sustained in the first year of cells

5. Conclusions:

6.

1. We complied with the standards prescribed by the current Mexican
2. Engineering controls were implemented through:
   a) were improved work areas with more light,
   b) decreased redesign of machinery noise
   c) the use of workstations in the corresponding cells that fulfilled the relevant principles
   d) Development of tools to reduce ergonomic hazards
   e) Improved handling containers and material moving
3. Administrative Controls
   - Work was rescheduled through the seasons in the manufacturing cell
   - were established relaxation breaks that allow staff
4. Work practice controls
   - is looking to keep the body in neutral positions
5. Based on the data obtained from the RULA ergonomic evaluation and implementation of manufacturing cells

Posiciones	Análisis	Derecho	Izquerda
Brazo (Tabla 1)	1-Extensión 20° a flexión 20°	1	1
Modifican (Tabla 2)	1-Brazos abducidos	1	
	1-Hombro elevado o brazo rotado		1
Antebrazo (Tabla 3)	1-Flexión 60° - 100°	1	1
Modifican (Tabla 4)	1-Si el antebrazo cruza línea central de cuerpo	1	1
Muñeca (Tabla 5)	1-Posición neutra respecto a flexión		1
	2-Flexionada o extendida entre 0° - 15°	2	
Modifican (Tabla 6)	1-Desviada radial o cubitalmente	1	1
Giro (Tabla 7)	1-Pronación o supinación en rango medio	1	1
	Puntuación Global Grupo A	3	2
Postura	0-Dinámica, si tarea es ocasional, poco frecuente y corta duración	0	0
Puntuación para actividad muscular y fuerza ejercida			
Posición (Tabla 15)	1-Si la carga o fuerza esta entre de 2 - 10 Kg. y se levanta intermitentemente	1	1
	Puntuación Global Grupo C	4	3
Cuello (Tabla 8)	1-Flexión 0° - 10°	1	1
Modifican (Tabla 9)	1-Inclinación lateral	1	1
Tronco (Tabla 10)	2-Flexionado 0° - 20°	2	2
Modifican (Tabla 11)	1-Inclinación lateral del tronco	1	1
Piernas (Tabla 12)	1-De pie con peso simétricamente distribuido y espacio para cambiar de posición	1	1
	Puntuación Global Grupo B	3	3
Postura	0-Dinámica, si tarea es ocasional, poco frecuente y corta duración	0	0
Puntuación para actividad muscular y fuerza ejercida			
Posición (Tabla15)	0-Si la carga o fuerza es menor de 2 Kg. y se realiza intermitentemente	0	0
	Puntuación Global Grupo D	3	3
	Puntuación Final Derecho e Izquierdo	4	3
Requiere cambios en la tarea; es conveniente profundizar en el estudio			

Figure 5 RULA evaluation in cell

a. Reduce the frequency rate of tendinitis injuries, neck and back pain, impacting favorably rotation
b. be considered for the design of workstations, the population mean anthropometric study
c. It was found that the cost benefit of the application of ergonomics led to significant improvements in working conditions, benefiting nearly 500 employees

5. REFERENCES

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