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Presidente SEMAC 2002-2004

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Prefacio

La Sociedad de Ergonomistas de México A.C. (SEMAC), como parte relevante de su actividad e interés en la difusión, promoción y apoyo a la ergonomía, ha organizado desde 1999 y de forma anual, su Congreso Internacional de Ergonomía. En Abril de 2012, El Instituto Tecnológico de Los Mochis nos abre sus brazos para recibir el XIV Congreso Internacional de Ergonomía, con la participación de ergonomistas profesionales e interesados en esta área.

Este año, participan en esta edición 32 trabajos que involucra a múltiples investigadores de diferentes Universidades, asi como profesionistas comprometidos en mejorar el ambiente laboral de nuestros compañeros trabajadores, estudiantes, maestros o los habitantes de una vivienda. Aunque hemos estado trabajando en la difusión de la Ergonomía, todavía es común encontrarnos con prácticas laborales contrarias a la salud de los trabajadores o que nos vendan productos con el sello de ser un producto "Ergonómico", aunque este no lo sea y poder incrementar su precio, sin medir las consecuencias que puede tener su uso en la salud de los clientes.

Se reúnen en este libro una selección de los trabajos más representativos de las diversas áreas que participan en la ergonomía, aportando diferentes investigaciones y soluciones a problemas específicos, con la finalidad de contribuir a la difusión, apoyo en la educación e investigación, de temas de interés para la ergonomía.

Los editores, árbitros y comité académico, a nombre de la Sociedad de Ergonomistas de México, A.C., agradecemos a los autores de los trabajos aquí presentados su esfuerzo, e interés por participar y compartir su trabajo y conocimientos asi como su valiosa aportación que estamos seguros derivará en el avance de la ergonomía en las Instituciones de Educación Superior y en la planta productiva nacional y mundial.

Enrique de la Vega Bustillos

Presidente SEMAC 2002 – 2004

SOCIEDAD DE ERGONOMISTAS DE MÉXICO A.C.

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ANTHROPOMETRY DIMENSIONS OF ADULT NATIVE POPULATION LIVING IN NORTHERN SINALOA.

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Resumen: México está situado en Centro América, es un país multiétnico, con una población total de 112, 336, 538 habitantes (INEGI, 2010) de los cuales el 12% pertenecen a un grupo étnico. En México se han realizado poco estudios antropométricos, y la mayoría orientados a los trabajadores de la industria. Actualmente no hay antecedentes de estudios antropométricos en grupos étnicos, por lo tanto se utilizan cartas antropométricas de otros países en donde las características físicas de la población son muy diferentes. El determinar las características antropométricas de la población indígena adulta que habita el norte de Sinaloa, desarrollando una base de datos antropométricos de los adultos pertenecientes a las etnias: chatino, chol, mayos y mixtecos. Las medidas fueron tomadas a 200 personas entre los 18 y 25 años (100 hombres y 100 mujeres), estudiantes de nivel profesional de la Universidad Autónoma Indígena de México pertenecientes a las etnias antes mencionadas. El equipo de trabajo encargado de la recolección de los datos se integró por 15 estudiantes de la UAIM, los cuales recibieron entrenamiento durante 3 sesiones. Se tomaron 20 medidas antropométricas a los participantes en posición de pie. La vestimenta de los participantes fue ropa ligera y zapatos de trabajo. Los resultados muestran que existen diferencias significativas entre las dimensiones del cuerpo de los diferentes grupos étnicos de México, por lo tanto es necesario considerar este factor al momento de diseñar estaciones de trabajo, objetos y ropa para la población mexicana.

Palabras claves: antropometría, grupo étnico, complexión física.

Abstract: México is located in Central America, it's a multiethnic country, with a total population of 112, 336, 538 people according with the records from INEGI in 2010, 12% of them belong to an ethnic group. In Mexico have been very few anthropometric studies, and most of them are oriented towards industry workers. At the time, there are no records of anthropometric studies done on ethnic groups; therefore we use anthropometric cards from other countries where the physical characteristics are very different. The objective is to determine the anthropometric characteristics of the adult native population living in northern Sinaloa, developing an anthropometric data base of the adults belonging to the following ethnics: chatino, chol, mayos and mixtecos. The measures were taken to 200 people between the ages of 18 and 25 years (100 men and 100 women), students at a professional level at “Universidad Autónoma Indígena de México (UAIM)” that belong to the previously mentioned ethnics. The team responsible for the data recollection was formed by 15 UAIM students, who received training for 3 sessions. 20 anthropometric measures were taken to the participants in the study. The measures were taken standing up. The participants had light clothes and work shoes. The results show that there are significant differences between the dimensions of the body of the different Mexican ethnic groups, therefore it’s important to consider this factor when designing the workstations, objects and clothes for the Mexican population.

Keywords: Anthropometry, ethnic group, physical constitution.

1. INTRODUCTION

Mexico is a country located in North America, it´s composed by 31 states and one federal district, it´s a multiethnic country, with a total population of 112, 336, 538 people according to the records from INEGI in 2010, 12% of them belong to an ethnic group. The native population constitutes a priority group for the population policy in this country with considerable differences between the more than 60 ethno linguistic groups that exist in Mexico. Most of the ethnic groups are focused on the southwest of this country, in the following states: Campeche, Chiapas, Guerrero, Hidalgo, Michoacan, Oaxaca, Puebla, Quintana Roo, San Luis Potosi, Veracruz and Yucatan.

The “Universidad Autónoma Indígena de México (UAIM)”, an intercultural institution of Sinaloa state has three units in: Mochicahui, Los Mochis and Choix, which receives students from all Mexican Republic mainly coming from ethnic groups with a list of 1614 students. This research was carried out in the Mochicahui unit, considering that here is where the ethnic groups are focused, knowing that 80% of the students (academic holders) belong to one of these ethnicities: Chatino, chol, mayo-yoreme and mixteco.

The Mexican economic growth and technological improvements will lead to greater demand and development of machines and devices used in industrial and non-industrial settings and which also increase the higher probability of human and machine interaction (Klamklaya et al., 2008). Anthropometry is a key element in designing workstations, tools, equipment and clothing. Ergonomically design saves time in the execution of tasks, reducing effort and movements, and therefore, improved working conditions and increasing the quality and productivity (Leilanie and Prado, 2007).

The anthropometry data are considered more critical in designing for a group of diverse population such as Mexican. In Mexico there have been few studies anthropometric, and most aimed at workers in the industry. Currently there is no history of ethnic anthropometric studies therefore used anthropometric data from other countries where conditions and physique of the population are very different.

Similar to the Karmegarm et al. (2011) study, it will be interesting to find out whether there are significant differences in mean body dimensions and bodily proportions of the ethnics. However, there is a lack of sufficient anthropometric data; this may due to the reason of high expenditure and time consuming in the anthropometry data collection process.

2. OBJECTIVE

To develop an anthropometric database of adults living in northern Sinaloa and belong to different ethnicities: Chatino, chol, mayo-yoremes and mixtecos.

3. METODOLOGY

3.1 Sample

The financial and temporal constraints restricted the participation of the total of native students. Only the voluntary participation of a group of 400 people (200 male and 200 female) between the ages of 18 and 25 years from the different ethnicities will be considered: chatino, chol, mayo-yoreme and mixteco, considering they are the most representative.

3.2 Dimensions of the body

In this study, 20 anthropometrical dimensions were measured for both males and females in centimeter (cm) and kilograms (kg). The dimensions were related to standing and weight of human body. (Table 1) The measurements were taken with participants wearing light clothing and work shoes.

3.3 Survey team

The team responsible for the recollection of the data was formed by 15 UAIM students, which received training for three sessions with the objective that they familiarize with the way of measurement.

3.4 Materials and equipment

Anthropometer Clarita model
Digital scale
Anthropometric card
Computer
Minitab 15 Software

Table 1.The definition for each anthropometric measurement collected during this study

Dimension	Definition
Weight	Body weight of the subject taken to the nearest half kilogram
Stature	Vertical distance as measured with an anthropometer between the standing surface and the top of the head
Eye height	Vertical distance from the level of eye to the floor when the person stands
Shoulder height	Vertical distance from the level of acromion to the floor
Elbow height	Vertical distance from the elbow of flexed arm to the floor
Waist height	Vertical distance from the waist to the floor
Buttock height	Vertical distance from the buttock to the floor
Wrist height	Vertical distance from the wrist to the floor
Fingertip height	Vertical distance from the fingertip to the floor when the person stands
Width of arms	Width of arms extended laterally
Elbow breadth	Elbow breadth with hands on the center of chest
Horizontal Fingertip reach	Horizontal Fingertip reach (from wall)
Horizontal fist reach	Distance between the wall and fist
Shoulder breadth	Horizontal distance between right and left deltoid muscles
Chest breadth	Maximum horizontal distance across chest
Hip breadth	Maximum horizontal distance across hip
Neck circumference	Circumference as measured with a tape at the neck
Chest circumference	Circumference as measured with a tape at the chest
Waist circumference	Circumference as measured with a tape at the waist
Hip circumference	Circumference as measured with a tape at the hip

3.5 Data analysis

Data analysis using Minitab 15 was performed to determine the descriptive statistics (mean, standard deviation, minimum, maximum, 5th percentile, 50th percentile and 95th percentile) in order to achieve the first objective of this study which is to determine the anthropometric dimensions of the sample. The data was grouped by gender and ethnicity.

4. RESULTS

The preliminar results of anthropometric database for Chatinos, Chol, Mayo-Yoreme and Mixtecos are presented in Tables 2 to 5. They highlight the statistical analyses of anthropometric measurements which include the mean, standard deviation (SD), minimum (Min), maximum (Max), 5th percentile, 50th percentile and 95th percentile for male and female among the four ethnics.

5. CONCLUSIONS

The results show that there are significant differences between the dimensions of the body of the different Mexican ethnic groups, therefore it’s important to consider this factor when designing the workstations, objects and clothes for the Mexican population.

Table 2.Anthropometric data for Chatinos (male)

Dimension	Mean	SD	Min	Max	5th	50th	95th
Weight	69.7	12.30	61	78.4	61.87	69.7	77.53
Stature	168	14.84	157.5	178.5	158.55	168	177.45
Eye height	157	15.83	145.8	168.2	146.92	157	167.08
Shoulder height	139.4	13.43	129.9	148.9	130.85	139.4	147.95
Elbow height	105	8.34	99.1	110.9	99.69	105	110.31
Waist height	101.1	5.51	97.2	105	97.59	101.1	104.61
Buttock height	78.95	6.29	74.5	83.4	74.945	78.95	82.955
Wrist height	82.85	5.44	79	86.7	79.385	82.85	86.315
Fingertip height	65.15	5.02	61.6	68.7	61.955	65.15	68.345
Width of arms	167.35	18.87	154	180.7	155.335	167.35	179.365
Elbow breadth	83.2	5.65	79.2	87.2	79.6	83.2	86.8
Horizontal Fingertip reach	83.5	6.92	78.6	88.4	79.09	83.5	87.91
Horizontal fist reach	73.8	7.77	68.3	79.3	68.85	73.8	78.75
Shoulder breadth	43.45	2.89	41.4	45.5	41.605	43.45	45.295
Chest breadth	28.2	3.53	25.7	30.7	25.95	28.2	30.45
Hip breadth	35.05	1.06	34.3	35.8	34.375	33.55	35.725
Neck circumference	34.75	5.58	30.8	38.7	31.195	34.75	38.305
Chest circumference	91.5	2.82	89.5	93.5	89.7	91.5	93.3
Waist circumference	84.25	6.01	80	88.5	80.425	84.25	88.075
Hip circumference	98.75	1.76	97.5	100	97.625	98.75	99.875

Table 3.Anthropometric data for Chol (male)

Dimension	Mean	SD	Min	Max	5th	50th	95th
Weight	63.10	10.39	51.60	71.80	52.61	61.70	70.79
Stature	171.50	3.04	168.00	173.50	168.28	170.75	173.23
Eye height	160.63	4.39	155.60	163.70	156.01	159.65	163.30
Shoulder height	144.90	4.84	139.60	149.10	140.08	144.35	148.63
Elbow height	109.27	4.70	104.10	113.30	104.56	108.70	112.84
Waist height	103.40	2.25	100.80	104.80	101.00	102.80	104.60
Buttock height	80.60	2.60	79.10	83.60	79.33	81.35	83.38
Wrist height	87.00	5.09	81.30	91.10	81.79	86.20	90.61
Fingertip height	67.17	3.88	62.80	70.20	63.17	66.50	69.83
Width of arms	172.17	0.25	171.90	172.40	171.93	172.15	172.38
Elbow breadth	87.87	0.76	87.00	88.40	87.07	87.70	88.33
Horizontal Fingertip reach	85.37	3.21	82.00	88.40	82.32	85.20	88.08
Horizontal fist reach	73.00	3.02	69.80	75.80	70.10	72.80	75.50
Shoulder breadth	43.53	1.72	42.00	45.40	42.17	43.70	45.23
Chest breadth	28.60	2.23	26.20	30.60	26.42	28.40	30.38
Hip breadth	33.43	0.32	33.20	33.80	33.23	33.50	33.77
Neck circumference	35.57	3.08	32.10	38.00	32.40	35.05	37.71
Chest circumference	89.30	8.82	79.20	95.50	80.02	87.35	94.69
Waist circumference	77.63	6.45	70.20	81.70	70.78	75.95	81.13
Hip circumference	92.43	2.46	89.60	94.00	89.82	91.80	93.78

Table 4.Anthropometric data for Mayo-Yoreme (male)

Dimension	Mean	SD	Min	Max	5th	50th	95th
Weight	58.65	7.17	52.10	68.10	52.90	60.10	67.30
Stature	162.85	4.31	156.50	166.00	156.98	161.25	165.53
Eye height	152.35	4.23	146.10	155.50	146.57	150.80	155.03
Shoulder height	135.53	3.61	130.20	138.20	130.60	134.20	137.80
Elbow height	125.88	47.09	101.50	196.50	106.25	149.00	191.75
Waist height	97.33	3.47	92.50	100.30	92.89	96.40	99.91
Buttock height	75.28	2.53	71.80	77.60	72.09	74.70	77.31
Wrist height	79.53	3.58	75.00	83.00	75.40	79.00	82.60
Fingertip height	61.75	3.43	58.20	65.30	58.56	61.75	64.95
Width of arms	163.88	3.42	158.90	166.70	159.29	162.80	166.31
Elbow breadth	83.78	1.73	81.40	85.10	81.59	83.25	84.92
Horizontal Fingertip reach	80.90	2.38	78.10	83.60	78.38	80.85	83.33
Horizontal fist reach	70.18	2.46	66.80	72.20	67.07	69.50	71.93
Shoulder breadth	41.40	2.49	39.00	44.90	39.30	41.95	44.61
Chest breadth	27.23	0.87	26.30	28.30	26.40	27.30	28.20

Hip breadth	34.80	3.34	32.20	39.60	32.57	35.90	39.23
Neck circumference	33.98	2.62	30.70	37.00	31.02	33.85	36.69
Chest circumference	89.63	6.05	83.20	97.60	83.92	90.40	96.88
Waist circumference	78.38	9.95	70.70	93.00	71.82	81.85	91.89
Hip circumference	95.98	9.32	87.60	109.30	88.69	98.45	108.22

Table 5.Anthropometric data for Mixteco (male)

Dimension	Mean	SD	Min	Max	5th	50th	95th
Weight	57.66	5.97	50.80	64.20	51.47	57.50	63.53
Stature	159.15	5.58	153.20	166.10	153.85	159.65	165.46
Eye height	148.43	4.95	142.70	154.40	143.29	148.55	153.82
Shoulder height	130.65	3.96	126.10	135.70	126.58	130.90	135.22
Elbow height	97.43	5.66	90.70	104.20	91.38	97.45	103.53
Waist height	95.93	2.89	93.40	100.00	93.73	96.70	99.67
Buttock height	70.90	4.42	65.10	74.50	65.57	69.80	74.03
Wrist height	78.55	2.73	74.60	80.80	74.91	77.70	80.49
Fingertip height	85.55	50.77	57.50	161.60	62.71	109.55	156.40
Width of arms	159.75	3.82	155.80	164.90	156.26	160.35	164.45
Elbow breadth	82.25	2.53	79.00	85.00	79.30	82.00	84.70
Horizontal Fingertip reach	77.68	3.56	74.60	82.80	75.01	78.70	82.39
Horizontal fist reach	71.53	2.24	69.30	74.30	69.55	71.80	74.05
Shoulder breadth	42.15	1.73	40.50	44.50	40.70	42.50	44.30
Chest breadth	31.50	3.25	28.40	34.50	28.71	31.45	34.20
Hip breadth	32.35	1.39	30.60	34.00	30.77	32.30	33.83
Neck circumference	35.88	1.18	35.00	37.50	35.13	36.25	37.38
Chest circumference	87.83	3.48	83.00	91.30	83.42	87.15	90.89
Waist circumference	78.30	6.73	70.00	86.20	70.81	78.10	85.39
Hip circumference	90.83	3.64	85.80	94.50	86.24	90.15	94.07

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ANTHROPOMETRIC CHARTS DEVELOPMENT FOR THE FEMALE WORKERS IN THE GARMENT INDUSTRY FROM THE STATE OF MORELOS.

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Resumen: Para dar inicio al proyecto de investigación "desarrollo de una metodología para la mejora de procesos industriales y sus ambientes de trabajo" con número PROMEP/103-5/11/4299, desarrollado en la Facultad de Ciencias Químicas e Ingeniería de la Universidad Autónoma del Estado de Morelos, se procedió a realizar un estudio antropométrico y de condiciones de trabajo de las mujeres que laboran en la industria de la confección. Para ello se acudió a la zona industrial conocida como Ciudad de la Confección de Emiliano Zapata. El objetivo es elaborar cartas antropométricas especiales para la región que puedan ser utilizadas en estudios posteriores para mejorar las estaciones de trabajo que provoquen enfermedades profesionales a las trabajadoras de la región. Los datos obtenidos fueron analizados estadísticamente para describir el comportamiento de la población, posteriormente se calcularon los percentiles para cada una de las 35 medidas corporales básicas observadas.

Palabras clave: Antropometrìa, Ambiente de trabajo

Abstract: As beginning of the research project called "Methodology development for improving processes and their work environments" identified as PROMEP/103-5/11/4299, developed by the Facultad de Ciencias Químicas e Ingeniería de la Universidad Autónoma del Estado de Morelos, México. We proceeded to perform an anthropometric study in women whose work in the garment industry. For this purpose we visited an industrial land known as Emiliano Zapata City Garment. In the first instance we are interested in know the body characteristics of the female workers population. The aim is to develop special anthropometric charts that can be used in future studies, to improve workstations that cause occupational diseases to workers in the region. Data were statistically analyzed to describe the behavior of the population, and then the percentiles were calculated for each of the 35 basic body measurements observed.

Keywords: Anthropometrics, work environment.

1. INTRODUCTION

The ergonomics is an study area that include the anthropometric features as a part of fundamental information to improve workstations and their environment. Lamentably in Mexico, there are not available anthropometric charts that can be used by the garment industry to develop workplaces with machinery, tools and clothing according with the people necessity in order they can performance their activities properly. Unfortunately, the work of the women at the garment industry has been characterized by a poor ergonomic areas, overworked shifts and stress causing cause occupational diseases that anybody has solved. Many manufacturing clothing companies hired women with the idea of they have a great ability for this activity and they abuse of the female abilities to reach the sales target and other issues of the company with areas completely neglected of safety [Salvendy 2004].

2. OBJECTIVES

The main objective of this work is to develop the anthropometric charts for female workers of garment industry. For this purpose we visited an industrial land known as Emiliano Zapata City Garment, where working 750 women approximately in 7 plants. Additionally, we want to know which areas are more susceptible to cause discomfort to the workers.

3. METHODOLOGY

The sample size was 76 people and represents approximately 10% of the female population of the industrial land.

1. In the first place, we designed a special sheet for recording the data and the result of the survey.

2. 2. 35 body measurements were collected from the workers organized in two data sets (See table 1)
   a. Measures on foot.
   b. Measures on sitting.

3. We take the measurements with the following equipment.
   a. Metric tapes of 1.5 mts.
   b. Anthropometer Lafayeffe with range of 60 cm.
   c. Anthropometer Lafayeffe with range of 30 cm.
   d. Scale Tanita WB-3000
   e. Anthropometric seats

Table 1: Format for recollect data.

	1	2	3	4	5	6
Measures on foot						
1. height						
2. Weight in kg						
3. Body Mass Index						
4. Vertical reach						
5. Eyes height						
6. Waist width						
7. Hip width						
8. Width of head						
9. Chest circumference						
10. Waist circumference						
11. Hip circumference						
12. Circumference of forearm						
13. Arm Circumference						
14. Circumference of lower leg						
51. Ankle circumference						
16. Circumference of wrist						
17. Circumference of hand						
Measures on sitting	1	2	3	4	5	6
1. Horizontal reach arm						
2. Foot horizontal reach						
3. High between thigh to seat						
4. Popliteal height						
5. Knee height						
6. lenght from popliteal to gluteus						
7. lenght from knee to gluteus						
8. Thigh Circumference						
9. Ankle height						
10. Foot length						
11. Width of the foot						
12. Width hip						
13. length of hand						
14. Width of hand						
15.height of hand						
16. Length from elbow to wrist						
17. Breast height						
18. width of shoulders						
19. cm reached to stooping						
20. Angel degree reached to stooping						
21. Age (years)						

4. We design an anthropometric maps with the measures required from the female workers. In the figure 1 we can see these anthropometric maps. The measurements recollected are shows in the figure 1 and the claves PM means are related with the format recollect data.

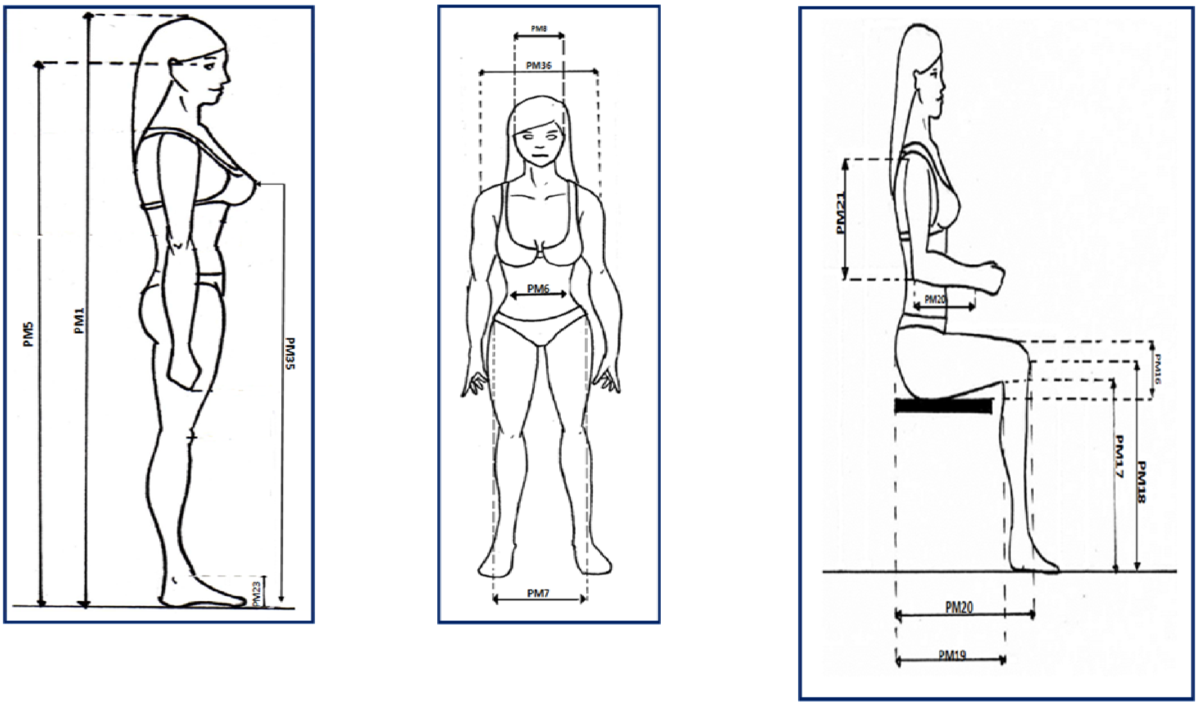

Figure 1. Anthropometric maps designed by help the students to identify the measurement with the part of the body required.

5. Recollect the information (see figure 2).

a) Measures on foot b) Measures on sitting

Figure 2. Activity of recollect data for female workers

4. RESULTS

We collect data form 76 operators from sewing area that represents the 80% of the female workers in the factory. The results and summary was performed using an Excel data sheet introducing the measures taken from operatives and analyzing each anthropometric parameter, thereby obtaining the results shown in Table 2, which is shown below:

Table 2. Results obtained from the anthropometric study.

Parámetros Antropométricos de Medición				Percentil		
	Medidas de pie	**Media aritmética**	**Desviación estándar**	**5**	**50**	**95**
PM1	height	152.6	5.8	143.4	152.8	161.6
PM2	Weight in Kg.	61.1	17.5	39.0	58.7	88.6
PM3	Body mass index	26.5	6.9	17.4	26.1	39.1
PM4	Vertical reach	190.4	7.1	180.4	190.0	203.1
PM5	Eyes higth	140.0	5.5	132.0	140.0	148.0
PM6	Waist width	28.4	4.4	22.7	28.0	36.3
PM7	Hip width	34.7	4.0	29.5	34.7	41.0
PM8	Widht of heat	15.4	0.9	14.0	15.5	16.6
PM9	Chest circunference	96.0	13.6	77.9	95.3	120.1
PM10	Waist circunference	84.5	15.1	63.9	83.0	111.5
PM11	Hip circunference	98.1	14.7	78.9	96.0	128.0
PM12	Forearm circunference	29.0	14.0	20.9	27.5	36.1
PM13	Circunference of arm	22.7	9.1	18.4	22.0	26.6
	Medidas sentado					
PM14	Horizontal reach arm	67.0	4.9	60.0	67.0	74.1
PM15	Foot horizontal reach	88.8	12.7	58.8	92.0	102.1
PM16	High between thigh to seat	12.1	2.2	8.9	12.0	15.3
PM17	Popliteal height	39.9	2.1	36.8	40.0	43.0
PM18	Knee height	46.7	2.8	42.6	47.0	51.0
PM19	lenght from popliteal to gluteus	42.9	3.6	37.3	43.0	48.0
PM20	lenght from knee to gluteus	52.7	3.8	47.9	52.5	59.1
PM21	Thigh Circumference	47.9	6.1	38.8	47.8	56.5
PM22	Circumference of lower leg	35.0	4.8	27.8	34.8	42.0
PM23	Ankle height	7.2	1.9	5.2	7.0	9.0
PM24	Ankle circunference	24.3	2.5	21.0	24.0	29.0
PM25	Foot length	22.0	2.6	20.0	22.2	24.5
PM26	Width of foot	7.9	1.2	5.9	8.0	9.2
PM27	Widht of Waist	38.8	8.5	31.4	38.3	47.0
PM28	length of hand	16.7	1.4	14.8	16.6	18.9
PM29	Width of hand	8.0	0.6	6.9	8.1	9.0
PM30	Circumference of wrist	15.2	2.2	12.9	15.0	18.0
PM31	Circumference of hand	19.9	1.4	17.5	20.0	22.1
PM32	Hight of hand	2.9	1.8	2.0	2.7	3.5

5. CONCLUSIONS

School of Chemical Sciences and Engineering at the Autonomous University of Morelos, is currently conducting an anthropometric study in the garment industry with the aim of generating anthropometric tables that can be used to improve the design of workstations in the industry.

The idea is to improve the working conditions of these workers. It should be noted that having a lab in the Faculty of Industrial Engineering further strengthened the idea of conducting an investigation of this magnitude. This is an aspect that should take into account all the universities for the development of students and foster research and technological development, to keep industrial growth.

Furthermore, the fact that he had the collaboration of a company of Morelos was of great importance to perform a thorough job and, above all, know the real needs of women working in this branch of industry.

With the development of anthropometric tables establishes the basis for the development of new and / or improved workstations; itself better working conditions and thus automatically increasing efficiency in the industry, the state's economy and most important is the quality of life of workers.

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Anthropometric Comparisons of heads among ethnic, rural and urban mixed race people, in the North of Sinaloa State.

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RESUMEN. La zona norte de Sinaloa, tiene un número considerable de grupos étnicos, predominando en la zona sur de Sonora y norte de Sinaloa los grupos mayos, yoremes y seris, sin embargo, en el área de Mochicahui se encuentra la Universidad autónoma Indígena de México, donde asisten personas indígenas de toda la república Mexicana, estas personas acuden a estudiar a este lugar no obstante algunos deciden quedarse a vivir en la zona, influenciando en el desarrollo social e industrial.

Se realizo un estudio de medidas craneales a un número de 120 individuos de entre 18 y 24 años, en ellos se midió la circunferencia craneal, diámetro occipitofrontal, longitud de cien a cien, oreja a oreja, barbilla a nariz, barbilla a nasion, y amplitud de nasion a vertex.
El estudio se dividió en 3 grupos principales, Mestizos, Etnias del Sur de México y Etnias del Norte de México, tomando esas divisiones principales pues estas etnias son las más representativas numéricamente, según el INEGI.
Un dato curioso es que no se observa una diferencia significativa en las comparaciones de las medias de las 8 medidas que se realizaron, a los tres grupos de individuos que se tomaron.

Los datos anatómicos y antropológicos obtenidos aportaran nuevos conocimientos al área de la salud y a la biología étnica Mexicana.
Keywords. Anthropometry, ethnicity, head

SUMMARY. The northern part of Sinaloa, has a considerable number of ethnic groups, predominantly in southern Sonora and northern Sinaloa groups Mayos, yoremes and seris, however, the area is Mochicahui Autonomous University of Mexico Indian, where indigenous people attending throughout the Mexican republic, these people come to study here however some choose to stay and live in the area, influencing the social and industrial development.

We performed a study of cranial measurements to a number of 120 individuals between 18 and 24 years, they measured the head circumference, occipitofrontal diameter, length of one hundred to

one hundred, ear to ear, nose, chin, chin to nasion, and nasion to vertex amplitude. The study was divided into 3 major groups, mixed race people, Ethnic groups of southern Mexico and northern Mexico Ethnic, taking these major divisions as these ethnic groups are the most representative numerically, according to INEGI.

A curious fact is that there is no significant difference in comparisons of the means of the 8 measures were performed, three groups of individuals that were taken. The anatomical and anthropological obtained provide new insights into the area of health and ethnic Mexican biology.

Keywords. Anthropometry, ethnicity, anthropometric cranial letter

INTRODUCTION.

Over the years man has modified their environment, their environment, their home, based on the physical, psychological and social, which is reflected today as comfort and ease of development of different jobs and housing. In different parts of the world seen different social and physical features, dress, language, food influence the progress of a society. Anthropometric measurements help in building equipment, furniture, tool. The head measurements aid in the development of protective equipment and fashion. The cranial development of Mexican indigenous societies has its particular characteristics, but you need to check what are the forms and rates of growth in the Mexican Indians and mixed race people of the various regions, so you need a database that allows for conjecture.

(INEGI, 2011) Indigenous people have the habits and customs. They have particular ways of understanding the world and interact with it. Dress, eat, celebrate their festivals, live and appoint their own authorities, in accordance with this conception of life. A very important element that distinguishes them and gives them identity, is the language with which they communicate. In Mexico, 6 million 695 thousand 228 people age 5 and over speaking an indigenous language, the most widely spoken are Náhuatl, Maya and Mixtec languages. (Ramirez, 1991) The ergonomic studies are not limited to man's problem - workplace, but go beyond, applying its criteria and schemes to any human activity, both in production and in daily life. One of its applications is the design and construction of complex industrial goods for domestic use cultural, vehicle applications for comfort and safety of users, etc.. Ergonomic work falls under the category of applied research that ensure the integration of science in production and offer measures to relieve work and raise their efficiency and quality.

(Rosa Ma, 2002) A study conducted in Mexico shows that the situation of a group of adult subjects belonging to the Triqui studied in 2002, exploring possible physical changes observed over a century. It was noted that over the years, the height of Triqui remains very low, no doubt associated with the environmental constraints that have limited their growth and physical development during the first twenty years of age. There were more women with small stature. Also noteworthy is the emergence of overweight and obesity cases in men studied in 2002 vs 1940. In 2002 more women than men were overweight. The above situations, along with lower education and higher illiteracy and monolingualism of women, gender inequalities translate. The physical status of Triqui adults has changed over time, however, this has impacted negatively on their health, since due to the circumstances in which his life has elapsed survivors is violated and therefore vulnerable.

(SUN, 2005) was performed in 50 anthropometric adults (19-83 years) male, the Mapuche ethnic group, belonging to some reductions in the coastal area of the IX Region of Chile. Individuals in the Mapuche ethnic group exhibit characteristics typical of mesocephaly, with a clear tendency to brachycephalization. The anatomical and anthropological data obtained provide new knowledge to the Biological and Physical Anthropology and professionals in the health area.

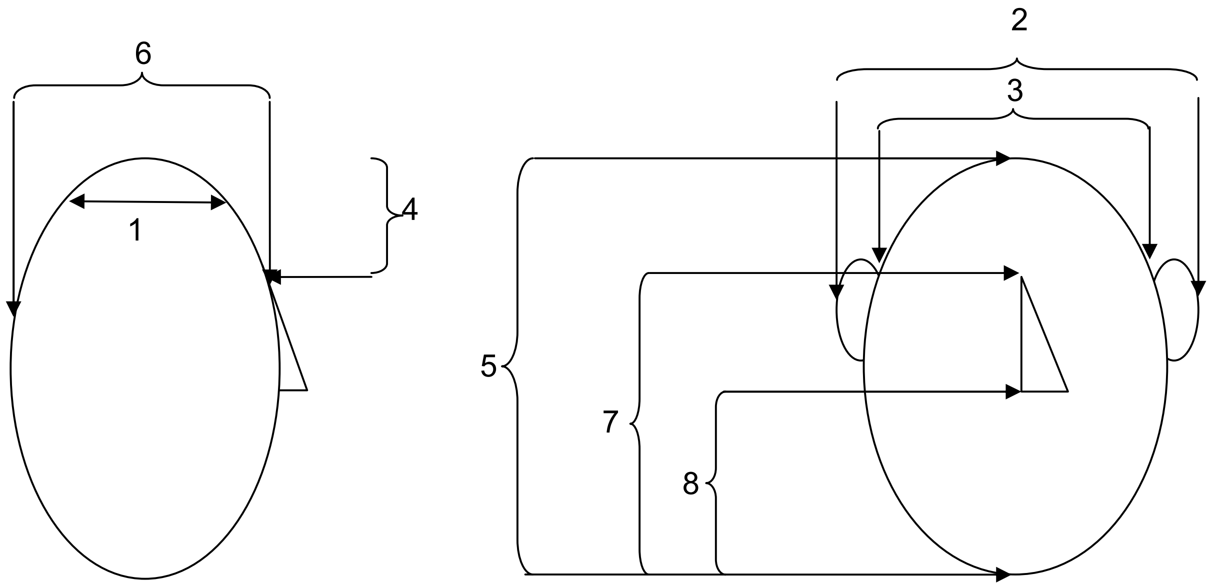
(Ferembach, 1956) In a large study (on the constant cranial, cranial braquicráneo and architecture, said the braquiocefalia appeared in the Mesolithic in a part of Europe and North Africa. However, the theory of population migration Yellow can not explain the expansion of braquiocefalia in Europe. This would occur under the influence of the muscles, the pressure on the skull during childhood, the size and on or deficient diet.

OBJECTIVE

Compare anthropometric measures of the head of mixed-blood people and ethnic origin in the north and south of Mexico.
When analyzing the mean anthropometric this may lead to the creation of team work, education and industry for indigenous people in Mexico, if the results indicate.

Subjects and Methods

It is clear that growth occurs in puberty, it was decided to study in people aged 18 to 24 years of age to standardize the results and because the students attend UAIM where study subjects have a age in these ranges.
Individuals volunteered to participate in the development of research. For each of them conducted a survey that asks ethnicity and cranial measurements are taken as follows:
1. Cranial circumference.
2. Length from ear to ear
3. Dot diameter about sphenoid sphenoid (one hundred to one hundred)
4.vertex-nasion length
5. chin-vertex length
6. occipitofrontal diameter
7. chin-nasion length
8. chin-length nasal spine



The data analysis will be made only with the comparison between the data of descriptive statistics for each of the classifications:
1. Mixed race people from the North of Sinaloa
2. Ethnic South Mexico
3. Ethnic Northern Mexico

The number of individuals was limited to people who go in the area of Mochicahui being Métis people who do not speak the language and know their indigenous roots (in the area of Los Mochis, Sinaloa), on the ethnic groups of South Mixtec, Zapotec , Chol, Chinanteco, Chatina, Zoque (Guerrero, Oaxaca and Chiapas), and Northern Mexico to Tarahumara, May, Yoreme, Tepehuano and Yaqui (Sonora, Sinaloa, Chihuahua and Durango), being the most representative ethnic Mexico .

Measurements were taken with an anthropometrical Clarita, and Holstain Roshcraft classroom multipurpose Indigenous Autonomous University of Mexico and the facilities of the Technological Institute of Los Mochis.

RESULTS

The results of the measurements made at each of the groups of individuals give very little statistical differences between the anthropometric measures of each of the groups. As to the cranial circumference no differences between the measurements representative even percentiles are similar to each other, as shown in Table 1.

Table1. Anthropometric measurements of head circumference between groups.

Statistic Results					
circumference	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	54.14333333	2.17006531	50.525	54.05	57.3
Ethnic South Mexico	54.0352381	1.96071911	51.2	53.8	57.2
Ethnic Northern Mexico	54.00485437	1.96141099	51.2	53.8	57.2

Just asthere isnosignificant difference inthe distancefrom ear to earacross groups,becausethe discrepancybetween the averageisonly2.7 mm.According to Table2.

Table2. Anthropometric measurementsfrom ear to earacross groups.

Statistic Results					
ear to ear	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	18.3035	1.20464	15.792	17.952	20.04
Ethnic South Mexico	18.04095238	1.2255058	16.095	18.05	20
Ethnic Northern Mexico	18.03333333	1.21121892	16.02	18.1	19.96

The distance of One Hundred to One Hundred(From point to points phenoidsphenoid), is about 1 mm lower in the crossbreds.Table3.

Table3. Anthropometric measurements ofone hundred to one hundredbetween groups.

Statistic Results					
Frompointtopointsphenoidsphenoid	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	14.65066667	1.36321504	13.29	14.8	15.755
Ethnic South Mexico	14.76190476	0.99463764	13.42	14.8	15.78
Ethnic Northern Mexico	14.77821782	1.00155918	13.5	14.8	15.8

The results of nasion-given vertex data in the lower half of the ethnic groupsinnorthern1.3mm.Table4.

Table4. Anthropometric measures nasion-vertex between groups

Statistic Results					
nasion - vertex	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	16.59927536	1.20264285	14.985	16.4	18.5
Ethnic South Mexico	16.59407407	1.20884569	14.97	16.4	18.5
Ethnic Northern Mexico	16.46346154	1.11599646	15	16.3	18.5

.

The data obtained in the middle of the mental-vertex differences not significant.

Table5. Anthropometric measuresment al-vertex between groups

Statistic Results					
mentoniano - vertex	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	22.80135135	1.74741739	20.3	23.2	24.7
Ethnic South Mexico	22.81448276	1.20884569	14.97	16.4	18.5
Ethnic Northern Mexico	22.7993007	1.74337767	20.3	23.2	24.68

.

The occipitofrontal distance apartgive.5 mm higher than in ethnically mixed. Table6.

Table6. Occipito frontal anthropometric measurements between groups

Statistic Results					
Occipitofrontal	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	18.61973684	0.9013448	17.3	18.6	20.045
Ethnic South Mexico	18.5771028	0.89446095	17.3	18.5	19.97
Ethnic Northern Mexico	18.55913462	0.90020937	17.3	18.5	19.985

.

The means obtained from nasion-menton, it appears that less than1 mm are mixed ethnicities.Table7.

Table7. Nasion-menton anthropometric measurements between groups.

Statistic Results					
nasion mentoniano	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	12.23178808	0.85902044	11	12.2	13.6
Ethnic Northern Mexico	12.32735849	0.83352756	11.1	12.3	13.575
Etnias Norte de México	12.32115385	0.84009628	11.1	12.3	13.585

Interestingly also observed that the mixed race people have less distance from chin to the nasal spine, having the same ethnic distance both North and South of the country.

Table8. Anthropometric measuresmental-nasal spine between groups

Statistic Results					
mentoniano - nasal spine	Media	Desv. Est.	Perc. 5%	Perc. 50%	Perc. 95%
mixed race people	7.110135135	0.57767301	6.2	7	8
Ethnic South Mexico	7.137864078	0.6113496	6.2	7.1	8
Ethnic Northern Mexico	7.137623762	0.61706588	6.2	7.1	8

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DISCUSSION AND CONCLUSIONS

One of the factors involved in the development of society is its culture, people of ethnic origin have immigrated to more developed urban areas, survival is a natural instinct in man, and not Mexico Indian society exception. This behavior has led to ethnic individuals to study, work and cope in urban industrial areas, seeking to have the same opportunities; the adaptation of people to their work will determine its survival.

In the analysis made to 120individuals, no significant differences in cranial measurements, in fact in a very subtle form of ethnic groups both North and South, have larger sizes millimeter mixed race people, of which the measures were expected over in the physique that seen with the naked eye mixed race people especially in urban areas.

With respect to the results obtained so far can be concluded that cranial measurements are not a factor in the adjustment of industry and education for Mexican ethnicity, so that the use of helmets, glases, goggles, caps, hats, caps, etc...Will not be different to run comfortable for these indigenous people, with difference cranial measurements significantly less development in urban societies of mixed races.

The investigation is ongoing, and results may vary, however, these results have given us notions of cranial anthropometric behavior in the various ethnic groups present at Mochicahui, El Fuerte, and Sinaloa.

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Foot: an anthropometric comparison between mayos-yoremes and urban mixed race people of the northern Sinaloa.

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RESUMEN

En la región norte del estado de Sinaloa se encuentra ubicado el grupo étnico mayo-yoreme, que comparte espacios laborales con los mestizos urbanos de la ciudad de Los Mochis, así mismo en el poblado de mochicahui se sitúa la Universidad Autónoma Indígena de México donde confluyen estudiantes, de los diversos grupos indígenas de México, siendo el más numeroso el de los mayos-yoreme, situación favorable para desarrollar el estudio , el cual consistió en medir 6 variables antropométricas del pie entre la cuales tenemos, largo del pie, talón-empeine, ancho de pie, ancho de talón, alto de empeine, y diámetro de tobillo, en 42 estudiantes pertenecientes al grupo étnico mayo-yoreme 18 mujeres y 24 hombres, en edades entre 18 y 24 años con el propósito de comparar antropométricamente con 42 estudiantes urbanos rurales de la ciudad de los Mochis. Estas comparaciones serán útiles para tomar la decisión de manejar una sola caracterización antropométrica para toda la región norte de Sinaloa o manejar dos caracterizaciones distintas para cada uno de los grupos participantes en el estudio, mismas que servirán como base para el diseño de calzado, dispositivos de protección, pedales, etc. que nos lleven al diseño de estaciones de trabajo adecuados a sus características y a sus lugares de origen.
Para la comparación de resultados se utilizo una prueba “***t*** ” para la diferencia de dos muestras, presentando los resultados estadísticos tabulados y en graficas de caja.

Palabras clave: Antropometrìa, Mayo-Yoreme, pie

ABSTRACT

In the northern state of Sinaloa is located the Mayo-yoreme ethnicity, shared work spaces with Urban mixed races of the city of Los Mochis, likewise in the town of Mochicahui lies the Universidad Autonoma Indigena de Mexico where students come together, of the various indigenous groups in Mexico, being the largest the Mayo-yoreme, favorable situation to develop the study, which was to measure 6 foot anthropometric variables between which we have, foot length, heel-instep , Foot width, heel width, height instep, and ankle diameter, in 42 students from the ethnic group Mayo-yoreme 18 women and 24 men, aged between 18 and 24 years with purpose to compare anthropometric with 42 rural urban students in the city of Los Mochis. These comparisons will be helpful in making the decision to manage a single anthropometric characterization for all northern Sinaloa or handle two different characterizations for each of the groups participating in the study, which shall serve as base for the design of footwear, devices protection, pedals, etc.. that will lead to the design of work stations appropriate to their characteristics and their places of origin.
For comparison of results it was used a test "***t*** " for the difference of two samples, presenting the statistical results tabulated and box plots.

KEYWORDS: Anthropometry, Mayo-Yoreme, foot.

INTRODUCTION

In a society that is considered respectful of multiculturalism, there should be no discrimination traits and should to worry about providing opportunities to all its habitants irrespective of dialects, language, religion to practice, because Mexico has its strength in the diversity of its people.

The generation or search for information on anthropometric characteristics of ethnic groups is important in two ways;

One of them leads us to the situation in the Mexican industry particularly in the north of Sinaloa, where members of different ethnic groups in the country share work spaces, educational and social urban mixed race, in major cities of Sinaloa, which have migrated from their homelands in search of better opportunities (Moctezuma & Lopez, 2007), mainly Mayo-Yoreme group, which has the largest presence in northern Sinaloa and southern Sonora, it is important to mention that the work they perform in the labor sector are affected by the use of tooling, designed, considering anthropometric data taken from populations with very different characteristics to those groups, May-Yoreme and mestizo urban northern Sinaloa, usually used to design anthropometric charts in other countries, developed countries generally throughout history have been characterized as the leaders in the design of technology, such as USA, Germany, England etc. Obviously this situation is reflected in high levels of exhaustion, injury, stress and low productivity.

The other is the high degree of marginalization of the places where populations are located to integrate ethnic groups, lack of jobs and the difficulty of governments to convey the satisfiers necessary to enable them to live with dignity and decorum.

An alternative for these people to develop, is to help them generate their own production facilities, to have jobs and are incorporated into the productive sector in their own places of origin, enabling them to preserve and promote its cultural structure, it is important that workstations that are designed, consider having the anthropometric characteristics of populations (Lockyer, 1998), to avoid wasting capacity, as well as prevent injury and low productivity by excessive fatigue.

That is why we consider important anthropometric generate letters serve as a starting point for the design of tools and devices that allow for its activities with high levels of comfort and efficiency.

This research focuses on obtaining 6 foot anthropometric measurements for the design of fashion footwear, safety shoes, stair treads, fasteners of the foot pedals, spaces such as cockpits, control, car etc .

Mayo region, is located in northern Sinaloa, in the municipalities of El Fuerte, Choix, Guasave, Sinaloa de Leyva and Ahome and the southern part of Sonora, in the towns of Los Alamos, Quiriego, Navojoa, Etchojoa and Huatabampo . Practically located at sea level, in the valleys and up to 2 000 m. above the sea to the foothills of the Sierra Madre Occidental. It is located between parallels 25 ° and 27 ° north latitude and the meridian 107 ° to 110 ° west longitude. (RAMOS, 1994).

GENERAL OBJETIVE

Compare anthropometric characteristics of the foot of the Mayo-Yoreme ethnicity, and Urban mixed races of the City of Los Mochis.

MATERIALS AND METHODS

This research consists of comparing anthropometric foot between students belonging to the group Mayo-Yoreme and Urban mixed students of the city of Los Mochis. These population groups were selected, considering that much of the working population is in those ages, in the case of Mayo-yoreme indigenous group was taken as a representative sample of students from the Universidad Autonoma Indigena de Mexico.

Participated in the study as subjects of study, students from the Universidad Autonoma Indigena de Mexico, at the confluence of indigenous students from around the country, including the Mayo-yoreme group, with the largest ethnic group in northern Sinaloa, where drew a random sample of 24 men and 18 women who were asked which they approached the workplace research in proper footwear in order to remove easily for measurements.

For this study raises 6 foot measures among which include: foot length, heel width, wide foot, high instep, ankle and heel diameter.

Measurements of the Mayo-yoreme students were made on the premises of the Universidad Autonoma Indigena de Mexico and mestizo students measuring urban facilities of the Instituto Tecnologico de Los Mochis, with an anthropometrical Roshcraft.

The data obtained so far were compared statistically with the software Minitab 16 by a "t" test for two samples, the results tables accompanying a box and whisker plot for better visual representation. (Levine, Krehbiel, & Berenson, 2006)

RESULTS

	N	Mean	StDev	SE Mean
mayos female	18	23.38	1.78	0.42
mixed race female	13	24.33	1.24	0.34
Difference = mu (mayos female) - mu (mixed race female)				
Estimate for difference: -0.953				
95% CI for difference: (-2.064, 0.158)				
T-Test of difference = 0 (vs not =): T-Value = -1.76				
P-Value = 0.090 DF = 28				

Table 1. Foot length: test T Two sample for mayos female vs mixed race female

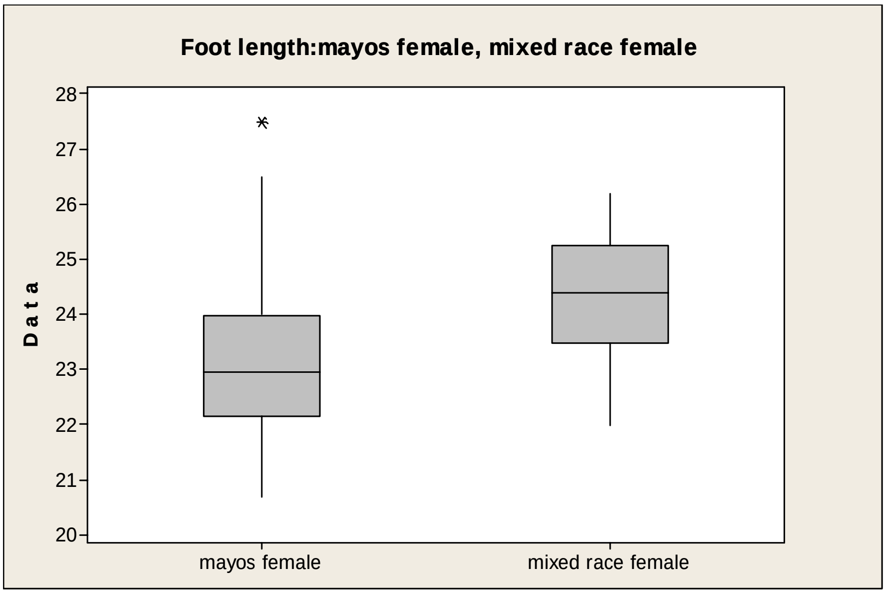

Figure 1. Foot length: Boxplot for mayos female vs mixed race female

Table 2. Foot length: test T Two-sample for mayos male vs mixed race male

	N	Mean	StDev	SE Mean
mayos male	24	25.79	1.16	0.24
mixed race male	29	26.500	0.948	0.18
Difference = mu (mayos male) - mu (mixed race male)				
Estimate for difference: -0.708				
95% CI for difference: (-1.302, -0.115)				
T-Test of difference = 0 (vs not =): T-Value = -2.41				
P-Value = 0.020 DF = 44				

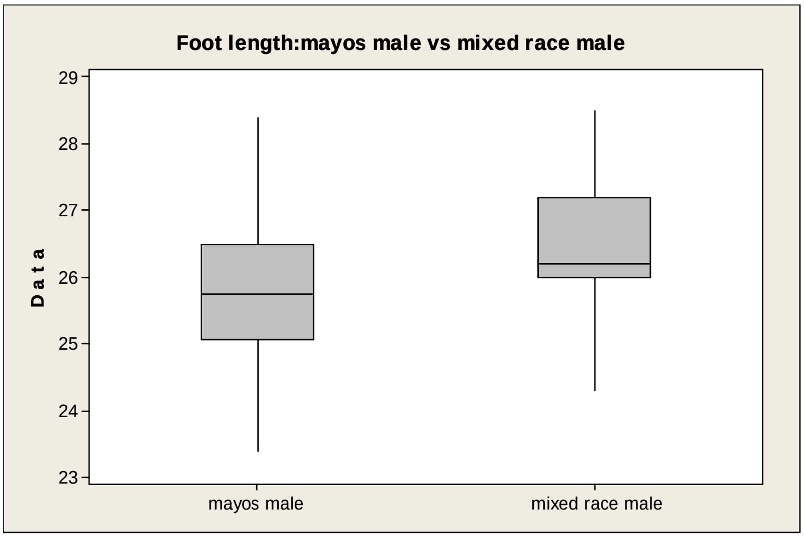

Figure 2. Foot length: Boxplot for mayos male vs mixed race male.

Table 3. heel length: test T Two-sample for mayos female vs mixed race female

	N	Mean	StDev	SE Mean
mayos female	18	5.633	0.980	0.23
mixed race female	13	6.646	0.670	0.19
Difference = mu (mayos female) - mu (mixed race female)				
Estimate for difference: -1.013				
95% CI for difference: (-1.620, -0.406)				
T-Test of difference = 0 (vs not =): T-Value = -3.42				
P-Value = 0.002 DF = 28				

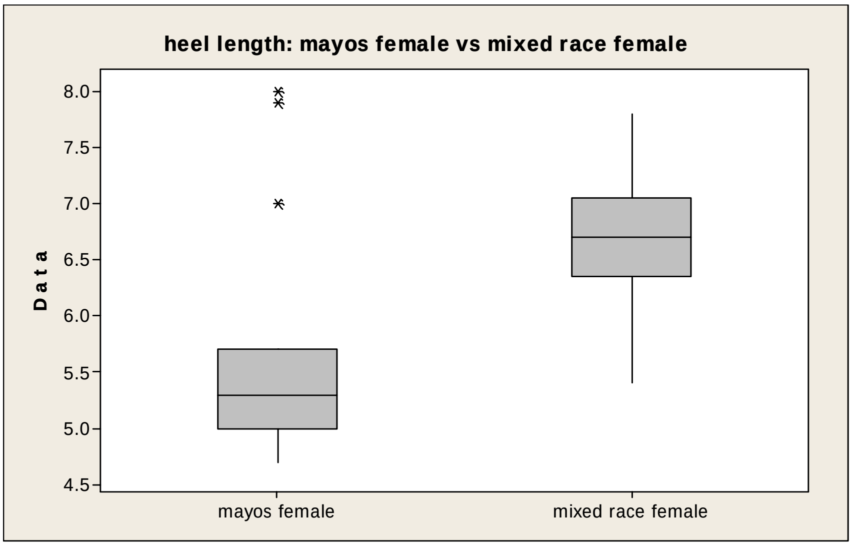

Figure 3. heel length: Boxplot for mayos female vs mixed race female.

Table 4. Heel lenght: Test T Two-sample for mayos male vs mixed race male

	N	Mean	StDev	SE Mean
mayos male	24	6.667	0.750	0.15
mixed race male	29	7.434	0.777	0.14
Difference = mu (mayos male) - mu (mixed race male)				
Estimate for difference: -0.768				
95% CI for difference: (-1.191, -0.345)				
T-Test of difference = 0 (vs not =): T-Value = -3.65				
P-Value = 0.001 DF = 49				

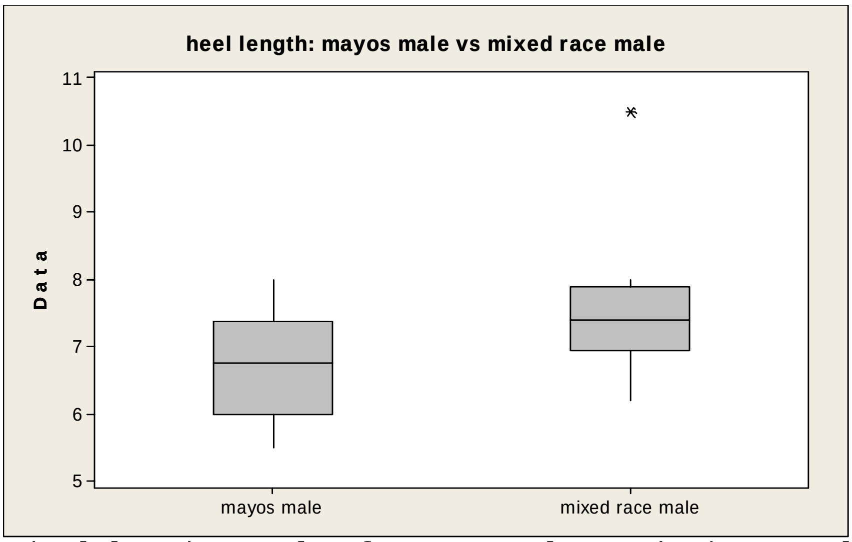

Figure 4. heel length: Boxplot for mayos male vs mixed race male.

Table 5. Foot width: Test T Two-sample for mayos female vs mixed race female

	N	Mean	StDev	SE Mean
mayos female	18	8.66	1.12	0.26
mixed race female	13	9.269	0.610	0.17
Difference = mu (mayos female) - mu (mixed race female)				
Estimate for difference: -0.614				
95% CI for difference: (-1.258, 0.031)				
T-Test of difference = 0 (vs not =): T-Value = -1.95				
P-Value = 0.061 DF = 27				

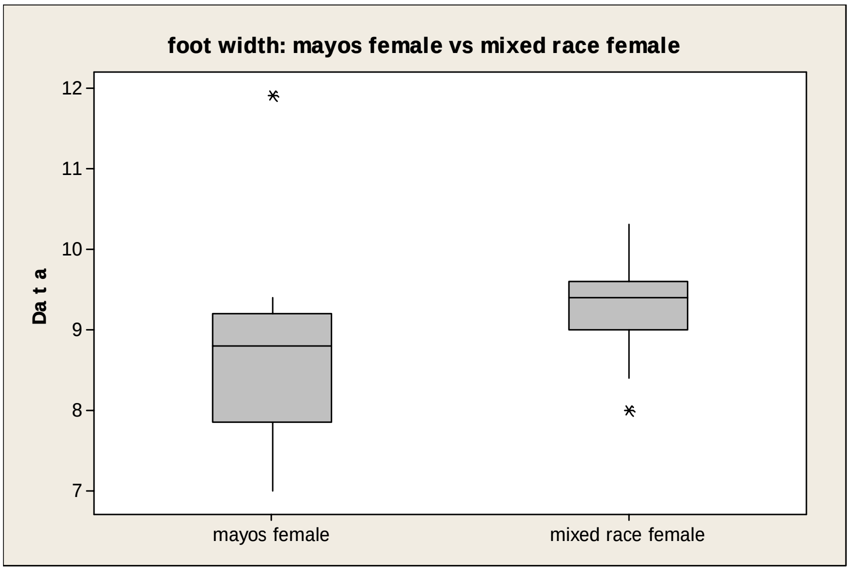

Figure 5. Foot width: Boxplot for mayos female vs mixed race female.

Table 6. Foot width: Test T Two-sample for mayos male vs mixed race male

	N	Mean	StDev	SE Mean
mayos male	24	11.73	1.21	0.25
mixed race male	29	9.993	0.374	0.069
Difference = mu (mayos male) - mu (mixed race male)				
Estimate for difference: 1.740				
95% CI for difference: (1.212, 2.268)				
T-Test of difference = 0 (vs not =): T-Value = 6.77				
P-Value = 0.000 DF = 26				

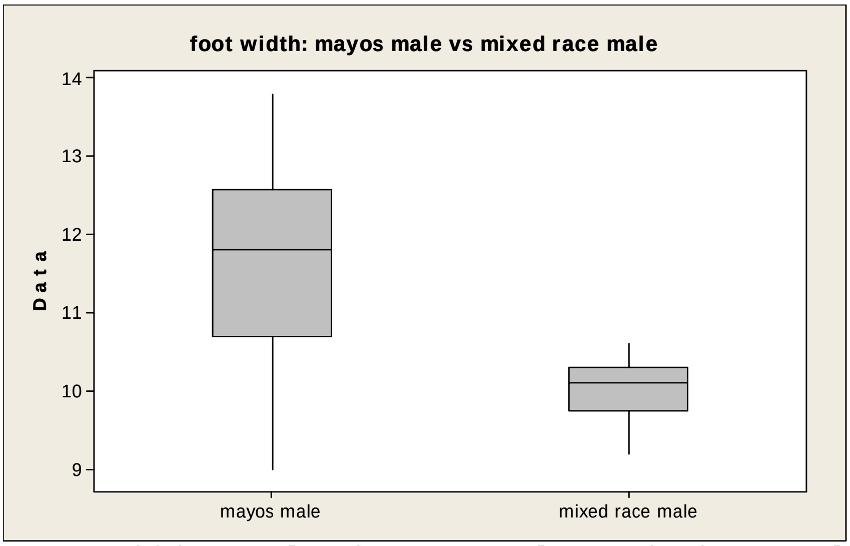

Figure 6. Foot width: Boxplot for mayos male vs mixed race male.

Table 7. Heel instep: Test T Two-sample for mayos female vs mixed race female

	N	Mean	StDev	SE Mean
mayos female	18	10.228	0.989	0.23
mixed race female	13	13.57	1.04	0.29
Difference = mu (mayos female) - mu (mixed race female)				
Estimate for difference: -3.341				
95% CI for difference: (-4.105, -2.578)				
T-Test of difference = 0 (vs not =): T-Value = -9.01				
P-Value = 0.000 DF = 25				

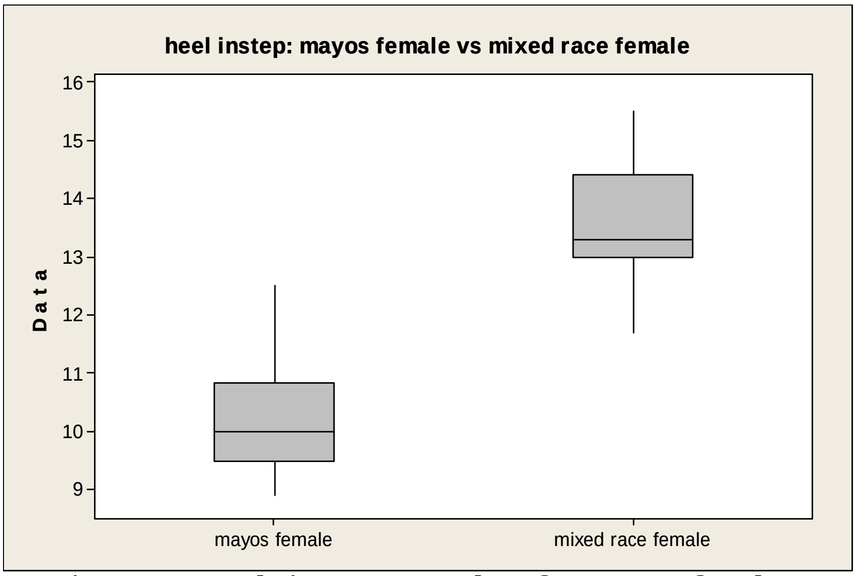

Figure 7. Heel instep: Boxplot for mayos female vs mixed race female.

Table 8. Heel instep: Test T Two-sample for mayos male vs mixed race male

	N	Mean	StDev	SE Mean
mayos male	24	11.73	1.21	0.25
mixed race male	29	15.438	0.972	0.18
Difference = mu (mayos male) - mu (mixed race male)				
Estimate for difference: -3.705				
95% CI for difference: (-4.322, -3.087)				
T-Test of difference = 0 (vs not =): T-Value = -12.10				
P-Value = 0.000 DF = 43				

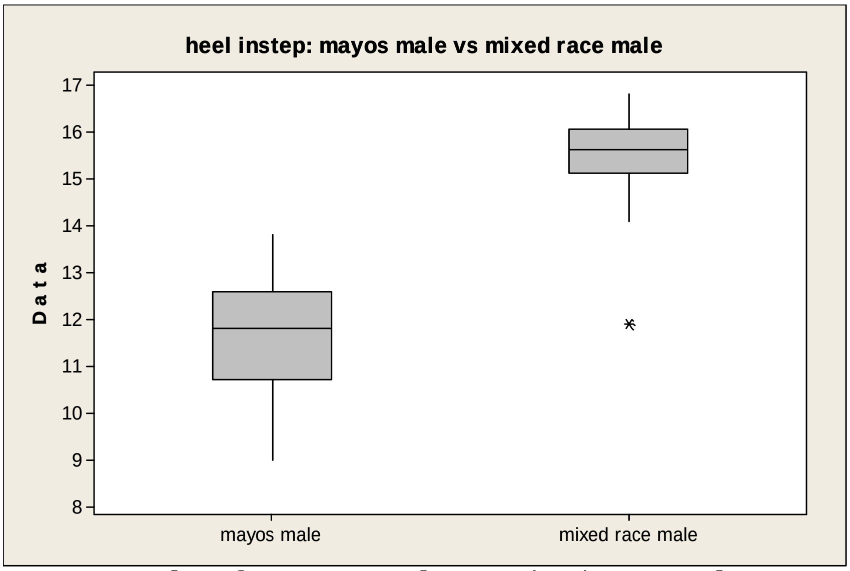

Figure 8. Heel instep: Boxplot for mayos male vs mixed race male.

Table 9. Height instep: Test T Two-sample for mayos female vs mixed race female

	N	Mean	StDev	SE Mean
mayos female	18	8.72	1.29	0.31
mixed race female	13	7.646	0.913	0.25
Difference = mu (mayos female) - mu (mixed race female)				
Estimate for difference: 1.076				
95% CI for difference: (0.264, 1.888)				
T-Test of difference = 0 (vs not =): T-Value = 2.71				
P-Value = 0.011 DF = 28				

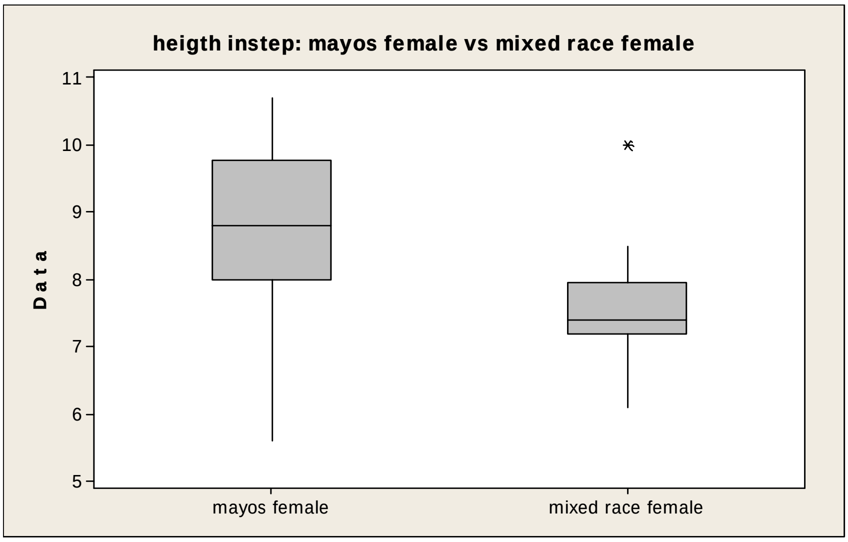

Figure 9. Height instep: Boxplot for mayos female vs mixed race female.

Table 10. Height instep: Test T Two-sample for mayos male vs mixed race male

	N	Mean	StDev	SE Mean
mayos male	24	9.163	0.856	0.17
mixed race male	29	7.372	0.590	0.11
Difference = mu (mayos male) - mu (mixed race male)				
Estimate for difference: 1.790				
95% CI for difference: (1.373, 2.207)				
T-Test of difference = 0 (vs not =): T-Value = 8.68				
P-Value = 0.000 DF = 39				

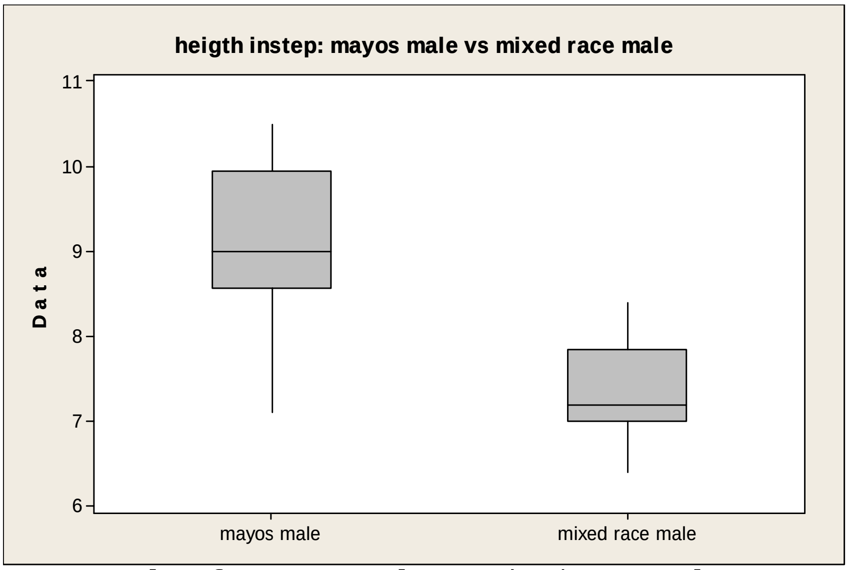

Figure 10. Height instep: Boxplot for mayos male vs mixed race male.

Table 11. Ankle diameter: Test T Two-sample for mayos female vs mixed race female

	N	Mean	StDev	SE Mean
mayos female	18	23.94	1.21	0.29
mixed race female	13	22.27	1.95	0.54
Difference = mu (mayos female) - mu (mixed race female)				
Estimate for difference: 1.670				
95% CI for difference: (0.383, 2.956)				
T-Test of difference = 0 (vs not =): T-Value = 2.73				
P-Value = 0.014 DF = 18				

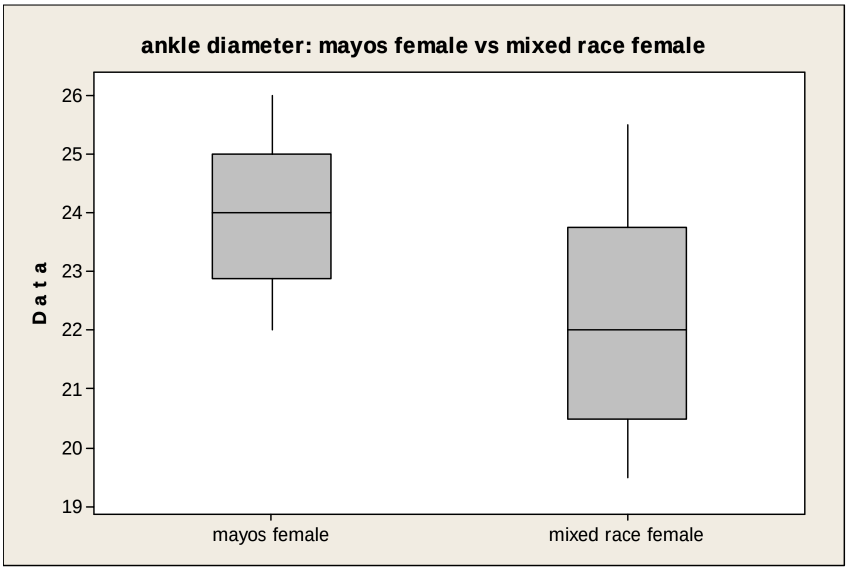

Figure 11. Ankle diameter: Boxplot for mayos female vs mixed race female.

Table 12. Ankle diameter: Test T Two-sample for mayos male vs mixed race male

	N	Mean	StDev	SE Mean
mayos male	24	25.64	1.65	0.34
mixed race male	29	25.41	1.46	0.27
Difference = mu (mayos male) - mu (mixed race male)				
Estimate for difference: 0.224				
95% CI for difference: (-0.648, 1.095)				
T-Test of difference = 0 (vs not =): T-Value = 0.52				
P-Value = 0.608 DF = 46				

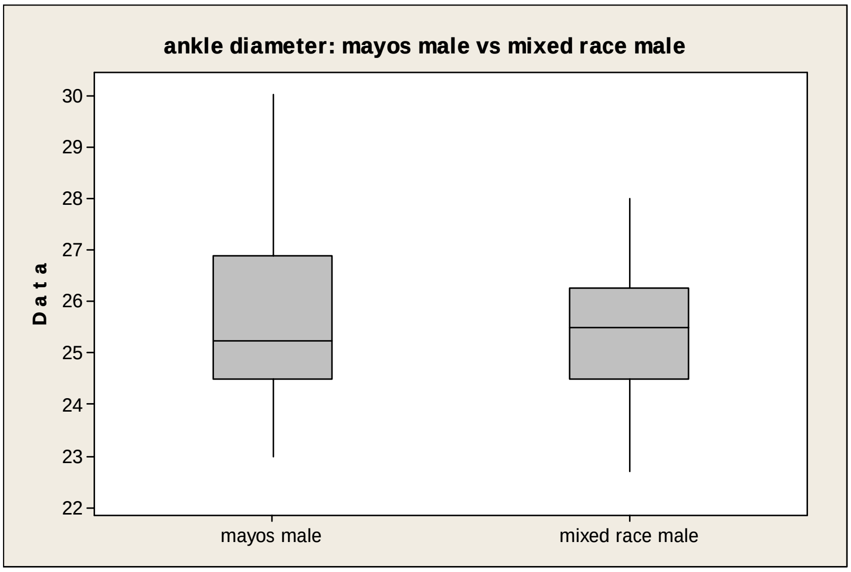

Figure 12. Ankle diameter: Boxplot for mayos male vs mixed race male.

DISCUSSION AND CONCLUSIONS

The results obtained so far show that the measures foot length and ankle diameter don't show significant statistical differences, the measures heel length, heel-instep show differences in favor of Urban mixed races while instep height show difference in favor of the group mayo-yoreme From this we can conclude that it would appropriate to continue data collection in order to confirm this behavior in the data, we can conclude that the six measures only two are statistically different from what is considered appropriate to generate two different databases for each group subjects.

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ANTHROPOMETRIC STUDY IN MALE POPULATION OF THE STATE OF MORELOS

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Resumen: Los estudios antropométricos en México son importantes porque hay pocos trabajos al respecto. En nuestro país los trabajadores varones del sector industrial tiene muchos problemas en sus estaciones de trabajo causadas por los diseños equivocados, como resultado de esto, los operadores padecen varias enfermedades profesionales. La ergonomía busca eliminar las lesiones causadas por los lugares de trabajo mal diseñados y aumentar la productividad, dando lugar a beneficios reales en la economía de las empresas que eliminan los riesgos de causar enfermedades profesionales. Un ejemplo de ello es el dolor de espalda baja, lo cual es posible evitar haciendo un mejor diseño de los lugares de trabajo. Como parte del proyecto de investigación denominado "Desarrollo de metodologías para la mejora de los procesos y de sus entornos de trabajo", identificado como PROMEP/103-5/11/4299, desarrollado por la Facultad de Ciencias Químicas e Ingeniería de la Universidad Autónoma del Estado de Morelos, México , estamos desarrollando un estudio antropométrico de la población masculina del estado de Morelos, a fin de mejorar estaciones de trabajo y evitar lesiones en los operadores.

Palabras clave: Antropometría, Ergonomía, Diseño del trabajo

Abstract: The anthropometric studies in Mexico are important because there are few works about it. In our country the male workers of the industrial sector has many problems in their workstations caused by the wrong designs, as a result of this, the operators suffer multiple professional diseases. The ergonomics looking for to eliminate injuries caused by workplaces and increase the productivity, leading to real benefits in the business economy as largely eliminate the disabilities of workers related to some diseases. One example of this is the low back pain which is possible to avoid doing better design using appropriate anthropometric data in support of the productive sector. As a part of the research project called “Methodology development for improving processes and their work environments" identified as PROMEP/103-5/11/4299, developed by the Facultad de Ciencias Químicas e Ingeniería de la Universidad Autónoma del Estado de Morelos, México, we are develop an anthropometric study for the male population of the state of Morelos in order to improve the workstation operator.

Keywords: Anthropometric, Ergonomic, Work design

1. INTRODUCTION

Anthropometry basically decides ergonomically conditions, is for that reason the anthropometric studies should be specialized in a single sector, hence the interest in the male population of the state of Morelos in order to improve the workstation operator.

The information in this work provide anthropometric information from tables based on field measurements within the male population of the state of Morelos, obtaining accurate data on their physical characteristics that help better assess efforts and have a more comprehensive study for the performance of stations adequate working to prevent occupational diseases such. So this work can be used to help designers to take due account of all ergonomic concepts to achieve successful designs especially in the early stages. This work discloses appropriate data that can provide the basis for starting a standardization in design methods and workstations. It also aims to create awareness among productive and unproductive areas, which if designed properly can reduce and even eliminate hazardous conditions that lead to disease-workers, that employees in the industry suffer at high risk tasks or repetitive tasks that cause exposure of any part of your body due to injury, which may require the worker to lose their jobs and health temporarily or even total, addition to production losses they may suffer for lack of labor and even maximizing, training costs and product as a result of sloppy work by other inexperienced operators. For do that, we are developed two study cases, the first one is relative to an anthropometric study realized in 50 men that work at the City Garment called Emiliano Zapata and the second one is an ergonomic analysis respect to reduce and eliminate hazardous conditions that are presents at packing areas that are causing low back pain to the workers.

2. OBJECTIVE

The main objective of this work is to develop an anthropometric study for male workers of the manufacturing industry. The idea is use this information in future studies about occupational diseases related with the vertebral column and the low back pain.

3. METHODOLOGY

As we are mentioned in the introduction we are developing two investigations:

a) Anthropometric study in male population of the state of Morelos.
b) Ergonomic study of the operating components at packing final area.

Both studies are strong related due that we need to know the characteristics of the male population where the problems of back pain have been appeared. The methodology used for made the anthropometric study is described below:

3.1 Anthropometric study.

1. Established the sample size for the study. We visited an industrial park known as Emiliano Zapata City Garment to take an appropriate sample which consists of 50 men. This sample represents about the 20% of the male workers in the industrial park.

2. We established three workstation to obtain anthropometric data of the population:

   a) Workstation 1: We measures weights and height on an electronic scale which automatically provides the body mass see figure 1a. Additionally, we use a tape measure to sample the circumferences of the body. See figure 1b.

a	b

Figure 1. Pictures of workstation 1 used for measure height, weights, body mass and circumferences of the body.

   b) Workstation 2: Measures workers on foot (see figure 2a.) like width of hip, width of shoulders and in sitting position like popliteal height, knee height among others. See figure 2b. All these measures were taken with anthropometer.

   c) Workstation 3: in this area the reach stooping of the workers is measured (see figure 3a). Additionally, a small survey to the workers was conducted in order to know what kind of inconvenient and discomfort they suffer during their performance. We are looking for information about the cases of low back pain. See figure 3b.

a b

Figure 2. Pictures of workstation 2. a) Measures on foot b) measures in sitting position.

a b

Figure 3. Pictures of workstation 3 a) measure of cm reached to stooping b) survey activity.

All information was recollected in a special sheet for recording the data and the result of the survey.

3.2 Methodology for ergonomic study of the operating components at packing final area.

Lately, in the packing area have being increasing the absence of the personnel. The supervisor has informed us that it is related with complaints made by the workers constantly about suffer back pain. This information was confirmed with the survey carry out to the workers during the anthropometric study.

In order to understand what is happened, we decide analyze the operation procedure from this area. The objective is found operation elements even eliminate hazardous conditions that are causing occupational diseases. The methodology used for this activity is the follow:

1. Make an analysis of the operation procedure developed by the workers.
2. Establish the hazardous conditions.
3. Simulate the operation in our laboratory in order to measure the effort realized by the workers.
4. Define if the effort realized by the worker during the daily operation is causing the back pain.
5. Using the information obtained in the anthropometric study, we propose a new workstation for the operation.

4. RESULTS

4.1 Results of the anthropometric study.

As results of measurements and analysis of data we are obtained an Anthropometric table for male population of the state of Morelos. We know that the sample size probably is not representative of all the men workers but it is the start of a series of studies related with this subject. In the table 1 we can observe the results obtained of measures obtained from the workers in the workstation 1 and in the table 2 shows the results obtained in the workstation 2 and 3 in this research. To results of survey indicate us, that the 65% of the workers interviewed manifesting suffer back pain in spite of they have 23.6 years old as average.

Table 1. Results obtained of measures on foot.

	Aritmetic mean	Standard desviation	Mode	Percentile 5%	Percentile 50%	Percentile 95 %
1. height	165.1	18.9	172.0	156.5	166.3	182.2
2. Weight in kg	68.3	14.6	60.0	47.9	66.8	89.6
3. Body Mass Index	28.9	30.5	23.0	17.6	24.0	36.7
4. Vertical reach	182.8	52.0	208.0	75.0	207.5	219.1
5. Eyes height	154.3	22.7	160.0	142.4	152.5	170.1
6. Waist width	29.4	3.9	33.0	24.1	28.9	36.1
7. Hip width	34.2	3.6	36.0	29.1	34.4	40.4
8. Width of head	18.7	19.8	16.0	15.0	16.0	18.0
9. Chest circumference	95.9	18.0	85.0	79.0	91.8	127.3
10. Waist circumference	85.4	13.4	110.0	67.8	84.5	110.0
11. Hip circumference	95.9	12.5	89.0	80.5	92.0	119.3
12. Circumference of forearm	27.2	3.4	26.0	23.5	26.0	32.8
13. Arm Circumference	25.3	7.8	30.0	18.2	23.3	35.0
14. Circumference of lower leg	35.8	4.1	35.0	29.2	36.0	42.0
51. Ankle circumference	26.6	2.0	26.0	23.2	26.3	30.0
16. Circumference of wrist	16.8	1.6	17.0	15.0	16.5	19.0
17. Circumference of hand	22.7	2.2	21.0	20.0	23.0	26.0

Table 2. Results obtained of measures on sitting.

	Aritmetic mean	Standard desviation	Mode	Percentile 5%	Percentile 50%	Percentile 95 %
1. Horizontal reach arm	72.9	4.0	74.0	67.0	73.0	79.1
2. Foot horizontal reach	96.6	8.2	93.0	85.9	97.0	105.6
3. High between thigh to seat	13.3	2.2	15.0	9.7	13.0	16.6
4. Popliteal height	43.2	2.8	43.0	40.0	43.0	47.6
5. Knee height	51.7	3.9	53.0	45.0	52.0	57.9
6. lenght from popliteal to gluteus	49.9	24.5	44.0	38.2	47.3	53.0
7. lenght from knee to gluteus	56.6	5.1	55.0	50.0	56.0	65.1
8. Thigh Circumference	45.9	5.3	44.0	37.6	45.0	53.0
9. Ankle height	7.5	1.2	8.0	6.0	7.7	9.6
10. Foot length	25.6	1.5	27.0	23.0	25.5	27.8
11. Width of the foot	8.6	1.2	9.5	6.5	9.0	10.1
12. Width hip	35.7	6.3	39.0	30.0	35.5	43.6
13. length of hand	18.6	1.5	19.0	15.6	19.0	21.3
14. Width of hand	9.0	0.8	9.0	7.7	9.0	10.0
15.height of hand	4.3	6.0	3.0	2.5	3.0	4.1
16. Length from elbow to wrist	26.2	3.7	27.0	22.8	26.5	30.6
17. Breast height	128.8	6.5	122.0	120.5	127.8	141.1
18. width of shoulders	42.7	3.3	40.0	37.7	43.0	47.0
19. cm reached to stooping	35.9	4.8	40.0	26.7	37.0	42.0
20. Angel degree reached to stooping	50.3	10.0	55.0	39.4	50.0	70.0
21. Age (years)	23.6	6.7	23.0	16.3	23.0	36.8

4.2 Results of the ergonomic study.

4.2.1 Analysis of operation procedure developed by the workers.

a) In the current method the operator leaves from the table a battery of 8 packages with a weight of 16 kg. During the operation he loads, moves and supports the material over his body around 3 to 4 meters away until he arrived to the packing area (it depends of the packing box location). See figure 4a.

b) The operator repeats this operation 200 times per shift of 8 hours.

c) The height of the inspection table is 80cm (from he takes the packages) and the base of the packing box (where he deposit the material) is 20 cm above the floor, and it is located on a platform timber (see figure 4b)

d) The time spends by the operator load and transport 80 packages to fill one packing box are 2.4 minutes.

e) The figure 4b shows the moment when the worker put the material into the box packaging. The operator remains the column ranging from 30 ° to 120 ° approximately at 46.6 minutes during the eight-hour shift.

a b

Figure 4. Operation number one, the operator loads, move and support the material over his body until he arrives to the packing area.

4.2.2 Analysis of operation in the ergonomic laboratory from FCQeI.

We have conducted in the laboratory a test in order to simulate the original operation for purposes of study and propose a new prototype station ergonomically better designed and conducted an anthropometric study that helps the analysis of this season, and to propose a new one.

In general, a lifting action which starts at a distance and moves towards the person’s body is likely to be easier to control tan one which starts closet to the body and moves away, since in the former case the individual will be lifting the load into the region of greater stability provided by his foot base and into his region of greater strength. See figure 5.

Figure 5. The first action on which stands the table weight for transport.

In this action the operator moves to accommodate the load end and the movement that is similar to the original operation mentioned is worth mentioning that this simulation is identical original wing. See figure 6.

Figure 6. Transporting the material to the place of packing

The posture a person adopts when performing a particular task is determinate by the relationship between the dimensions of the person's body and the dimensions of the various items in his or her workspace (a tall person using a standard kitchen will stoop more than a short one, etc.). the extent to which posture is constrained in this way is dependent upon the number and nature of the connections between the person and workspace. See figure 7 a and b.

a

b

Figure 7. a) Placement in the final embalaj b) Accommodate the material in the final package

Based on different formulas which will help the calculation of efforts, to make the laboratory simulation we noted that made forces complex as is in the diagram figure 8. tells as forces acting.

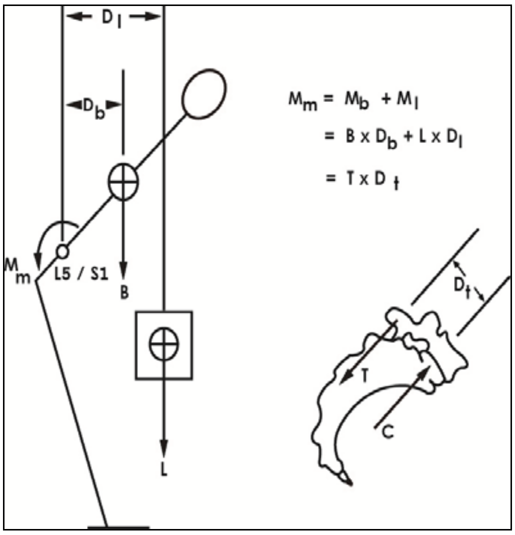

Figure 8. The mechanics of the lifting action [Pheasant 1991].

$$Mm = Mb + Mi \quad (1)$$

$$Mm = BxDb + LxD_1 \quad (2)$$

$$Mm = TxD_1 \quad (3)$$

Where

L is the weight of the load and is the weight of the superincumbenis the body t body parts. Mm is muscle moment, Ml is the load moment and Mb is the bocompressive to the osite dy moment. Note that the tension in the muscles (T) is equal and opposite to the compressive loading on the spine (C).

We are decide used this formula to calculate the effort realized by the worker, considering the posture may be defined as the relative orientation of the parts of the body in the space. to maintain such an orientation over a period of time, additionally we are consider that the muscles must be used to counteract any external forces acting upon the body exactly as Stephen Pheasant [Pheasant 1991 and 1996] describes in his books Ergonomics, work and health and Bodyspace: Anthropometry, Ergonomics and the design of work.

5. CONCLUSIONS

This study and knowledge gained results in the bases to make improvements in workstations thus helping to productive industrial workers in the state of Morelos, the data can be used for "risk analysis work associated with the problems of the spine "among others, these data will be very helpful for designers because they based on the dimensions of the workstations will be more ergonomic for workers and others who so desire.

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AN ASSESMENT OF THE ANTHROPOMETRIC AND EXTERNAL VARIABLES THAT INFLUENCE THE WEIGHT OF BACKPACKS OF JUNIOR HIGH SCHOOL STUDENTS

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Resumen: El dolor de espalda baja es uno de los problemas de salud más frecuentes en los niños y adolescentes en edad escolar. Una de las causas asociadas a esta dolencia es el peso que cargan los estudiantes en sus mochilas. El peso excesivo de las mochilas puede tener efectos en la salud y postura de los estudiantes a corto y a largo plazo. En países como Italia se han establecidos limites al peso de las mochilas y en la literatura asociada se ha encontrado como estándar la recomendación de que el peso no exceda el rango del 10 al 15% en proporción al peso corporal del estudiante. Considerando al factor peso como una de los más importantes al abordar este problema, este trabajo de investigación se enfoca en el análisis de las variables que ejercen influencia en el peso de las mochilas escolares tipo Backpack que utilizan estudiantes de secundaria para cargar sus útiles escolares. Las variables consideradas de tipo antropométrico fueron peso del estudiante, peso de la mochila, índice de masa corporal, porcentaje de masa corporal, edad, genero y estatura; como variable externa se consideró, en este caso la disponibilidad de lockers. El levantamiento de información se realizó en la Escuela Secundaria Latino de cd. Madero, considerando a 160 estudiantes, 100 hombres y 60 mujeres, en un rango de edad de 11 a 16 años. Dado el numero limitado de estudiantes se consideró evitar el muestreo y se optó por el censo. Los datos primarios mostraron que solo 6 estudiantes cargaban un peso mayor al 10% de su peso corporal sin llegar en ningún caso al 12%. Asimismo cabe destacar que se encontró una diferencia entre el peso promedio de las mochilas considerando la variable genero y la variable externa uso de locker. En el primer caso, el peso promedio de la mochila para los estudiantes hombre fue de 5.16 kg mientras que para las mujeres fue de 4.28 kg; en cuanto al uso del locker, el peso promedio para hombre con acceso a locker fue de 4.17 kg mientras que aquellos que no contaban con locker fue 7.78 kg. La significancia de estas variables fue comprobada mediante una ANOVA multifactorial por lo que se concluyó que para este estudio en particular, las únicas variables significativas en relación al factor peso de la mochila fueron el genero y el acceso a lockers en la escuela. En conclusión esta información permite establecer la importancia de que las escuelas cuenten con lockers o alguna alternativa similar que evite que los estudiantes transporten cargas pesadas en sus mochilas y que los padres de familia cuiden que los hijos varones no abusen de su constitución física en comparación a la de su contraparte femenina, en aras de un mal entendido sentido de masculinidad, pereza o desidia. Se recomienda a las autoridades escolares que procuren que las escuelas tomen medidas respecto al almacenaje temporal de los útiles escolares y que se informe a maestros y padres de familia de los alcances de esta investigación.

Palabras clave: Dolor de espalda, mochilas, antropometría, estudiantes

Abstract: Low back pain is one of the most common health problems in children and adolescents of school age. One of the causes associated with this disease is the load that students carry in their backpacks. Excessive weight of backpacks can have effects both in health and posture of students in the short and long term. In some countries, like Italy, limits have been set on the weight of the backpacks and the associated literature highlights as a standard recommendation that the weight does not exceed the range of 10 to 15% in proportion to the student's body weight. Considering the weight factor as one of the most important to address this problem, this research focuses on the analysis of the variables that influence the weight of school bags that Junior High School students use to carry their school supplies. The anthropometric variables considered were student’s weight, body mass index, percentage of body mass, age, gender, height and backpack weight, as external variable he availability of lockers was considered in this case. The information gathering was held at the Escuela Secundaria Latino of Ciudad Madero, taking a population of 160 students, 100 men and 60 women, ranging in age from 11 to 16 years. Given the limited number of students, the researchers considered to avoid the sampling and opted for the census. The primary data showed that only 6 students carried a weight greater than 10% of their body weight without in any case 12%. Also noteworthy that we found a difference between the average weight of the backpacks, considering gender and availability of lockers. In the first case, the average weight of the backpack for students man was of 5.16 kg while that for women was 4.28 kg; in the use of the locker, the average weight for men with access to locker was of 4.17 kg while those who did not have locker was 7.78 kg. The significance of these variables was tested by a multi factor ANOVA and was therefore concluded that for this particular study, the only significant variables in relation to the factor weight of the backpack were gender and access to lockers at school. In conclusion this information, sets the importance of lockers or similar alternatives within schools that will prevent students carrying heavy loads on their backpacks; also establish the need for strong parental care so children do not abuse their male physique compared to that of his female counterpart, for the sake of a misunderstood sense of masculinity, laziness or procrastination. It is recommended that school officials work to ensure that schools take action on the temporary storage of school supplies and to inform teachers and parents of the scope of this investigation.

Keywords: backpacks, back pain, anthropometry, high school students.

1. INTRODUCTION

Low back pain is increasingly common for primary and secondary school students. (Sheir-Neiss, Kruse, Rahman, Jacobson and Pelli, 2003; Jones & Macfarlane, 2005) The reason why this condition occurs at an early age could be explained, among other factors, by the weight of the load they carry in their school bags, mainly in those known as Backpacks. (Guzman, Vasquez & De la Vega, 2011; Skaggs, Early, D'Ambra, Tolo and Kay, 2006; Hazzaa, 2006, Mackenzie, Sampath, Kruse & Sheir-Neiss, 2003)

The problems associated with the weight of school bags and its effect on the health of children and adolescents has aroused interest in the academic community related to ergonomics and health, as can be seen in the many articles devoted to the topic in the international scientific literature. (Stelle, Bialocerkowsky & Grimm, 2003) Moreover, given the limited impact of ergonomic in the design of school furniture (Guzman et al, 2011; Castellucci, Arezes & Viviani, 2009; Dhara, Khaspuri & Sau, 2009) and the vast number of children and adolescents of school age, we can say that this sector of the population is one of the biggest problems from an ergonomic standpoint.

The stress caused by the load in backpacks, can potentially cause structural injuries in addition to back pain. (Neuschwander, Cutrone, Macias, Cutrone, Murthy, Chambers and Hargens, 2010) Previous studies show that the weight carried in backpacks strongly influence back pain and posture of the children, so it is not recommended to load more beyond 10 to 15% of their body weight. (Brackley and Stevenson, 2004; Simbanes, Martinez, Butler and Haider, 2004; Chow, Ou, Wang and Lai, 2010)

In addition to the anthropometric variables, there are external factors affecting this problem, such as usage habits of school bags (Zultowski and Aruin, 2008) and the availability of lockers in schools. (Whittfield, Legg and Hedderley, 2001, Skaggs et al, 2006)

Focusing on the weight factor, the scope of this study is on the identification of anthropometric variables and external factors affecting the weight of backpacks, among Junior High School students in Ciudad Madero, Mexico.

2. OBJECTIVES

Main objective:

- To identify the anthropometrical and external variables that influence on the weight of backpacks of junior high school students.

Secondary objective:

- To determine if there is significance in the relationship among variables and the backpack weight.
- To measure the proportional ratio of backpack weight and students body weight.
- To compare the results of ratio measurements with the suggested standard of 10 to 15% established in the review of literature.

3. METHODOLOGY

The subjects of study for this project were the students of Latino High School in Ciudad Madero, Tamaulipas, Mexico. This school had the right conditions for the project and school officials showed keen interest on the outcome of the investigation.

The research hypothesis of this study was established as follows: there is a significant relationship between the variables age, gender and grade with the weight of school bags.

Given the number of students from the school, was determined not to use any type of sampling and opt for the census. The total school population is 160 students, of whom 100 are men and 60 women, with ages ranging from 11 to 16 years.

The variables considered in the collection of information were: gender, age, height, weight of the backpack, the student weight, body mass index BMI and body fat percentage and whether or not they have locker. The grade level of each student was also registered.

First, we analyzed the relationship between body weights of students with the weight of school bags to determine their compliance with the standards suggested in the literature review.

The collected data was then classified to carry out statistical analysis using Design of Experiments by considering those factors with a direct relationship with the weight of backpacks, as gender, the student's age and height, use of locker or not.

The statistical hypotheses were:

H_0: The average backpack weight for each element of each factor is equal.

H_1: The average backpack weight for each element of each factor is not equal.

In conducting the analysis of variance for each of the factors considered, each factor was significantly impaired in the average weight of the backpacks, so we proceeded to the combination of factors while considering 2, 3 at a time, and 4 together, in order to determine which factor actually significantly affect the response variable, which is detailed in the results.

This study was performed considering only the measurement of anthropometric, demographic and external variables as availability of lockers and school grade. The biomechanical study of the use of backpacks will be held in a second stage of this research project.

4. RESULTS

In assessing the weight of the backpack over the body weight of the students, we found that only 6 cases exceeded 10% of its own weight, without in any case 12%. This means that particularly in this research, the maximum limit of 15% proportional ratio over the student own body weight was not exceeded.

Measuring the weight of the backpacks over the gender variable, we found that the average weight of backpacks for men was 5.16 kg while that of women was 4.28 kg.

Relating the weight of the backpack with the variable use of locker, we found that the average weight of the backpack for students without access to locker was 7.78 kg, while that of those who if they had locker was of 4.17 kg.

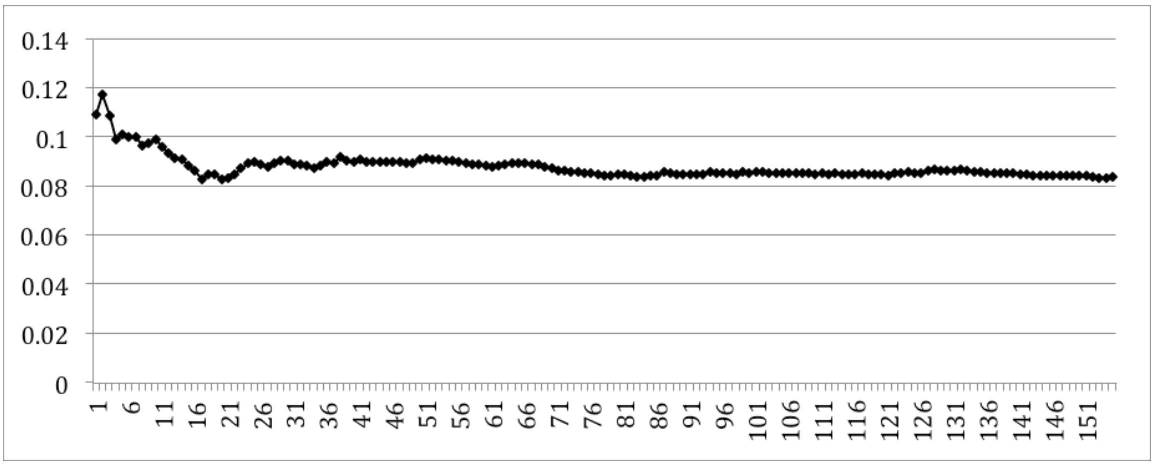

Figure 1. Proportional ratio of backpack weight over body weight.

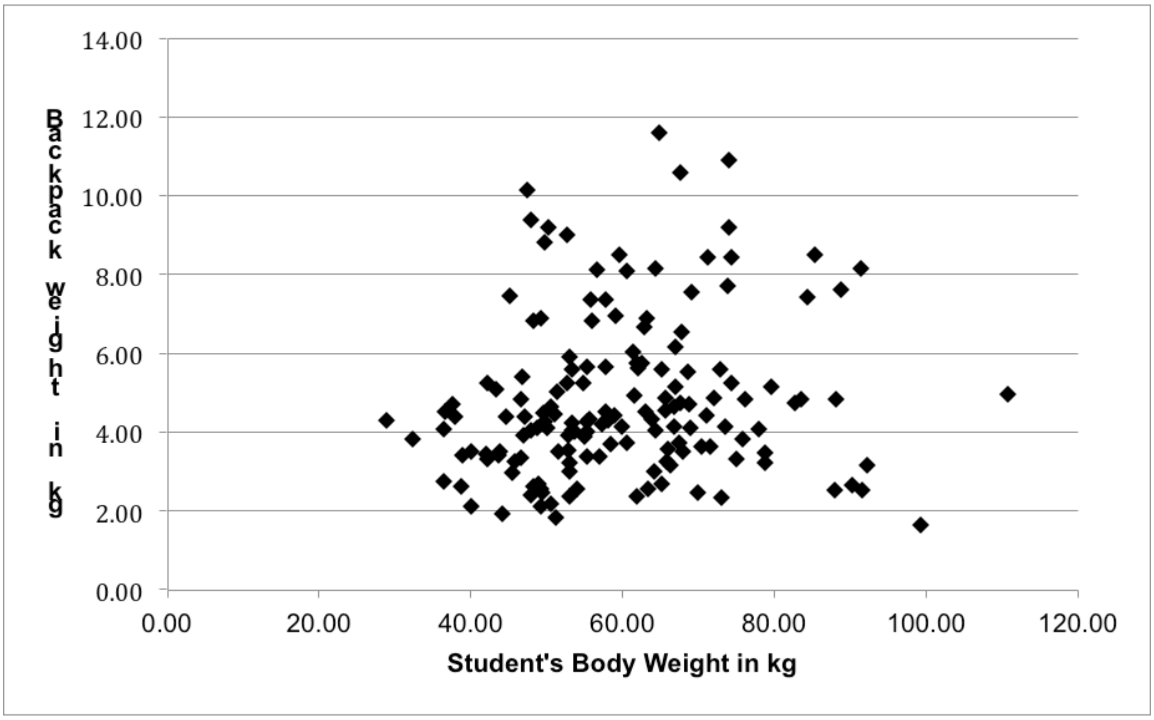

Figure 2. Scatter graph of backpack weight / student’s body weight in kg

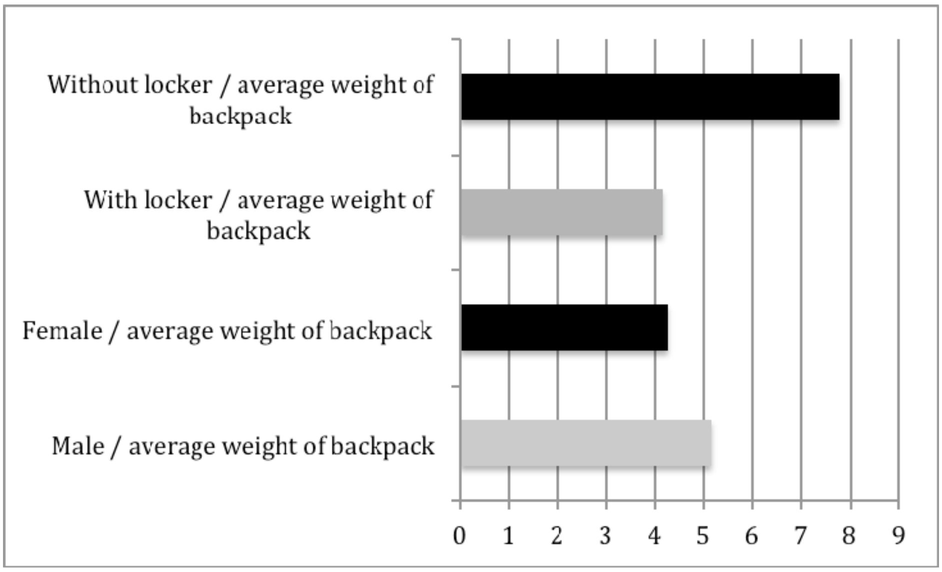

Figure 3. Comparative bar graph of average weight of backpacks in kg / Gender and Use of lockers.

The differences were confirmed with the completion of the multifactorial ANOVA which showed that statistically significant variables in relation to the weight of the backpack was precisely Gender and access to lockers.

Table1. Multifactorial ANOVA.

Source	Sum of squares	Degrees of freedom	s^2	F		F_{tables}
Between students use of lockers (Yes/no)	298.87	1	298.87	155.80	>	3.84
Between students gender (male/female)	28.70	1	28.70	14.96	>	3.84
Between students ages	19.61	5	3.92	2.04	<	3.21
Between students height	18.64	5	3.73	1.94	<	3.21
Unexplained	272.40	142	1.92			
TOTAL	638.23	154				

5. CONCLUSIONS

The results of this study show that the most significant variables in relation to the weight of the backpacks were gender and the use of lockers.

Since the use of lockers significantly affect the weight of the backpacks that students carry, it is recommended that as far as possible, the schools have lockers or some similar alternative temporary storage of supplies, to prevent that students have to carry this weight in their backpacks.

Moreover, we found that the average weight of the backpacks in male students was higher than women, although a large majority of them had access to locker, indicating an extra variable located in habits and behavior.

We conclude that although in this case, the weight of their backpacks do not exceed the maximum limit of 15% of owns body weight, it is important to consider all alternatives that help reduce the load placed on students to avoid potential health and posture related problems. It is recommended that educational authorities take action in the matter and also to start a campaign to train both teachers and parents on this issue.

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STUDY OF THE ACCEPTABLE MAXIMUM STRENGTH OF GRIP PER CATEGORY OF AGE IN WOMEN WORKERS IN INDUSTRY MANUFACTURING WITH HIGH RATE OF REPETITION.

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Resumen: La aplicación de diferentes esfuerzos físicos es una práctica común para numerosas actividades que se requieren realizar habitualmente en las tareas del ámbito industrial. Esto incluye el traslado manual de materiales, la aplicación de presiones manuales o con el dedo al utilizar alguna herramienta o durante alguna actividad, el levantamiento o colocación de algún instrumento, etc. El estudiar la máxima fuerza de agarre manual, es importante para la prevención de lesiones y accidentes laborales provocada por la aplicación de un esfuerzo excesivo o por la alta tasa de repetición requerida para la actividad desempeñada. Treinta y cinco sujetos de prueba con experiencia laboral en la industria manufacturera en la ciudad de Hermosillo, realizaron una simulación de agarre manual en 3 horas diferentes de su jornada laboral durante una semana. El grupo fue distribuido en tres categorías de edad para estudiar su comportamiento. El promedio de fuerza de agarre aplicada fue mayor entre los sujetos de la tercera categoría (55.37 kg.), seguida de la segunda categoría (50.6 kg.) y finalmente la primera categoría (49.07 kg.).

Palabras claves: Fuerza de agarre manual; Inserciones repetitivas; Máxima fuerza aceptable.

Abstract: The application of different physical effort is a common practice for many activities that are required to perform regularly in the work of the industrial field. This includes the transportation manual of materials, the application of manual pressure or the finger to use any tool or during any activity, lifting or placement of any instrument, etc. Study the maximum hand grip strength, is important for the prevention of injuries and accidents caused by the application of an excessive effort or the high rate of repetition required for the activity carried out. Thirty-five test subjects with prior working experience in manufacturing industry in the city of Hermosillo, conducted a simulation of manual grip in 3 different from their working day hours for a week. The Group was distributed in three age categories to study their behavior. Applied grip strength averaged higher among subjects of the third category (55.37 kg), followed by the second category (50.6 kg) and finally the first category (49.07 kg.).

Keywords: Manual grip strength; Repeated insertions; Maximum force acceptable.

1. INTRODUCTION.

According to the Federal Labour Act (articles 474 and 475), we can understand as an accident at work all organic lesion or functional, immediate or subsequent disturbance or death suddenly produced in exercise or work, regardless of the place and time in which is provided. An occupational disease is understood as any pathological State derived from the action continued for a cause that has its origin or motive at work or in the environment in which the worker be forced to provide their services.

Lack of adequate adaptation of the workplace to the employee, as well as the lack of precaution of the same employee to carry out its work, can bring as a consequence these diseases and accidents at work (Mital et al., 2000)

According to information provided by the National Institute of Statistics and Geography in the 2010 census (INEGI), people in working age in Mexico, spend on average 42.1 hours a week at work. For this reason it is clear that working conditions can have a significant and direct effect on the health and welfare of workers. In addition, anxieties about the safety and health at work going well beyond the obvious implications in health, disease, accidents and deaths generated in the work.

Despite this, occupational health and safety issues have had little importance in Latin America due to lack of interest on the need for a work place healthy and safe, and to the lack of interest of the institutions responsible for promoting and monitoring the improvement of conditions of labour. (Idrovo y Guevara, 2007).

Not implement or enforce appropriate laws relating to security produces loss of production, loss of wages, medical expenses, disability and even death. Diseases, injuries and deaths for the work often are considered an unintended consequence, a negative factor of the production process. However, as most of the health problems generated by the work can be prevented easily and at little cost (Sanchez-Roman et al., 2006).

2. OBJECTIVES.

The main objective is to conduct a study on the behavior of the grip strength of women workers in the manufacturing industry with a high rate of recurrence according to age categories.

Other objectives are to determine age categories for the analysis of the strength of the workers, determine the strength of grip acceptable maximum for women workers according to their age category, use statistical tools for the processing of the data and determine the type of activity that can develop women workers according to the amount of grip strength which can generate.

The study considers only working-age female gender play activities of manufacturing with high repetition rate in the city of Hermosillo and will focus it to the anatomical region of the hand.

3. METHODOLOGY.

A group of 35 women with work experience is randomly selected and to perform daily activities in the manufacturing industry, in the community of Hermosillo. We considered three categories of age, the first category of age between 19 and 20 years old, the second category of aged 21-29 years old and the third category of aged between 30 and 39 years old.

The test subjects were subjected to medical review to prevent injuries. The age of the women's group is between 19 and 39, with an average age of 26.2 years. The average height of the group is 162 cm (± 6.44). The average weight of the group is 68.97 kg. (± 11.72).

3.1 Data collection.

Dynamometers were prepared to measure hand grip strength. The test subjects were instructed to be placed against a structure holding the dynamometer at a height that forming a right angle with his elbow. The wrist stayed in a neutral position with the hand resting on the dynamometer. The test subjects were instructed to carry out a manual grip strength in the dynamometer. They were 3 shots of grip force manual first, half and at the end of the days work a week. The test subjects were instructed to implement its maximum acceptable force, assuming that grip level selected can be repeatedly sustained.

During the meeting of the study, the results that were recorded were not shared with the test subjects during the session, this in order to ensure that the level of force applied to it was based on sensations and/or feedback biomechanics as opposed to Visual indicators (Snook et al., 1970, 1999).

3.2 Data processing.

Data were collected in a few formats previously designed for research, in which scored information on the physical characteristics of the person who was analyzing, as well as the hand grip strength. Later, data were recorded in a spreadsheet for easier handling. The peak force was recorded for each insertion with the dynamometers.

3.3 Statistical analysis.

ANOVA (analysis of variance) was made to determine the main effects of the data against the test group. For this, software Minitab 16 was used for the calculation of the corresponding graphs and data.

4. RESULTS.

The data indicated that the third category can apply higher hand grip strength. Efforts for manual grip averages were in first category 49.07 kg, in the second category was 50.6 kg and in the third category was 55.37 kg.

Table 1 shows the mean and standard deviation of the data.

Table 1. Mean force of manual grip by age categories.

Category	Mean (Kg.)	Standard deviation	Standard error of the mean
19 to 20 years	49.07	11.31	6.53
21 to 29 years	50.6	8.53	1.74
30 to 39 years	55.37	8.29	2.93

Efforts averages in kilograms for the hand holds in each category are shown in Figure 1.

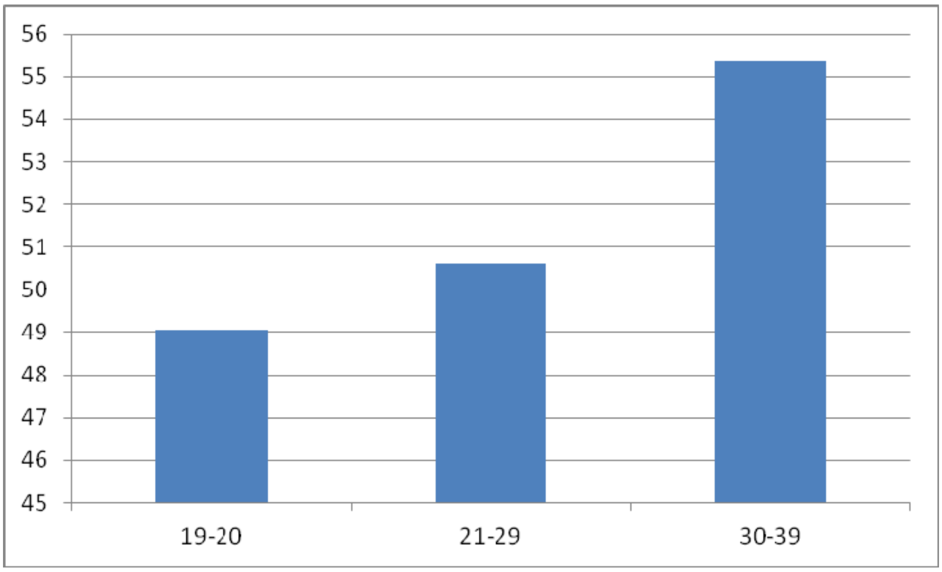

Figure 1. Average efforts in kilograms per category.

One way to observe the variation of data in each category is the graph of intervals. Such a graphic can be observed that according to the averages and standard deviations obtained for each category, it would have for the first category with a range of 95% of confidence with an estimated average of 49.07, 20.96 to 77.17 range; for the second category with an average of 50.6, an interval of 47.00 to 54.20 and for the third category with an estimated average of 55.37, an interval of 48.44 to 62.30.

Figure 2 shows the graph of intervals corresponding to each analyzed category. The graph shows a wider range obtained in the first category, since it was obtained as a result greater standard deviation compared to the other two categories.

Another way to observe the variability in the data is the graph of boxplot. Figure 3 presents the boxplot graph obtained

The graph looms in a median of 47.53 for the first category with a range interquartile of 22.47, a median of 49.23 with 13.10 range interquartile was obtained in the second category and in the third category was obtained a median of 52.57 with 14.1 range interquartile.

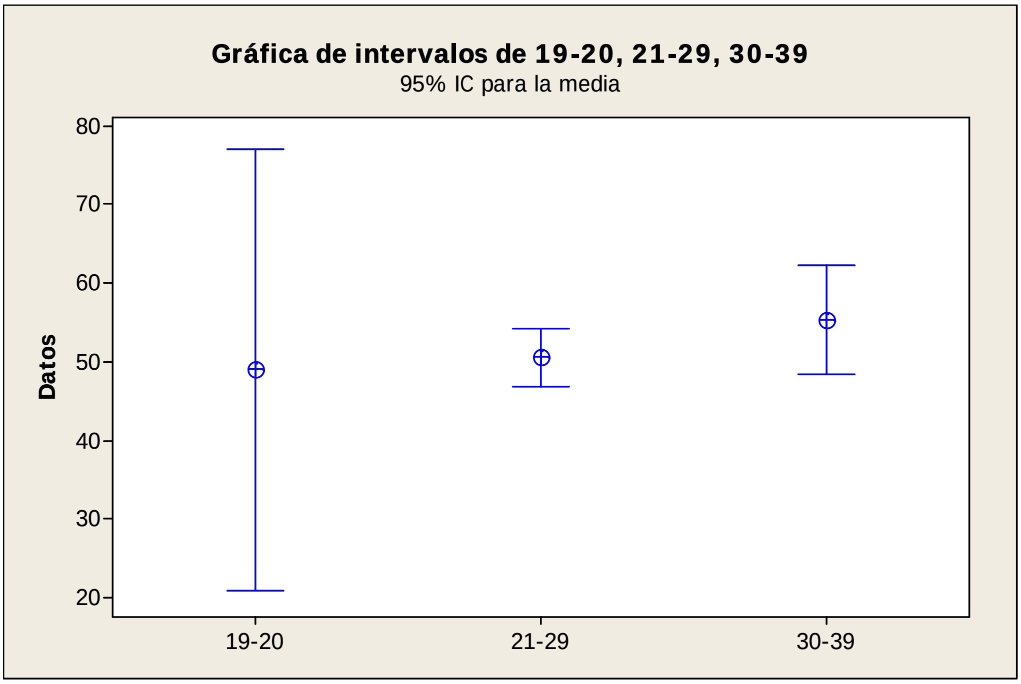

Figure 2. Graph of intervals for each category.

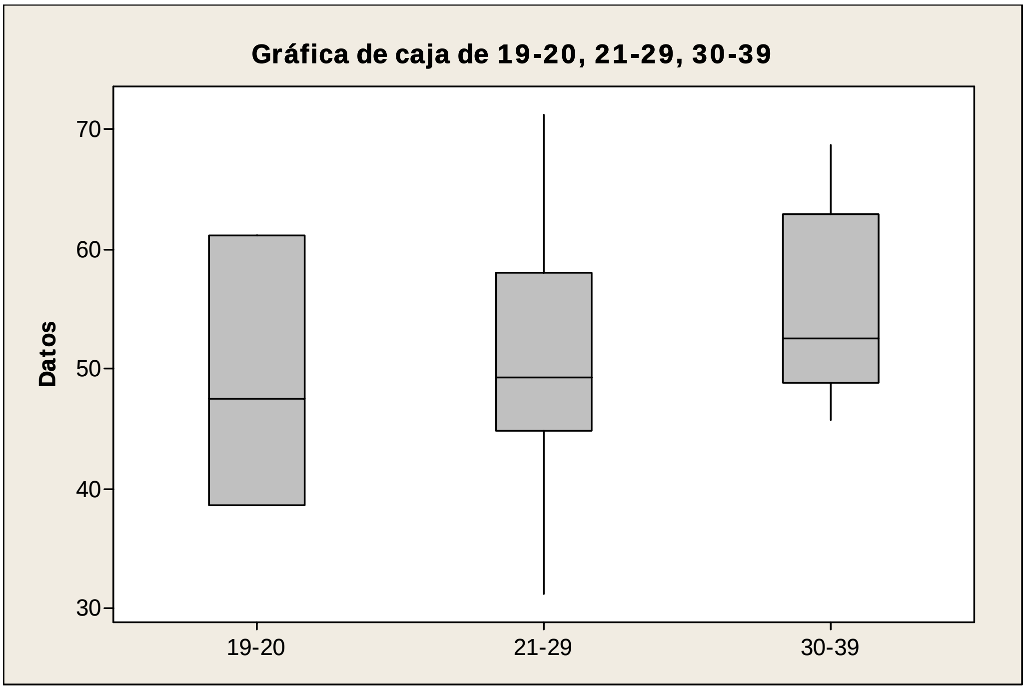

Figure 3. Graph of boxplot for the three categories.

5. CONCLUSIONS.

As moving in age category, shows that a greater average effort for manual holds can be applied. Recommended in average 49.07 kg for the first category (19 to 20 years), 50.6 kg for the second category and 55.37 kg for the third category. The increase in the application of force is due to several factors, mainly the fact that physical work should be done longer, muscle tone is improving and acquired experience to perform a particular activity, in this case the manual grip. To exercise the manual movement repeatedly brings as consequence the application of a higher force, so concludes that greater category of age, increases the ability of application of force.

It would be interesting to analyze an age category greater than those presented in this study, to get to know their behaviour tailored to analyze elderly aged 39, however, this study would be difficult to carry out in the community of Hermosillo, since the age of persons who were found carrying out manual work with high repetition rate does not exceed 39 years.

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HUMAN PROPULSION VEHICLE (HPV)
WHEELCHAIR WITHOPTION OF PERCEPTION TO BE STAND UP

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Resumen

Si analizamos Antropométricamente al ser humano, tiene geometría y dimensiones muy especiales, en las cuales son muy distintas la percepción del medio ambiente si la persona está en posición de pie y cuando está en posición sentado.

Las percepciones a las que hacemos referencia son: la vista y el tacto
Además de la autoestima al no poder ver a la cara con la gente que están hablando, los ven para abajo, también por razones médicas ya que mejora la circulación sanguínea y reduce la presión que se ejerce en los órganos internos.

Si por desgracia una persona de talla de 1.80 Metros de altura y 80 Kilogramos de peso, pierde la capacidad de caminar y tiene que estar en una silla de ruedas permanentemente, su mundo cambia radicalmente, de repente su altura de visión será de una persona de 1.40 Metros de altura y el alcance de sus brazos y manos también variará. Cambia totalmente su mundo, su percepción del mundo.

Palabras clave: *Diseño, Antropometría, estudios interdisciplinarios*

Abstract When a person is anthropometric analyzed, you can see the dimensions and geometry, depending of the position, it would have a different perception of the environment. Example: if the person is sit down or standing up. When we talk about perception we refer to the touch and to the sight.

If a person is 1.80 meters height and weights 80 kilos loose his ability to walk and had to be in a wheel chair, his perception radically changes, his vision it would be like a 1.40 meters heights person, and the reach of the arms and hands will change too. His self esteem will also change due to he can not see at the same level of the people who he is talking to. People will look down as they speak to him. When you are standing up, comparing to be setting down, the blood pressures it is better and it reduces the pressure in the internal organs.

Key Words: Design, Anthropometry, Interdisciplinary studies

Introduction

The different capacity is a very individual experience that differs not only between individuals, may be of a different type of greater or lesser degree, the way to overcome or compensate for functional limitations, with the nature of the task being performed and the environmental conditions to which this occurs.

In Mexico, by 2010, people who have some kind of different capacity is 5 million 739 thousand 270, which represents 5.1% of the total population, highlighting the 58.3 percent neuromotorand 27.2 visual .

The ergonomics but always interested in adapting the environment to the user, in the case of people with disabilities adaptation is especially necessary because much more dependent on their immediate environment than other people. If that environment (product, labor, space, etc..) Does not fit their characteristics, needs and limitations, impact not only on comfort, ease of use and efficiency in the short term, but also their health, safety, independence, social welfare and ultimately on their quality of life. The negative consequences of not implementing it, are perhaps greater than for other populations.

If we analyze anthropometric humans, have very special geometry and dimensions, the dimensions are different if the person is standing and when seated and environmental perceptions also change

Perceptions to which we refer are the sight and touch. In the same forms of social relations are affected by not being able to see face to face with the person you are speaking, look down. The posture of sitting for long periods leads to problems with blood circulation and has exerted pressure on internal organs, etc.

With the design of a human-powered vehicle, using the parallel and iterative design through brainstorming, that to acquire standing and sitting posture is achieved by eliminating and / or reduce some aspects mentioned above and thus achieve a better integration into environments and improve the quality of life of people.

Objective

Improve Human Propulsion vehicle is a wheelchair so that the person can operate it to stand up and use it as a chair to avoid, neutralize, offset or mitigate the functional limitations of people to access settings and use products and services, improving their social participation, independence and quality of life.

Delimitation

Use the driving force of the person using the vehicle

Methodology

Understand the concept of what it wants to reach and use ergonomics and product design for users with disabilities.

Analyze which is a human-powered vehicle HPV.

Analyze the human body, from the ergonomic point of view the dimensions of sitting and standing, biomechanics, strength, to do the design according to human beings.

Taking as basis the knowledge of how to design a conventional wheelchair used by a person 18 to 25 years and then gotten down to make adjustments or improvements relevant to reach the target.

Using the method of parallel and iterative design through brainstorming, the solution was reached.

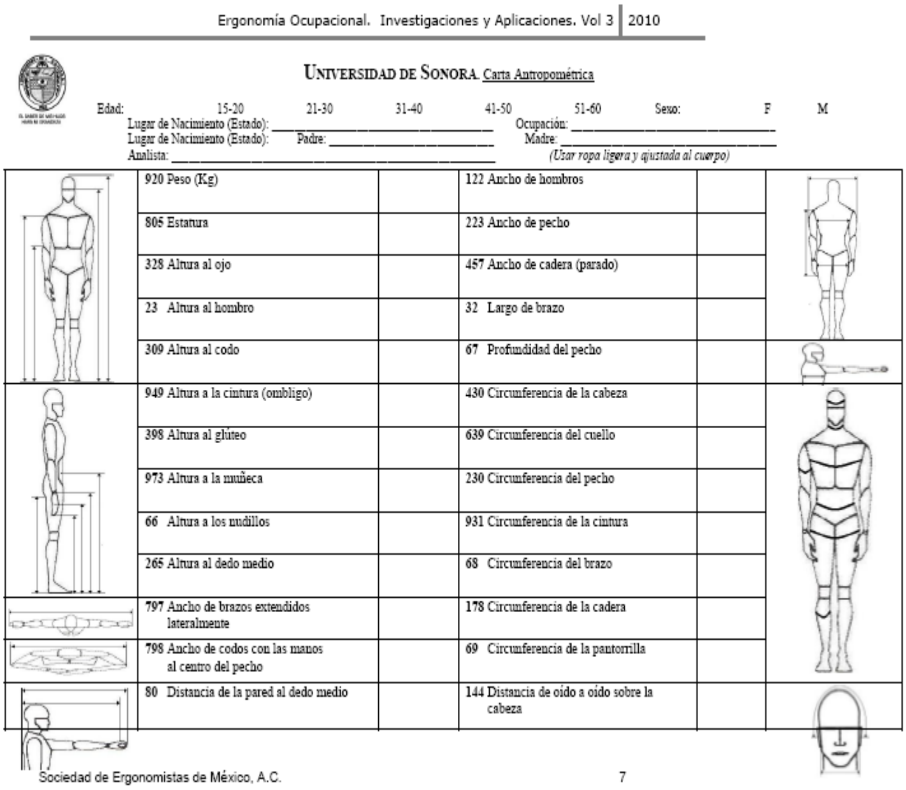
DEVELOPMENT

Designing a human-powered vehicle that is the wheelchair so that the person can operate it to stand up and use it as a chair.

We all know the human-powered vehicles, water, land and air with the possible addition of new variants in the future. An HPV has no other source of energy that the human being, so it must be very efficient in using it.

All HPV's are subject to continuous development in search of better efficiency, improve comfort, reduce your cost, follow fashion trends, using alternative materials, improved user safety, etc..

In the design of the chair so the person can use it up, were considered in designing some dimensions obtained from the measurements made to students of industrial engineering at the University of noise presented at the conference on ergonomics in 2010 (Platt, Martina, 2010) and information from biomechanics and strength (Mondelo, Peter Gregori, Henry, 2001)



Ergonomía Ocupacional. Investigaciones y Aplicaciones. Vol 3 | 2010

UNIVERSIDAD DE SONORA. Carta Antropométrica

Edad: 15-20 21-30 31-40 41-50 51-60 Sexo: F M

Lugar de Nacimiento (Estado): ________ Ocupación: ________

Lugar de Nacimiento (Estado): Padre: ________ Madre: ________

Analista: ________ *(Usar ropa ligera y ajustada al cuerpo)*

920 Peso (Kg)		122 Ancho de hombros		
805 Estatura		223 Ancho de pecho		
328 Altura al ojo		457 Ancho de cadera (parado)		
23 Altura al hombro		32 Largo de brazo		
309 Altura al codo		67 Profundidad del pecho		
949 Altura a la cintura (ombligo)		430 Circunferencia de la cabeza		
398 Altura al glúteo		639 Circunferencia del cuello		
973 Altura a la muñeca		230 Circunferencia del pecho		
66 Altura a los nudillos		931 Circunferencia de la cintura		
265 Altura al dedo medio		68 Circunferencia del brazo		
797 Ancho de brazos extendidos lateralmente		178 Circunferencia de la cadera		
798 Ancho de codos con las manos al centro del pecho		69 Circunferencia de la pantorrilla		
80 Distancia de la pared al dedo medio		144 Distancia de oído a oído sobre la cabeza		

Sociedad de Ergonomistas de México, A.C. 7

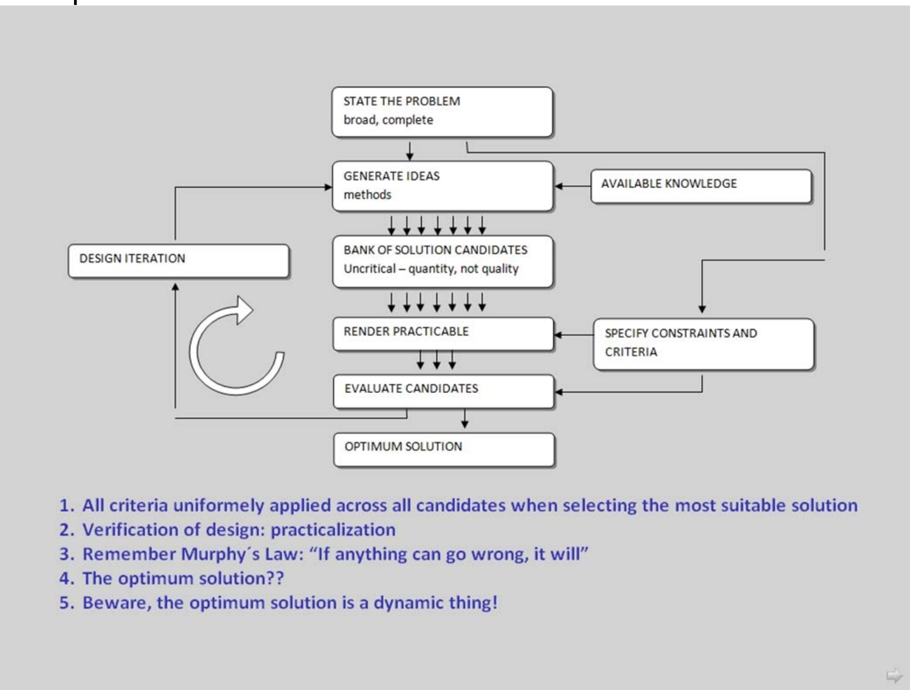
Some Biomechanical Considerations of the manual wheelchair (Sunrise Medical Co.) were used in the design of HPV as the following.

- Factors that affect mobility - friction
- Factors affecting the propulsion
- The position in the wheelchair
- Types of components of a wheelchair
- Measures in the Prescription of wheelchair

Process was applied to mechanical design solution

and the iterative design process in parallel combined with the generation of brainstorming solutions, ending with 4 iterations to reach the solution to the next solution.

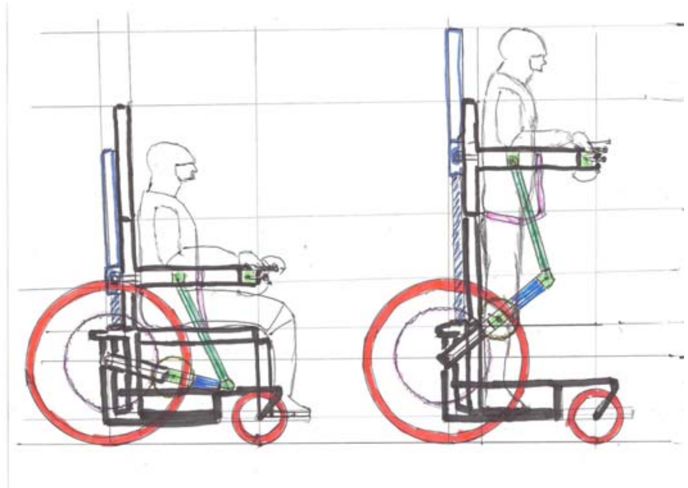
1. Turning first iteration chair in a person standing (upright). Option person standing
2. Second iteration lifting mechanism. Mechanical jack for lifting and lowering
3. Third iteration movement of the wheels. Spur gears and bevel gears to move wheelchair wheels
4. Fourth iteration subject the patient to the wheelchair. Seat type walker with seat belt to restrain the person



Process for mechanical design solution.

MAKING PROPOSAL (IMAGE)

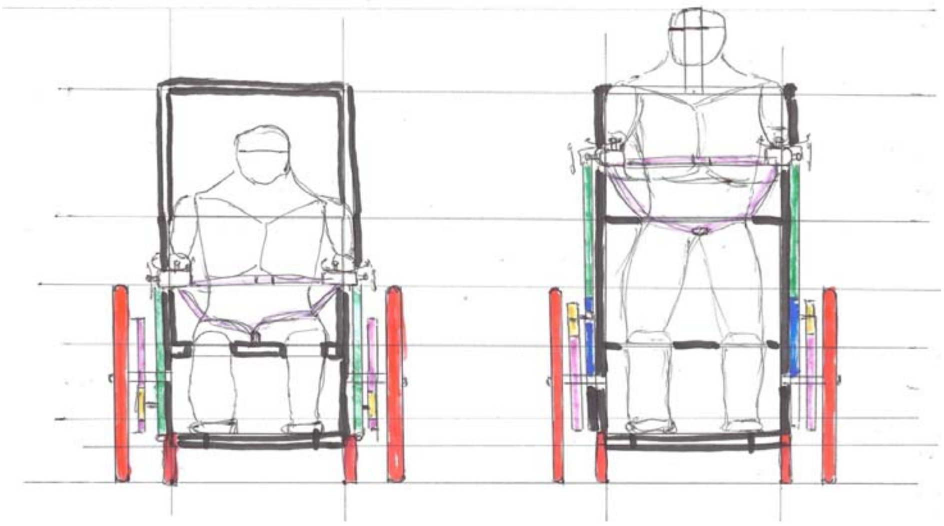
SIDE VIEW



Side view of design, drawing is left when in lowered position in which it operates like a normal wheelchair, his arms moving directly to a tire with thrust rings that bring all wheelchairs.

In the right picture is the side view when the chair stopped in its movement in the plane, it triggered the brakes of both wheels are on the inside of each arm rests and triggered the levers to raise the support of the chair by means of mechanical jack which is in the rear of the vehicle, to be upright.

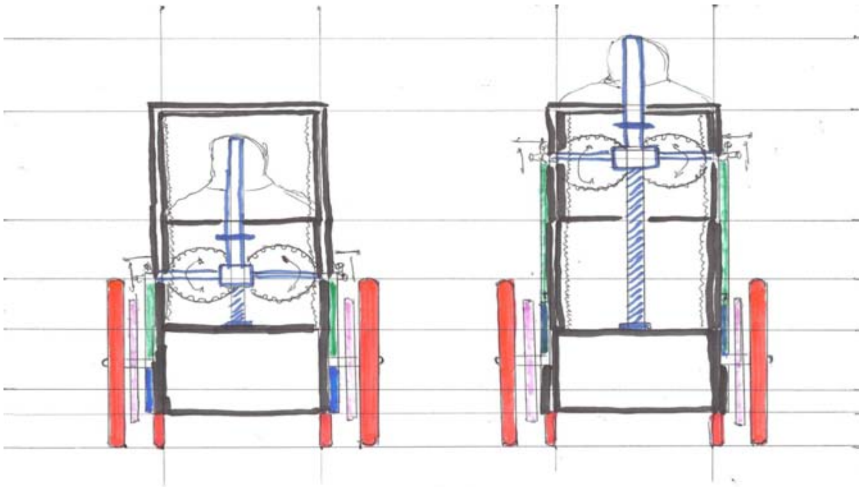
FRONT VIEW



Front view of design, on the left is when in the wheelchair position normal is when a person enters the chair and put your seat belt and seat type walker with a safe for later use.

At right is the front view to be above the chair, the person is supported by a seat belt and seat type walker, here you see the person as someone who is upright and can reach the same objects located in front of him, because there is nothing to stop him doing so, you can remove the wheel brakes and move to make approximations and then re-apply the brakes, down to the starting position.

REAR VIEW



Rear view of the design on the left side in the low position and on the right vertical position, the backrest has a drawer-type mechanism to prevent snagging when sliding from one position to another.

Results

Using the method of design iterations in parallel, after several iterations we reach the optimal solution proposal with the following features: Option person standing with the use of mechanical jack for lifting and lowering, adequacy of spur gears and bevel gears to move wheelchair wheels and a seat type walker with seat belt to hold the person.

With the proposed design will have some advantages as no similar products, so it is innovative, helps proper blood circulation and prevents compression of internal organs and allows sitting and standing users already need help others to see and reach for objects being in the wheelchair can not do such as: kitchens cabinets comprehensive, public phones, etc.. Improvements could be made with electric motors up and down, move, etc.. But it departs from the premise of being an HPV. No improvements have affordable and mechanisms leading only, it contains sophisticated electronics, and alternative energy to be renovated and a very important aspect not require great expertise to repair in case of failure, you can have access to the mechanisms easily and quickly

And some disadvantages encountered are: Not everyone has the ability and physical strength to operate the device designed, the elderly people or sick people in their upper extremities, arthritis, or who can not hold the controls are tailored to each person on request. As a rigid design, it can be bent to move, so it is recommended that you use in the home or buildings

Recommendations: For outdoor use we recommend moving in the down position and when you reach your destination is placed in the upright position and make small movements approximation to the transport mechanisms and elevation.

Conclusions

People with disabilities are those with one or more physical, mental, intellectual or sensory impairments which in interaction with different environments of the social environment may hinder their full and effective participation on an equal basis to others.

To overcome these deficiencies we can use biomechanical aids such as crutches, walkers or wheelchairs, hearing aids, in the case of deaf guides or canes for the blind and ergonomics will allow designs to achieve

The design of human powered vehicle is an example to overcome the deficiencies of those who remain in wheelchairs, an opportunity to mobilize, access, and use the infrastructure remain unimpeded, either indoors or outside it improves the quality of life, social integration support community and lays the foundation for building "a society for all" (Ronald Mace, 1963).

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CRIMP PLIERS BASE FOR TERMINAL PUNCHING IN THE CATSCAN AREA OF MEFASA PLANT, AGUA PRIETA.

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RESUMEN

Introducción: Este proyecto se realizó con el fin de mejorar el puesto de trabajo en un área determinada en la empresa MEFASA debido a las lesiones presentadas en el historial del puesto de trabajo el cual indica una baja de labores debido a la repetitividad de movimientos y fuerza ejercida para llevar a cabo la operación de ponchado de terminales. **Objetivos:** Mejorar la estación de trabajo rediseñando el proceso de ponchado mediante un dispositivo que eliminará la fuerza ejercida manualmente sobre las distintas pinzas crimpeadoras que se utilizan en la operación, por una fuerza neumática ejercida por un mecanismo semiautomático, para eliminar la lesión de trabajo que se presentó por la repetitividad de crimpeado dentro de un área de la empresa Mefasa. **Delimitación:** El proyecto se llevó a cabo en el área de CATSCAN de la empresa MEFASA planta Agua Prieta. **Metodologías:** Entrevista y análisis de operación, Propuesta y elección del dispositivo, Diseño de prototipo, Estudios y pruebas de laboratorio. **Resultados:** con las pruebas de laboratorio pudimos observar que esta herramienta cumple satisfactoriamente con todas las especificaciones requeridas por el cliente y la calidad del producto en este caso de la resistencia, fuerza de tiro, medición de presión y cambio en el sistema SMED o set up. **Conclusiones:** Este dispositivo elimina completamente el riesgo de cualquier lesión que pueda ocurrir a lo largo de varios años por traumatismos repetidos en la misma estructura por causa de la aplicación de fuerzas con la mano.

Palabras Claves: Riesgo de Trabajo, Diseño, Productividad

ABSTRACT

Introduction: the present Project has as an end the improvement of a specific workstationinside the MEFASA plant, due to a history of injuriesrelated to repetitive movements and the way in wish force is applied during the crimpling of terminal. **Objectives:** the improvement of the Workstation through the redesign of the crimpling process, this by adding a device that will eliminate the manually appliedforce on the crimpling tools used during the process, and have it replace by a pneumatic operated by a semiautomatic mechanism, thus to prevent the injuries to the workers.**Delimitation:**the Project center in the CATSACN area of the MEFASA plant in AguaPrieta, Sonora. **Methodology:** Interviews, operations analysis, options selectionprototype design, device studies and lab test. **Results:** the laboratory test observations allows to see that the device complies with the specifications requirements designated by the customer and the quality requirements of the product measure by its resistance, pull strength, pressure applied and changes in the SMED system or set up.**Conclusions:** this device eliminates the risk of injuries due to repetitive operations on long periods that require the application of force with the hand.

Key Words: work hazard, Design, Productivity

1. INTRODUCTION

The need to protect the workers against the source of injuries and work hazards is unquestionable.Every workplace must take action toward the prevention of work hazards, with the advantages in productivity and the compliance of the planned production rates, achievingwellbeing for the workforce and the workplace

The work related injuries represent a mayorproblem for small, mediumor large companies.According to information reported by the InstitutoMexicano del Seguro Social between 1999 and 2003, injuries to the synovial capsule, inside the synovial and tendons, as well as the carpal tunnel injuries, are in the eleven first most common work related injuries, thus can be reduce through a good process evaluation, and the proper design or redesign of the process or workstation. Been the operation of the crimper pliers a classiccause of carpaltunnelsyndrome, was the reason for the development of this improvement to the operation.This syndrome is caused by work activities and hobbies that require very repetitive movements of hand or wrist, especially when combined with the application of force to hold a fistor close the hand in order to squeeze something. or the tightening of objects with the fingertips, or the usage of vibrating tools or those instruments that require an augmented precision of the hand.(SILVA 2011).

In the developing of this project it was necessary to detect the main problem with the repetition of movements generated with the terminal crimpling operation, as this was causing a series of injuries and work related illnesses In the workplace of the MEFASA plant in Agua Prieta.A study performed gave as a result the main fails in the process, which were mainly wrist injuries due to the force applied and the movements performed by the worker in a totally manual operation. A non adequate handling angle during the operation can be harmful to the worker health. Several principles of tools and workstation design show that this non adequate angles hurt the productivity as well as the comfort of the worker (KONZ 2005)

To achieve the improvement changes in the production line where necessary, and thus changeswere the adaptation of a semiautomatic devices that performed the retentivemovement and applied the exact forceneeded for the operation with a pneumatic driven mechanism, this device has the necessary supports to hold the pliers that the worker uses on daily operations.This eases the crippling process and it completely eliminates the need to appliedforce bye hand, application that causes the work hazard to the wrist.,

With this device we completely eliminate the injuries suffer by workers and it came with an incrimination on productivity as it accelerates the production and reduces the length of the process, as well as the quality assurance as the force applied by the device is always delivers the same amount of pressure in comparison to a worker whom could have a low production rate, so it assures the quality.

If during any process, any of the hands of the worker is busy holding something then that hand is not making anything useful for the operation, as is always possible to design a holding device to do an acceptable work, and be able to use both hands to make a useful action. These devices not only save time, but are also capable to hold in a moresteady and precise form the parts of the work material. Many times foot operated devices allow for the hands to be free to do more productive activities. (McCormick 1993).

2. OBJETIVE

General Objective

To improve the workstation, by the residing of the crippling process thus with the usage of a device that will eliminate the manually appliedforce on the crippling pliers used in the operation, by a pneumatic driven semiautomatic mechanism, looking to eliminate the work hazard presented by the repetitive process of crimpling inside of the MEFASA plant.

SpecificObjetives

- Elimination of possible injuries in wrist or forearms.
- Operation Time Reducción.
- Unnecessary movement suppression.
- Tool setup changes time reduction.
- Product quality assurance.
- Work hazard related incapacities cost reduction.

3. DELIMITATATION

This Project took place inside the area of CATSCAN of the MEFASA plant in Agua Prieta, Sonora, Mexico.

4.METODOLOGY

This project was develop by a series of stages that will be describe in the following:

4.1. -Interviews and Operations Analysis.

The first step was a meeting with the Plant General Manager, who explained the problems related to the studied operation, that caused the dismissal of a worker, and work hazard related injury that related in another worker medical levee and the need to prepare other yet to replace him. A later meetings with the workers and the supervisor, was performed to learn and understand the production process and its operations, as well as the process specifications, the repetitive of the task in a daily bases, the workers rotation, the set up changes , and the levels of scrap and devolution of products with quality issues, as well as other things; During the study of the process, the identification of an improvement opportunity was achieved in the area, that could avoid the occupational hazard. So in order to prevent the work injuries the measure to be taken was to change one of the manuals operations task so a device could perform it. Negligence in the manual tools design might produce physical health problems that could manifest as accidents, injuries, recurrent micro trauma, tiredness, deficiencies in task performances and costly mistakes.(Mondelo, Gregori, Blasco y Barrau 2001)

The following is an internal report about the worker

REPORTE INTERNO DE INVESTIGACION DE ACCIDENTES

EVALUACION	GRAVEDAD POTENCIAL DEL ACCIDENTE						PROBABILIDAD DE REPETICION					
	INCAPACITANTE		LEVE		PERD. MATERIAL		FRECUENTE		OCACIONAL		RARO	

A) DESCRIBA EN FORMA DETALLADA COMO OCURRIO EL ACCIDENTE

El operario estaba trabajando alrededor de las 4:30 pm el dia jueves 15-sep-2011 tomó las pinzas crimpeadoras y al aplastarlas para crimpear sintió que se le encogió el nervio del brazo derecho y no le tomo mucha importancia penso que podia ser un dolor cualquiera y no lo reporto a recursos humanos ni a su jefe inmediato.

B) QUE CONDICIONES EN EL TRABAJO O ACTOS DE LA PERSONA CAUSARON DIRECTAMENTE EL ACCIDENTE

Probable repetitividad máximo de crimpeado 100 veces diario

C) PORQUE EXISTEN ESAS CONDICIONES O ACTOS

Debido al proceso que es determinado en las especificaciones el cliente y a la vez el mismo provee las herramientas para el trabajo

D) QUE ACCIONES SE HAN TOMADO O SE TOMARON PARA EVITAR LA REPETICION

Rotar más al personal que crimpea

DEPARTAMENTO	FECHA EN QUE OCURRIÓ	FECHA EN QUE SE INFORMÓ	TURNO	HORA	TIEMPO EXTRA
Catscan Harness	15-sep-11	22-sep-11	1	04:30	

LESION PERSONAL			DAÑO MATERIAL	
Dolor en antebrazo derecho			n/a	
NOMBRE DEL LESIONADO			MAQUINARIA, EQUIPO O PROPIEDAD DAÑADA	
Maria De Jesus Franco Moreno			n/a	
EDAD	NUMERO	PUESTO QUE DESEMPEÑABA		
40	1879	operador		
EXPERIENCIA EN EL PUESTO		NATURALEZA DE LA LESION	NATURALEZA DEL DAÑO	
4 años			n/a	
PARTE DEL CUERPO AFECTADA			OBJETO O EQUIPO QUE CAUSO EL DAÑO	
Antebrazo derecho			n/a	
OBJETO O EQUIPO QUE CAUSO LA LESION			COSTOS ESTIMADOS	
Pinzas crimpeadoras			n/a	
ATENDIDO POR:			INVESTIGADO:	FECHA:
Dr de IMSS			Boggar Ahumada	22-sep-11
REVISADO POR:		FECHA	ENTREGADO:	FECHA:
Boggar Ahumada		22-sep-11	Juan Bosco Davila	22-sep-11

4.2.-CATSCAT HARNESS area initial assessment:

In order to achieve this stage, a series of techniques were develop to solve the problems shown by the diagnostic resulted from the operation analysis. The Crimpling operation was analyzed wish consist in the holding of the crimpling pliers with the left had while the right had reaches for a pin and is place in the pliers vises, this applying a moderated force in order to hold the pin in place, then the pliers are change to be hold by the right hand, while with the left hand a piece of cable is reach to be assembled within the pin, then both hand are used to applied enough force join the cable and the pin inside a connector.

TABLE 4.2.1 BIMANUAL DIAGRAM OF THE CRIMPLINGOPERATION.

LEFT HAND DESCRIPTION	Symbol	Symbol	RIGHT HAND DESCRIPTION
Reach Pliers	**AL**	**AL**	Reach Pin Connector
take	**T**	**T**	Take
Move	**M**	**M**	Move
Hold	**SO**	**P**	Place
Hold	**SO**	**SL**	loose
Hold	**SO**	**AL**	ReachPliers
Hold	**SO**	**T**	Take
Hold	**SO**	**SO**	Hold
Loose	**SL**	**SO**	Hold
Reach Cable	**AL**	**SO**	Hold
Take	**T**	**SO**	Hold
Move	**M**	**SO**	Hold
Place	**P**	**SO**	Hold
Loose	**SL**	**SO**	Hold
ReachPliers	**AL**	**SO**	Hold
Take	**T**	**SO**	Hold
Use	**U**	**U**	Use
LoosePliers	**SL**	**SO**	Hold
ReachAssable	**AL**	**SO**	Hold
Take	**T**	**SO**	Hold
Move	**M**	**SO**	Hold
Place	**P**	**SO**	Hold
Loose	**SL**	**SL**	Loose

With the analysis of this operation, a high repetitively is found in the crimpling task, this then been the cause of the work hazard to the injured worker forearm who use to perform the task, resulting in a six month medical leave of the worker an producing the need to hire a new worker for the task, who could take up to a week of training. Another improvement opportunity was found at the material management analysis, as it was observed that due to the small dimensions of the pin, it was difficult for the worker to pick them up and hold them.

Base on the mentioned analysis the reach conclusions was the need to develop a device pneumatic driven that through the use of an air piston, and the compressed air installation in the plant facilities. Thus consider the best solution as it eliminates the need to applied manually force, and with the use of a foot pedal to activate it, both hands are free to better handle the materials and tasks of the process.

4.3. -PrototypeDesign

Taking into account several design issues, like the size, components, available tools, the capacity to easily adapt to different pliers, as well as the client specifications of the product manufacture with it, and the set up changes need it during the production process, including the way of using pneumatic drives taking advantage of the existing compress air lines available in the facilities.

The prototype was built so it could be operated no matter the gender, age or anthropometric built of the person.

The force requiring task that can easily be performed by younger workers might be overwhelming for older ones. For each muscle group the strength of a woman is 55% as to the 88% of a man (Oborne 2004),

Once the design was achieved, the fabrication of a working model began. The milling of a especial main support, to hold the different pliers, that the process might use, this with a width adjustment to allow it to tightly hold the pliers in place and providing an improved stability that ensures they won`t came loose or move out of place (Fig. 4.3.1); Other element of the device consist of foot pedal, thatregulates the air flow to the pneumatic piston that handles the pliers vises (Fig.4.3.2), performing the task that use to be done by hand but with enough force to join all of the components in the required form.

Once the device is deployed an implemented, the new operation analysis would be:

When place the pliers in the device the number of task are reduce to reach the pin with the right hand, at the same time the left hand reaches for the cable, as they come together they get assembled and place in the pliers vises, then the pedal is press and the pliers close joining the pieces of the assemble together.

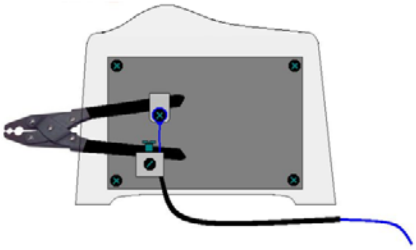

Fig 4.3.1 Crimp Pliers Base Holder

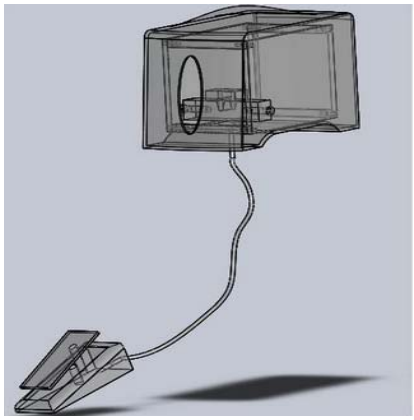

Figura 4.3.2 SemiautomaticCrimplingDevice

TABLA 4.3.1 BIMANUAL DIAGRAM OF THE CRIMPLING OPERATION

Lefthanddescription	Symbol	Symbol	Righthanddescription
Reach Cable	**AL**	**AL**	Reach Pin conector
Take	**T**	**T**	Take
Move	**M**	**M**	Move
Assamble	**E**	**SO**	Hold
Place	**P**	**P**	Place
Use	**U**	**U**	Use
Move	**M**	**SL**	loose
Place	**P**		
Loose	**SL**		

4.4 Studies and laboratory test

The laboratory test were made inside the installation of the Universidad de la Sierra using the tools, labs and workshops available witch made easy the tests that were realize, like the measures of the pressure applied consider in the operation of the struck out to see if it meets with the specifications established by the client; It was submitted to a comparison test between the force made with the hand and the force made by the new device, and make sure that with these were higher or equal, with a minimum margin of variability. The measurements were made using a dynamometer

4.4.1 Laboratory test

Visual quality inspection

The visual inspection is one of the oldest activities in the industrial and the first testing that wasn´t destructive to any piece or component.

In order to do this it was necessary the use a magnifying glass. A tool that increases the visual size images, normally ten times or higher. It has been used as assistance in the visual evaluation of crimp termination for a better overview. The pliers used in this test were the same as the one used in the production line, there were any deformations found nor alterations in the procedure of crimp in this part.

Set up times

The set up times are really important for MEFASA Company, this is why the insurance that there were inside permissible limits, the SMED used, indicates that the length of time to change the tools (Pliers) is not greater than 10 minutes. The final results obtained for set ups of the device oscillatesaround five minutes and it meets with the client´s specs.

Measurement of height of crimp

For this method a micrometer was used to measure the height of the crimp. The measurement was taken from the center of the crimp so that the flaring of the conductor doesn't affect it. There is a thin blade that holds the top of the crimp and a pointed section that determines the lower radial surfaces (curved). The readings obtained were between 29 and 28, and as we can see there is a minimum variation in the sample, this means that the force was constant during a significant number of samples.

Bending test

A way to prove how well crimp the insulation ends, consist in folding several times the wires, and then evaluated the displacement of the insulation and the strands of wire. Like a general rule, the crimp of the insulation has to be able of resist the repeated folding of the wire as far as 60 to 90 degrades in any direction. That was made with pin type connectors, obtaining a satisfactory result.

5. RESULTS

The results achieved with the development of this device, mainly proved the functionality of it, during the lab test it was submitted to, as well as the complete elimination of a work hazard the worker was subjected to, the reduction of the operation set up changes times where achieved as petitioned by the client, that should be reflected in a better used time, improved productivity and the assurance of the quality standards and safety and health regulation of the company.

6. CONCLUSIONS

The creation of a device that meets the specifications, and requirements expressed by a client of MEFASA, complying with the main objective of the project. the end conclusion that the large automation of procedures in the working place is not always viable, as many devices similar to this already exist in the market, but their specific utility nature could make them too costly and non practical for changing specification of products, as for the small adaptable tools and devices like the one design in this project that are easily move, portable, and unexpressive parts, might be a good investment for the company

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"DESIGN AND APPLICATION OF A SURVEY WITH AN ERGONOMICS APPROACH TO EVALUATE THE IMPACT THAT SUSPENDED PARTICULATE MATTER IN WORK CENTERS HAVE OVER THE WORKERS' PERFORMANCE AS REFERRED IN THE MEXICAN OFFICIAL NORM NOM 010-STPS-1999."

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Resumen: En el presente trabajo, se muestra la metodología de diseño y aplicación de una encuesta ergonómica en centros de trabajo, donde se emiten partículas suspendidas capaces de generar contaminación, con la finalidad de complementar los alcances de la Norma Oficial Mexicana NOM-010-STPS-1999 que regula las condiciones de higiene y seguridad en centros de trabajo donde se usan sustancias químicas. Dicha encuesta tiene la intención de promover la participación de los trabajadores respecto a la evaluación de su ambiente de trabajo, a través de cuatro dimensiones: Calidad del Aire, Capacitación, Salud, y Seguridad y bienestar.
La metodología que se siguió para el logro del objetivo de este trabajo, incluyó:1) La revisión a detalle de la Norma Oficial Mexicana NOM-010-STPS-1999 y la Norma Internacional UNE EN ISO 6385:2004 "Principios ergonómicos para el diseño de sistemas de trabajo", con la finalidad de comprender su contenido en cuanto alcances, limitaciones, y aplicación de la ergonomía; 2) El diseño del instrumento de medición (encuesta), que a su vez contempló: el establecimiento de las dimensiones de la calidad, la elaboración de las aseveraciones y formato de respuesta, y la aplicación de la encuesta; 3) Los cálculos para la obtención de resultados.
La encuesta diseñada se aplicó en empresas de diferente giro, que estuvieran dentro del campo aplicación de la NOM-010-STPS-1999; los resultados se presentan a través de un modelo gráfico que evalúa la Importancia y Desempeño.

Palabras clave: *Ergonomia, evaluacion, particulas suspendidas.*

Abstract: The present work shows the methodology of the design and application of a survey with an ergonomics approach in work centers where suspended particulate matter is emitted, capable of generating pollution; with the intention of fulfilling the objectives of the Mexican Official Norm NOM 010- STPS (1999) which regulates the health and occupational safety in work centers where chemical substances are used. This survey has the purpose of promoting the participation of workers regarding the evaluation of their occupational environment through four dimensions: Air Quality, Training, Health, and Safety and Welfare.
The methodology that was followed to reach the objective of this research included: 1) The detailed revision of the Mexican Official Norm NOM 010- STPS (1999) and the International Norm UNE EN ISO 6385:2004 “Ergonomics Principles for work systems design”, to understand its content concerning its scopes, limitations and the application of ergonomics; 2) designing the measuring instrument (survey) which also considered the establishment of the quality dimensions , the writing of the statements and the answering format, and the application of the survey; 3) the computation for obtaining the results.
The designed survey was applied to a number of companies with different line of business within the application field of the NOM-010-STPS-1999; the results are presented through a graph model that evaluates the Importance and the Performance.

Key words: *Ergonomics, evaluation, suspended particulate matter, survey.*

1. INTRODUCTION

Illnesses and accidents generally considered as occupational risks are one of the most important contemporary issues for the workers’ health and welfare. All over the world and significantly in Mexico present a high frequency compared to other countries (Ortega, 1999); for this reason, the prevention, detection and evaluation of occupational risks are important, and, as long as possible, the decreasing or eradication, since “the worker is the most important resource of all”, his tasks in a work center require strength, precision, observation, concentration, etc.; in other words, physical and mental effort for the commitment of the tasks.

Also, it implies the worker’s exposure to conditions where chemical, physical, biological, ergonomics, psychosocial, mechanical, electrical, etc., occupational risks are found.

The Norm ISO 9004:2000 applied to Quality Management Systems, Guidelines for the performance improvement, in its requirement 6.4, reads about Occupational Environment, describing it as a combination of human and physical factors which must consider methodologies, rules and welfare orientations, use of personal protection equipment, ergonomics, social interaction, facilities and environmental factors such as noise, lighting, temperature, vibrations, quality of air, among others. The environmental factors are studied by Environmental Ergonomics and, in the case of Interior Air Quality, according to González (2007) there is a classification including chemical contaminants, biological contaminants, sick building syndrome, legionellosis and tobacco in work centers.

Mateo (2007) makes a subdivision of the chemical substances present in the occupational environment, taking into account gas, vapor, smoke, dust, fog, fibers, particles, the latter corresponding to the object of this paper. (See Figure 1).

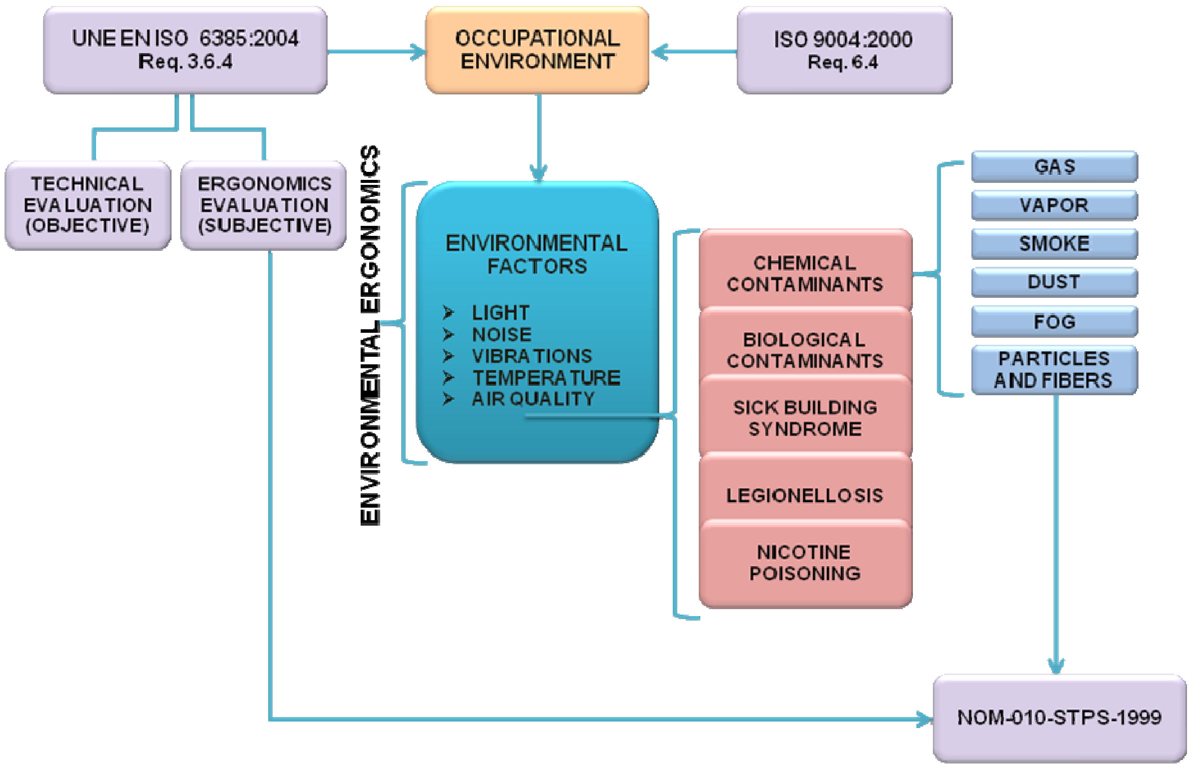


Figure 1. Diagram of this paper objective.

In the context of the study of occupational environment factors, the Official Mexican Norms issued by the Secretariat of Labor and Social Forecast are compulsory regulations which contain characteristics or specifications certain products or processes must observe when they might represent a risk for the workers' safety or damage the human health. In Mexico, the Norm that regulates the occupational safety and Health in work centers where chemical substances are used is the NOM-010-STPS-1999. This norm contemplates all the range of chemical substances generating pollution in the occupational environment while their handling, transportation, processing, or storage; considering the suspended particles as part of their scope, being an issue of special interest for the affectation of the health. This norm also states a series of technical procedures adequate for the in situ evaluation of the concentration of the suspended particulate matter, which tries to assure the air sampling taking into account the area and volume of the room, the location of the workers regarding the emission sources, the kind of particles according to their size and nature, as well as the calibration of the equipment and the expertise of the personnel doing the air sampling.

Therefore, it is subject to the procedures of quality control made through the services of Verification Units and Testing Laboratories, with the capability of documenting the duties established by the norm in the presence of the corresponding authority. However, even the effort made to accomplish the norm, there is a gap between the concepts and the application of the ergonomics conceptions which allow the involvement of the worker from the evaluation or diagnosis of his occupational environment according to his perception, the decision taking to improve himself, to his follow up and control. Internationally, the ergonomics precepts are considered within the laws, as shown in the European Norm UNE EN ISO 6385:2004, "Ergonomics principles for the design of work systems", where the qualitative evaluation allows to know the workers' opinion and feelings about their occupational environment, but not the technical evaluation being less important, which objective is the care of the workers' health, the decreasing of risks and improvement of their labor.

2. OBJECTIVE:

To design and to apply a survey with an ergonomics fundaments and methodology to be used as an analytical instrument supplementary to the established in the Mexican Official Norm NOM 010-STPS (1999), which regulates the safety and health in work centers where chemical substances are handled, transported, processed, or stored which present suspended particulate matter in the air, capable to generate pollution in the occupational environment.

3. METHODOLOGY

The structure considered for the methodological follow up of this paper was based on the detailed revision of the NOM-010-STPS- 1999 and UNE EN ISO 6385:2004 Norms, which may allow to define the conformation of a qualitative evaluation instrument based on the Quality Dimensions obtained from the norm itself, and its application in work centers where production processes generate suspended particulate matter. Next, the steps followed are presented:

3.1 Relevant aspects from the domestic and international norms used for the survey design.

The objectives of the NOM-010-STPS-1999 are to establish the regulations to prevent health damage in the occupational environment of those workers exposed to polluting chemical substances, and to determine maximum permissible levels; this is done by setting the regulations to the employers, such as the analysis of the potentially contaminating substances, the possible risks of their use through employees' training, and to watch the employees' health. In turn, the employees have the right and obligation to participate in training and instruction, to use personal protection equipment, take medical examinations, and to observe the prevention and control measurements, depending on the substances they work with, and, as it is compulsory, the employer must have the documents to prove the accomplishment of the norm.

The norm establishes that the activities of Recognition and Evaluation for chemical substances correspond to Verification Units and Testing Laboratories, which functions and characteristics as outsourcing, are described in Requirement 10, a long statement since it includes three Appendices dealing with technical aspects, chemical analysis methods, and procedures to establish maximum permissible levels of exposure (Appendix I); with the statement of chemical substances in the occupational environment (Appendix II); and with the Reports produced by the Verification Units and the Testing Laboratories (Appendix III).

Once the Verification Units and Testing Laboratories have produces their evaluation result reports and determine the maximum permissible levels of exposure, the employers must conduct Control activities as set in Requirement 9. The suggested measures are oriented to the nature of the production processes, technological aspects, ergonomics, feasibility and viability, giving an emphasis on the possible improvements the company could carry out. This requirement concerning the Control also includes issues related to medical examinations for the exposed worker to contaminating chemical substances, as established in Mexican Official Norms released by the Department of State Health, the periodicity the should be carried out; however, if these Norms did not exist, the Norm NOM-010-STPS-1999 suggests that the company's doctor determines the kind of exams to be taken.

Concerning the Requirements 11, 12, 13 and 14, briefly mentioned at the end of the Norm, deal with the supervision by the Secretariat of Labor and Social Forecast for their accomplishment, the corresponding bibliography, its concordance and the transitory articles.

It is important to mention that the Federal Regulations of Occupational Safety, Health, and Environment, in its First Chapter, Article 2, Ergonomics is defined as the "Adequacy of the work place, equipment, machinery, and tools for the employee according to his or her physical and psychical characteristics in order to prevent work injuries and illnesses, to optimize the employee's activity with less effort, and to avoid fatigue and human error. Besides, in Chapter Ten, Article 102, named "Ergonomics", states that "the Secretariat of Labor and Social Forecast will promote that, regarding facilities, machinery, equipment and tools in the workplace, the employer has to consider ergonomics aspects, in order to prevent work injuries and illnesses"; so, these regulations should be included in the Mexican Official Norms issued by the Secretariat of Labor and Social Forecast.

However, in no section of the NOM-010-STPS: 1999 any aspect related to Ergonomics, neither conceptually nor applied to any of its sections, biometrics, environmental, cognitive, preventive, conception, specific or corrective (González, 2007) , is mentioned. Therefore, it is evident its inclusion as the Secretariat of Labor and Social Forecast itself has considered necessary some changes to adapt it to the precepts stated in the Federal Regulations of Occupational Safety, Health, and Environment (Official Journal of the Federation, January 1997)

Concerning International Norm UNE EN ISO 6385:2004 "Ergonomics Principles for work systems design", it generally describes an integrative approach for the design and improvement of the work systems-either before its installation or when it is already functioning-taking into account each element: the human factor, the tasks, equipment, space, environment, and working processes. It states actions for the design of optimal working conditions, considering health, safety, and welfare, the prevention of occupational risks through the development of existing abilities and the acquisition of new others, without losing sight of technological and economical efficacy and proficiency; highlighting the importance of the role the employee has in the accomplishment of the objectives.

Specifically, when referring to the occupational environment, the fundamental objective is the satisfaction of the human being. It remarks it is convenient employees get involved in the work system designing process so the physical, chemical biological and social conditions do not have adverse effects on the people, assuring their health, capability and the disposition to perform the tasks. For that, it suggests objective and subjective evaluations that allow the setting of environmental conditions need to be carried out; assuring these are maintained within acceptable levels for the preservation of health and welfare. It also establishes as the employee has this knowledge, he should be able to act on his occupational environment including environmental factors such as lighting, temperature, ventilation, air quality, etc.

3.2 Designing of the measuring instrument (survey)

Evaluation is a priority factor for the continuous improvement, but its execution needs a measurement instrument which allows an accurate analysis. In this case, the selected instrument was a survey applied to the employees who work in an environment presenting suspended particulate matter.

The employees in a work center should be seen as users in the facilities. Therefore, it is important to know their needs, for a better understanding on the way employees perceive their occupational environment. When these needs are understood, firstly, there is a better position to know how to satisfy the users and, secondly, it facilitates the production of the measuring instrument (survey).

For the design of the survey with an ergonomics fundaments which allows to diagnose what was previously mentioned the Establishment of Quality Dimensions (Hayes, 1999) was used. The points used are stated next:

3.2.1. Establishment of quality dimensions.

The quality dimensions of the conditions and the occupational environment were identified; these represent the critical issues the norm intends to accomplish. Since they are the objectives that support it, these issues emerged from the analysis of the norm. In table 1 the dimensions defined to write the statements for the survey are shown:

Table No. 1. Quality dimensions identified from the Mexican Official Norm NOM-010-STPS-1999.

Quality dimensions	Foundations in the Mexican Official Norm NOM-010-STPS-1999
Air Quality	It is the absence of pollutants in the air that are harmful to health. So, when the Norm covers the study of chemical substances and these are in the form of smoke, dust, gas, vapor, mists and particle and fibers; the dimension arises naturally from all of them that affect air quality.
Training	It is the willingness and ability to achieve a goal Through this, it is posible to know whether the workers are instructed about the risks of work, the unsafe acts or conditions, if they use the personal protective equipment and if they know the prevention and control measures. (Requirements 5.5 and 6.2).
Health	Health is a complete state of physical, mental and social welfare; and not only the absence of disease or illness, as defined by the World Health Organization in its constitution adopted in 1948. (Requirements 5.2, 5.3 and 5.6).
Safety and Welfare	The term Security refers to the absence or risk, and the Welfare is a state or condition of satisfaction or happiness. (Requirements 5.5, 6.3 and 6.5)

3.2.2. Production of the statements and answer format

In this stage a survey was designed to evaluate the specific information about the perceptions users have based on the established quality dimensions. It is fundamental to point that the survey was designed to evaluate the employees' (users) satisfaction regarding the Performance in presence of suspended particulate matter as well as the Importance they give to the dimensions: Air Quality, Training, Health, Safety and Welfare.

A survey to measure the user's satisfaction should use specific assertive statements to avoid various and multiple interpretations. The statements should be concise to avoid confusion and should state a single idea. An example of a correct statement is: "I use the breathing protection equipment along my working shift;" an ambiguous statement is "I use the breathing protection equipment along my working shift and I think it is uncomfortable".

The format of the answer used was the Likert scale, which is designed so the users respond according to the level of agreement or disagreement to each of the statements, in addition, this kind of scale allows determining the number of positive and negative answers. For example: 1) I am not provided with equipment, 2) I never use the equipment, 3) I sometimes use the equipment, 4) I usually use the equipment, 5) I always use the equipment.

The questionnaire is accompanied with a brief introduction explaining the purpose of it, and the instructions to answer the questionnaire are provided. The inclusion of the purpose of the questionnaire contributes to widen the perception of the users as their answers will be valued which will benefit them.

3.2.3. Application of the Survey

In this stage the survey was applied in different work centers where suspended particle matter to evaluate the user's satisfaction. First, a visit to the facilities was made to know the production process, the materials utilized in each stage of the process, the machinery used, and the involved personnel. Once the main sources of particulate matter were identified, the application of the survey took place; previously, the purpose of the application was explained to the administrative and operative personnel. See Table 2.

Table No. 2 Work centers where the survey was applied.

Line of business	Metal-mechanics, stainless steel products	Pharmaceutical	Manufacture of wooden furniture
Materials utilized	Polishing fiber roll, polishing wax and other chemical substances.	Different chemical substances, roughly 261.	Varnishes,paints, solvents, and other chemical substances.
Activities that generate suspended particle matter	Polishing and soldering	Weighing of feedstock, mixing and granulation,sieving,drying.	Cutting,inking and lacquered, varnished and painted.
Areas where activities that generate suspended particle matter are achieved	Polishing and soldering area	Storage areas for inputs, outputs and waste. Process areas: production and packaging.	Finish areas

4. RESULTS

Once the questionnaire was applied, the obtained answers were computed. The data was registered in a matrix, which format allowed the obtaining of the weighted average for every three statements included in the four dimensions set. Every dimension includes three statements in the questionnaire, which are necessary to average (Martínez, 2006).

As it can be observed, the matrixes for the calculation of the results (see Tables 3 and 4) are divided in two sections, one corresponding to the sentences measuring the Performance of employees (statements with an odd number in the questionnaire) and the second, corresponding to the sentences measuring the Importance given to each dimension: Air Quality, Training, Health, Safety and Welfare.

Table No. 3 Matrix for the calculation of the results of measuring the Performance and Importance for affirmation.

Assertion	PERFORMANCE						IMPORTANCE					
	Number of surveys for evaluation scale					Weighted average	Number of surveys for evaluation scale					Weighted average
	5	4	3	2	1		5	4	3	2	1	
1	0	1	3	2	4	2.1	5	5	0	0	0	4.5
2	1	3	0	6	0	2.9	4	4	1	1	0	4.1
3	0	1	3	2	4	2.1	6	3	0	1	0	4.4
4	0	3	1	4	2	2.5	5	4	1	0	0	4.4
5	4	4	1	1	0	4.1	6	4	0	0	0	4.6
6	0	1	7	1	1	2.8	5	5	0	0	0	4.5
7	1	3	5	0	1	3.3	5	5	0	0	0	4.5
8	1	4	3	2	0	3.4	6	4	0	0	0	4.6
9	0	1	5	3	1	2.6	1	4	4	1	0	3.5
10	0	4	2	2	2	2.8	4	5	1	0	0	4.3
11	0	4	3	2	1	3	5	4	0	1	0	4.3
12	0	7	3	0	0	3.7	6	4	0	0	0	4.6

Table No. 4 Matrix for the calculation of the results of measuring the Performance and Importance for each dimension

Dimension	PERFORMANCE AXIS (Y)			IMPORTANCE AXIS (X)		
	Assertion	Weighted average	Simple average	Assertion	Weighted average	Simple average
Air quality	1	2.1	2.367	1	4.5	4.333
	2	2.9		2	4.1	
	3	2.1		3	4.4	
Training	4	2.5	3.133	4	4.4	4.5
	5	4.1		5	4.6	
	6	2.8		6	4.5	

Health	7	3.3	3.1	7	4.5	4.2
	8	3.4		8	4.6	
	9	2.6		9	3.5	
Safety and Welfare	10	2.8	3.167	10	4.3	4.4
	11	3		11	4.3	
	12	3.7		12	4.6	

The simple averages obtained from the weighted averages (see Table 4) were graphed in a rectangular coordinate system. The x-axis was designed to the Importance employees give to each of the dimensions set in the statements, and the y-axis is the evaluation employees make to their Performance.

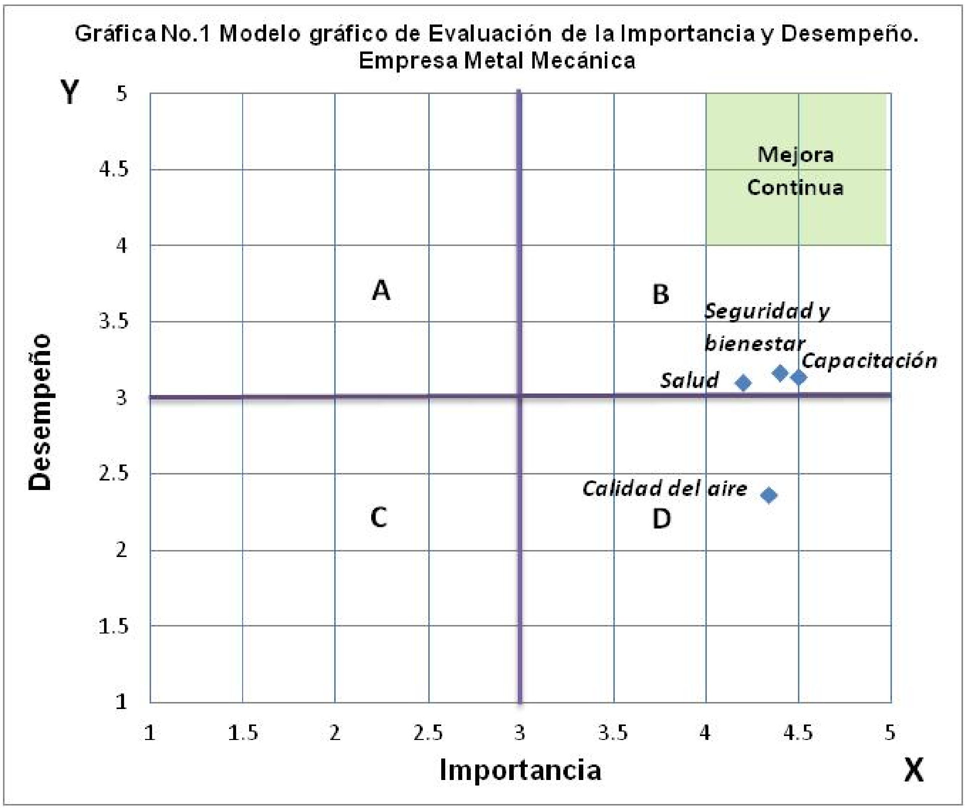
The interpretation of this graph model (see Table 5) will depend on the quadrant the averages are located. This will give an idea of the decision and the measures that should be adopted, either to improve the work system or to confirm the efficacy of the system. See Table 5

Table No. 5 Interpretation of graph model of the Importance and Performance Evaluation for each quadrant.

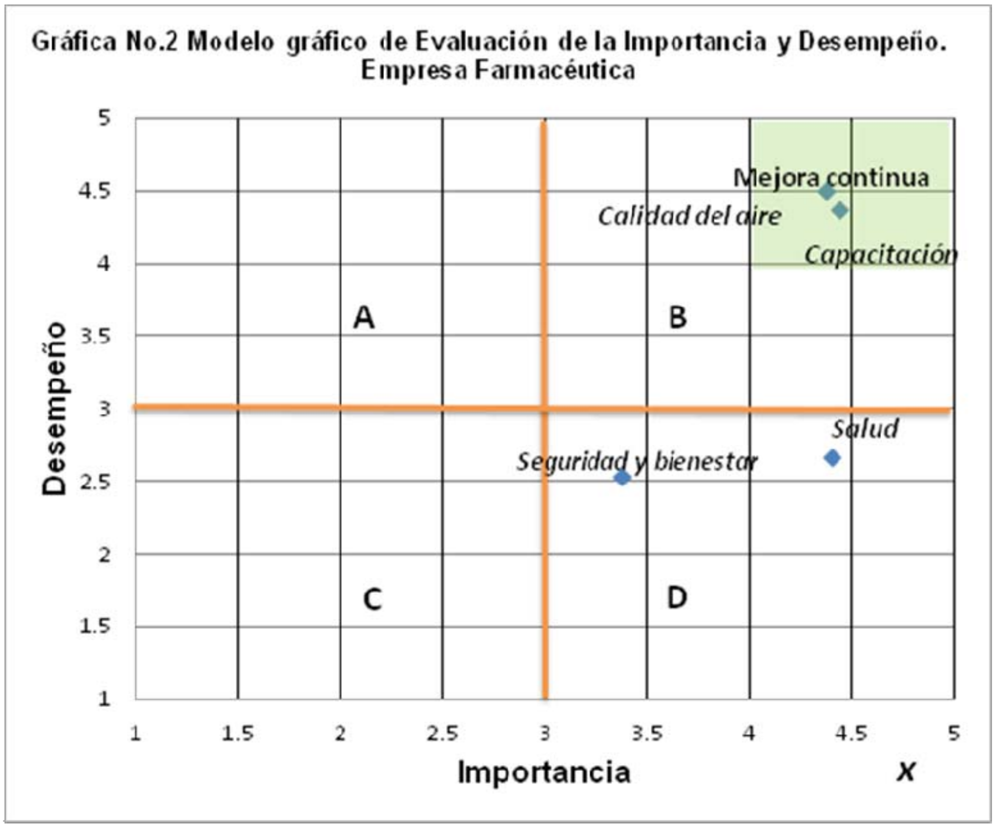
QUADRANT	VARIABLES	RANK	INTERPRETATION
A	**Importance**	Low - Regular	Quadrant A indicates areas of opportunity for analysis and corrective or control actions.
	Performance	Regular - Excelent	
B	**Importance**	Regular - Excelent	In quadrant B is situated the Continuous Improvement Zone (shaded area), which indicates that the system was designed correctly and operates under rules and regulations and the monitoring it is necessary to ensure its permanence. If the values are not in the area of Continuous Improvement, corrective or control actions are necessary.
	Performance	Regular - Excelent	
C	**Importance**	Low - Regular	The values that are located in quadrant C, represent low Importance and low Performance, so it is suggested not to invest in corrective or control actions and eliminate as far as possible.
	Performance	Low - Regular	
D	**Importance**	Regular - Excelent	In quadrant D, it is suggested a reconsideration of resources and the investment for improvement.
	Performance	Low - Regular	

The interpretation of the graphs obtained from the application of a survey in the previously mention work centers are explained below (see Table 2)

In Graph 1 the results of the questionnaires applied in a metal-mechanics line of business, to the polishing and soldering areas employees are presented. As it can be observed the dimensions Safety and Welfare, Health and Training were located in Quadrant B of the graph, which indicates that they were evaluated as Important but with low values regarding the Performance. Corrective or control measures should be taken immediately. Employees evaluate these dimensions as important; however, they find them inefficient while performing their duties. Regarding Air Quality, due to a high concentration of suspended particles and fibers to which employees are exposed to, the evaluation was low regarding Performance, but Important.



Graph 2 shows the results of the questionnaire applied in a Pharmaceutics company to the production area personnel. The dimensions Air Quality, and Training, were located in Quadrant B. It is interpreted that employees find these dimensions satisfactory in importance and performance. This can be corroborated as the air extraction systems are highly efficient and the training employees receive takes place every four months. Regarding Health, and Safety and Welfare were evaluated with a low level of performance as employees expressed they have had eye and skin disorders as well as mucus, and they are medically examined frequently to know their health condition; they think the personal protection equipment is uncomfortable (as stated in the survey), therefore Health was evaluated with greater importance than Safety and Welfare.


Gráfica No.2 Modelo gráfico de Evaluación de la Importancia y Desempeño. Empresa Farmacéutica
Desempeño
Importancia
x
A
B
C
D
Mejora continua
Calidad del aire
Capacitación
Salud
Seguridad y bienestar
5
4.5
4
3.5
3
2.5
2
1.5
1
1.5
2
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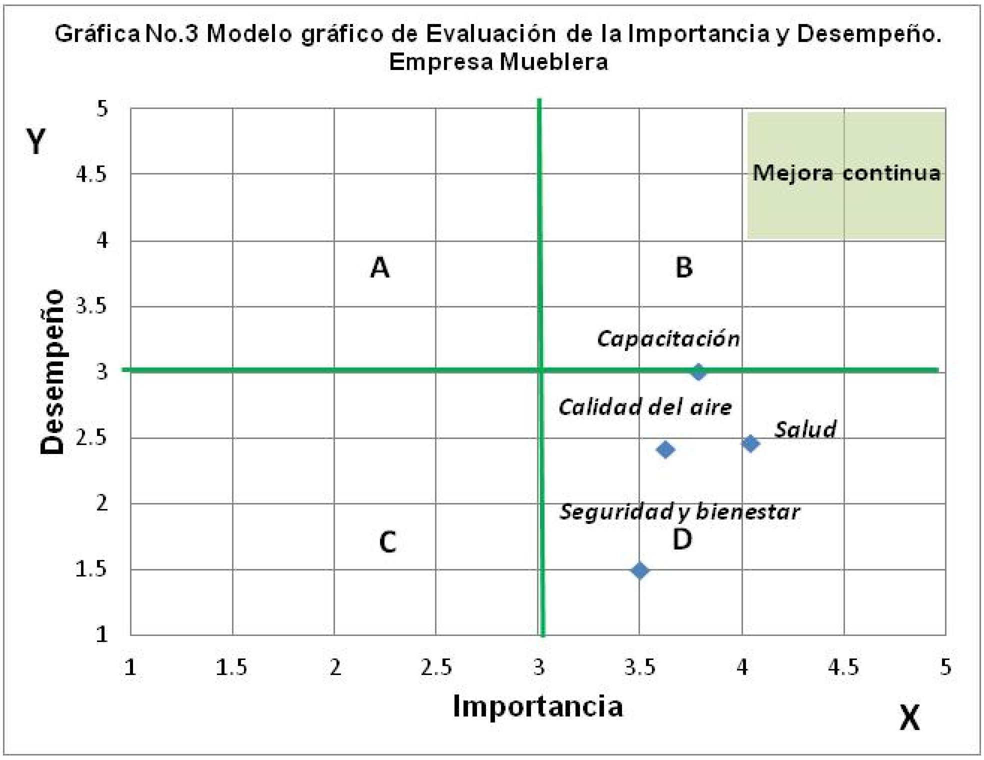
3.5
4
4.5
5


Gráfica No.3 Modelo gráfico de Evaluación de la Importancia y Desempeño. Empresa Mueblera
Y
Desempeño
Importancia
X
Mejora continua
A
B
C
D
Capacitación
Calidad del aire
Salud
Seguridad y bienestar
5
4.5
4
3.5
3
2.5
2
1.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Graph 3 shows the results of the questionnaires applied in a wooden furniture factory to the finishing area employees. The dimensions Safety and Welfare, Air Quality, and Health were located in quadrant D; the employees evaluated these dimensions as important in different degree but inefficient regarding Performance, being Safety and Welfare the most notorious as employees consider the personal protection equipment uncomfortable, they are not frequently medically examined to know their Health condition and they do not apply or do not know preventive or control regulations regarding suspended particulate matter in their occupational environment. The low Performance in Air Quality is due to the high concentration of solvents, paint, and wood dust employees are exposed to; and the low Performance in Health is due to the employees expressed they have had eye and skin disorders as well as mucus (as stated in the survey). Regarding **Training**, it was evaluated as Important but with a regular Performance.

5. CONCLUSIONS

In Mexico Occupational Norms in Health, Safety and Environment play a fundamental role in risk prevention; however, there is a lot to do concerning the inclusion and application of ergonomics principles, not just to supplement the existing Norms but to favor the welfare, health, safety, comfort and therefore, the efficiency of the human factor at work.

The Mexican Official Norm NOM-010-STPS-1999 refers to chemical substances generating pollution in the occupational environment while their handling, transportation, processing, or storage; and it has a wide structure related to a series of technical procedures adequate for the evaluation of the concentration chemical substances; however, it does not consider the possibility of qualitative evaluations which may allow the appreciation of the employee regarding his occupational environment and, based on that, the setting of improvements which will be positively reflected not only in the employees' health, welfare and comfort from an ergonomics perspective, but the legal accomplishment in presence of the Secretariat of Labor and Social Forecast, as it already mentions Ergonomics as part of its approach as established in the Federal Regulations of Occupational Safety, Health, and Environment.

In contrast, in European countries, the inclusion of ergonomics in their Occupational Norms is stated in an integrative way. Such is the case of the International Norm UNE EN ISO 6385:2004 "Ergonomics Principles for work systems design" which highlights the importance of the role the employee has for the accomplishment of the design of optimal working conditions, considering occupational health, safety, and risk prevention as important as the technological and economical efficacy and efficiency. The Norm also establishes objective and subjective evaluations to set the environmental conditions as part of its requirements.

Under these premises, the objective of this paper is to design and a survey with an ergonomics fundaments and its application in work centers where chemical substances are suspended particulate matter. This instrument permitted to know the employees' perception concerning their occupational environment, defined in four Dimensions: Air Quality, Training, Health, and Safety and Welfare; evaluating their Performance and their Importance, therefore it is intended the survey becomes a qualitative supplementary instrument to the technical aspects included in the Mexican Official Norm NOM-010-STPS-1999.

Finally, the insertion of Environmental Ergonomics in Mexican Occupational Norms represents a cultural advance in the consideration of a humanitarian scope in occupational safety and health, not only referring to the employees' health preservation and welfare, but the satisfaction and motivation in them for the performance of their duties, and the improvement of their quality of life, the quality of the union and the workplace the employee is part of.

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ERGONOMÍA EN EL SECTOR ARTESANAL DEL BAMBÚ.

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Resumen

En este congreso se presenta el proyecto *Ergonomía en el Sector Artesanal del Bambú,* cuyo objetivo es mejorar las condiciones de trabajo de los artesanos y la calidad de los muebles que se producen, mediante el diseño ergonómico de dos bancos de trabajo, uno para perforar y el segundo para armar muebles con piezas rectas de bambú, en talleres de los estados de Puebla y Veracruz. Este trabajo se desarrolla en la FES Aragón de la UNAM en la carrera de Diseño Industrial y participan académicos y algunos alumnos con fines de titulación, servicio social y prácticas profesionales. Los objetivos académicos son vincular la docencia con la investigación y con los sectores artesanal y productivo.

El proyecto abarca dos etapas. En la primera etapa, se visitaron algunos talleres representativos para conocer las actividades con base en la observación y registrarlas mediante fotografías y videos. Posteriormente se diseñaron y construyeron los prototipos para probarlos en los laboratorios de la Universidad. La segunda etapa consistirá en probar y evaluar los prototipos en alguno de los talleres.

Palabras clave: diseño ergonómico, estación de trabajo, bambú.

Abstract

In this conference we will present the project *Ergonomics in the Field of Bamboo Crafts* based on ergonomic design of equipment planned to improve working conditions of artisans and the quality of furniture produced with straight bamboo pieces, mainly in the states of Puebla and Veracruz. This work is being developed in UNAM - FES Aragon in Industrial Design career, concerning teachers and some students, as social service, professional practices and degree assignments. The academic goals are to link teaching with research, crafts and production.

The project comprises two stages; in the first one, we visited some workshops to learn about the activities through observation and register them with photos and videos. Two prototypes were designed and built for testing in the laboratories of the University. In the second phase, the prototypes will be tested and evaluated in one the workshops.

Key words: ergonomic design, workstation, bamboo.

1. INTRODUCTION

Chinese and Japanese bamboo products are based on millennia-long tradition. In Mexico, bamboo has a short story of use in furniture and in diverse group of articles. About fifty years ago, several manufacturers have established in areas where bamboo grows naturally and it is used for utensils, crafts and furniture. These are located in the states of Puebla, Veracruz and Oaxaca. (FONART, 1985).

Bamboo transformation is divided into two main branches. The bamboo industry, with high-technified machinery manufactured in Asia to cut and laminate the stalks into sheets and planks. Products made from bamboo laminate, including flooring, cabinetry, furniture and even decorations, are currently very popular. The other branch is handcrafts, where special equipment has not been developed and common tools for woodworking are being used.

In workshops of Monte Blanco, Veracruz and Cuetzalan, Puebla, furniture is made of bamboo in its natural form, as an almost round tube retaining its shell. Artisans have installed small workshops in annexes where they live. Using woodworking tools and equipment lack of appropriate facilities, often working on the floor and improvised tables in awkward positions, which upsets their health and the quality of products.

Since 2009, in FES Aragon, UNAM, a group of teachers and students of the School of Industrial Design are working on a project called *Equipment for Bamboo Craft Workshops.* (Chávez Aguilera, 2011).

After visiting the workshops and analyzing the furniture, it was found that quality joints are inevitable in all the products and so assembly procedures have to be considered. Careful planning reduces quality issues, such as joint alignment, location and visibility. The operator is an essential consideration in the design process and manufacturing conditions. The artisan in his own workshop carries out various tasks. Over a working day, he may be responsible for drying, cutting, drilling, assembly and buying materials.

Figure 1. Craftman dried bamboo. Monte Blanco, Ver.

Figure 2. craft workshop at Monte Blanco, Ver.

Figure 3. Craftmen working on floor. Monte Blanco, Ver.

2. OBJECTIVES

Apply ergonomic assessment procedure in the working conditions of artisans and increase the quality of bamboo furniture by providing equipment that will help accurate drilling and assembly procedures of multiple-part products.

To achieve these goals we designed two workbenches, one for drilling and one for assembly of parts.

The academic objectives are: relate research to teaching, production and craftsmanship. Generate Social Service programs, Internships and Degree Projects. (Chávez Aguilera, 2011).

3. DELIMITATION

This project has focused on workshops at Cuetzalan, Puebla and Monte Blanco, Veracruz. Although the artisans received technical advice, the shops are not provided with suitable equipment for working with bamboo, nor the consultants nor the artisans have considered that woodworking is different. Therefore we are interested in providing the craft workshops with these two benches.

4. METHODOLOGY

- First stage:
  We visited the workshops of Cuetzalan, Puebla and Monte Blanco, Veracruz.
  We observed and recorded different activities and working conditions with photographs and videos. (Chávez Aguilera, 2011).
  We measured the artisans to know the size of the users needed to carry out the process of adjusing the figures to understand the anthropometric data needed to design the two workbenches. (Chaurand Avila, 2007). We also defined the user profile to specify clearly that the work done in these workshops, as we know, is about 50 years old and the products are not recognized as traditional crafts. (FONART, 2009).
  Design of equipment taking into account ergonomic and technical-productive requirements. (Gutiérrez Torres, 2009).
  Prototyping.
  Simulation and evaluation of prototypes in the laboratories of the University.
  In this conference we present only the first stage.
- Second stage:
  Apply ergonomic assessment procedure in the working environment with equipment designed to achieve the optimum relationship between the user and the object.

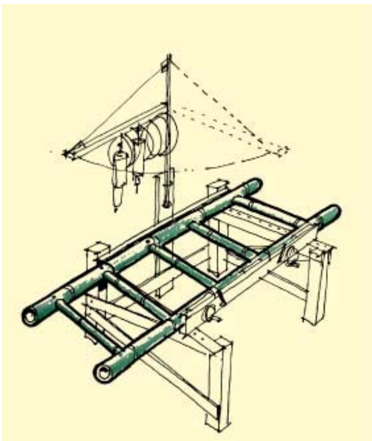

Figure 4. Work table to join straight pieces of bamboo

Figure 5. Anthropometric measurements of the participants

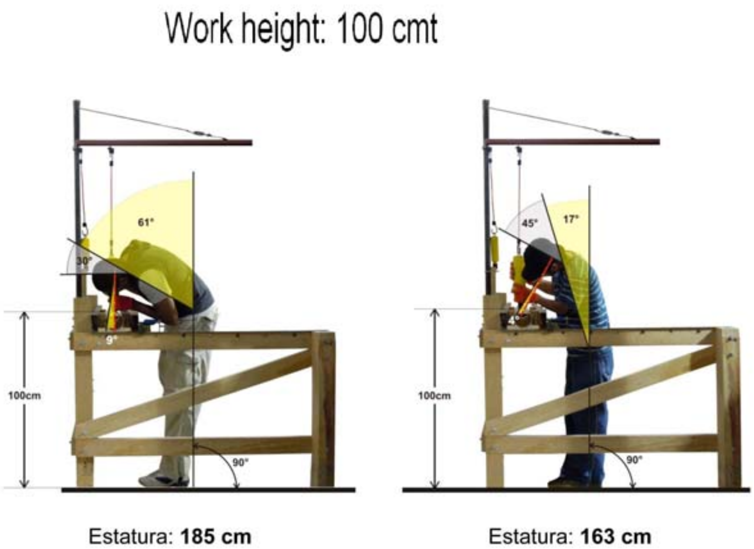

Imagen 7. Simulación en Laboratorio de FES Aragón

5. RESULTS

Two prototypes: bench for drilling and a bench for assembly of furniture. Currently being tested in the laboratories of the Faculty. In academia: Social service, Professional Practice and two degree projects with honorable mentions.

6. CONCLUSIONS

The two benches are tested in the laboratories of FES Aragon. The next step is to move to Puebla and Veracruz to apply an ergonomic assessment procedure and interpret the practical situation.

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Design Ergonomícs: D.I. Ma. Fernanda Gutiérrez Torres

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Social Services: Luis Enrique Castro Jiménez (Premio al Servicio Social "Gustavo Baz Prada" 2010. UNAM), Diego Martínez Villalobos, Ángel Gregorio Hernández Velázquez y Saúl Sánchez Mariano
Professional Practice: Orlando Aquino López y Ángel Gregorio Hernández Velázquez.
Two projects submitted for certification in Professional Exam (2011), with honors: Orlando Aquino López y Diego Martínez Villalobos and another one in process: Luis Enrique Castro Jiménez.

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"NI-K, PORTABLE URINE CONTAINER FOR GIRLS"

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Resumen: Al conformarse una familia, la mayoría de los padres buscan cubrir aquellas necesidades que de cierta manera generen una buena calidad de vida. Sin embargo, la salud es una constante que día a día se pone en juego. En torno a lo anterior, dentro del seno familiar, los menores, y en mayor medida las mujeres, son quienes requieren mayor atención en la higiene, debido a su anatomía. Así, y tras analizar diversas situaciones que afrontan tanto padres como sus hijas al encontrarse fuera de su casa, el objetivo fue, diseñar un contenedor de orina para niñas de entre 3 a 5 años de edad, factible de utilizar en espacios abiertos, reduciendo los riesgos de captar una infección urinaria.

Palabras clave: Diseño, Infecciones urinarias, Infantil.

Abstract: To settle a family, most parents seek to meet those needs in a way to generate a good quality of life. However, health is a constant daily is at stake. Around this, within the family, children, and greater extent women are those who require more attention to hygiene, because to their anatomy. Thus, after analyzing various situations faced by parents and their daughters to be outside of your home, the goal was to design a container of urine for girls aged 3 to 5 years of age, feasible to use in open spaces, reducing risks to capture a urinary tract infection.

Keywords: Design, Urinary Infections, Child.

1. INTRODUCTION

Urinary tract, is one of four human body excretory apparatus, and this is responsible for removing waste products through the urine. The apparatus consists of the kidneys, ureters, bladder and urethra. However, due to many factors cleaning and personal care, is likely to get infections easily.

However, it is estimated that more girls than boys have had a urinary tract infection before age 11, and is due to their inability to find or tell what they really feel, that the symptoms are not always specific to parents, which can generate long term in less scarring, stunted growth, high blood pressure and other problems of a kidney.

This situation is largely due to the physiology of the female urethra, which is very small and located a few centimeters of the anus. Added to that, the introitus is not protected by the labia as in adult women, favoring the entry of germs to reach the bladder, thus resulting in inflammation called cystitis.

In addition to cystitis (bladder irritation) may occur due to poor medical care urethritis (irritation and invasion of bacteria from the urethra) and vaginitis (thick white discharge and minor bleeding). However, the most common infection in children is vesico-urethral flow, which is generated, like other bacterial infections, viruses and microorganisms that may be in the environment, as well as poor hygiene. And where the urine in the bladder instead of out, concentrated or back into the ureters and kidneys.

It is to mention that among the factors that predispose to urinary tract infections are poor hygiene after defecating or urinating, the urine retention in time to urinate, do not take the time to completely empty the bladder negligence on the part of parents with their children by allowing them to urinate in public open spaces, and the use of dirty underwear and narrow.

Regarding the control of urination, this is acquired in childhood and may be lost in a state of unconsciousness. During this stage, an infant urine from 6 to 9 times a day, with an average of 100 ml to 200 ml, which in many cases makes the parents look at the need for the child to use dimly appropriate to urinate, and logic into contact with microorganisms that can infect her.

2. OBJECTIVE

Due to the behavior exhibited by children between 3 and 5 years old, about their need to urinate more often than an adult, not having the ability to coordinate their physiological needs, especially when you are away from home and, the incidence of urinary tract infections in female children, set a target to design a container of urine for girls aged 3 to 5 years of age, feasible to use in open spaces, reducing the risk of capturing a urinary tract infection.

3. DELIMITATION

The work in question was determined to make the female child population of the municipality of Ocampo Zumpango in the state of Mexico, as this is, the geographical area where is located the University Center of the Autonomous University of Mexico State hosting the bachelor in industrial design, which has as its mission the development of material culture, prevailing innovation and adaptation of contextual characteristics. However, not ruling out the possibility of meeting other markets in the entity.

Zumpango is a Hispanic composition of the Nahuatl word "Tzompanco" consisting of "Tzompantli" that his meaning is: "Row of Skulls" and Co which means a place, site or footprint which means: "Place of tzompantli". This municipality is located at 19 ° 43 '10" and 19 ° 54' 52 'north latitude and 98 ° 58' 12" and 99 ° 11 '36" west longitude with an area of 244.08 km ² , a total population of 159.647 inhabitants, of which 13.342 are girls aged 3 to 5 years (INEGI, 2010).

4. METHODOLOGY

Having identified the need and established the market served, the design work was developed based on the method of Bruce Archer, a method is known as "systematic method for designers," besides being one of the most detailed and comprehensive published to date. That action is structured by six stages (*Definition of the problem, collection of relevant data, analysis and synthesis of data, development of prototypes, and design validation, documentation for production*).

Specifically, it was established as a problem, create an object that allows any child to urinate in the open, avoiding at all times get to capture a possible urinary tract infection. After that, it was necessary to obtain data for products that at first might solve the problem, which was analyzed in terms of its function, use, size, aesthetics and cost. Added to this, we also analyzed the behavior of the potential user to urinate and analysis of both the anatomical and ergonomic female urinary genital tract as well as of those joints that come into play during urination.

Already in the synthesis stage of the data identified that while coexisting in the market a wide range of products designed to train the child to the toilet (Fig. 1), none of them can be easily carried by the parents for use in the most unexpected places.

Figure 1. Several commercial products for children training

Moreover, products were found to be called analogs (collectors of urine, dialysis bags and bags with seal), which do not cover the need to 100% but showed elements that can be considered during the design process (Fig. 2). Finally, located 2 import products intended specifically to the problem, however, were not targeted to the specific population, together with one of them is promoted as a product in the test phase (Fig. 3).

Figure 2. Similar products

Figure 3. Containers feminine

Similarly, we observed that issues of culture and the same female physiology, every girl to urinate in open spaces tend to look a sandbox or with elements that cover the public view, later taking a position called "squatting, "which creates a distance between the lower vagina and soil from 10cm to 15cm on average. And anxiety, in most cases to be incorporated immediately, hygiene is not performed correctly (Fig. 4, 5 and 6).

Figure 4. Initiation

Figure 5. Urination

Figure 6. End

While, the lowest urinating in a public bathroom, the family tells you to take the position before mentioned near a drain or is held by the arms to be "floating" over the toilet. In addition to all this was identified the departure angle urine meatus, average dimensions were obtained from the genital area and finally settled as requirements that:

- The object design should be simple.
- It will be made for up to three pieces.
- Must effectively contain a discharge of 100ml to 200ml of urine.
- Withstands the acidity of urine.
- It will be perceived as an object safe and comfortable.
- The cleanup will be using soapy water under the tap choro, without deforming its structure.
- Its dimensions enable portability discreetly.
- Adapt to the female vulva 3 to 5 years without causing discomfort (ergonomic analysis).
- You must have an element of seizure to guide their placement by the user or external operator.

- The object present simple shapes and bright colors.

Having completed the first three stages, there were several design proposals, which were carried level with the corresponding functional model test, but will be executive surveying and cost estimating.

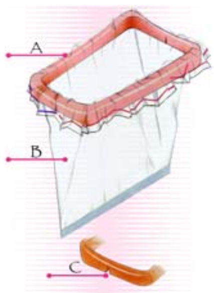

Figure 7. Sketch NI-K001

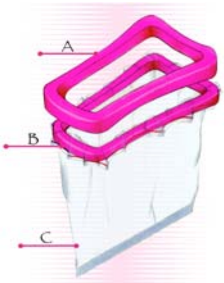

Figure 8. Sketch NI-K002

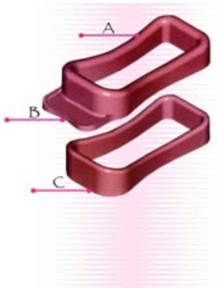

Figure 9. Sketch NI-K0(

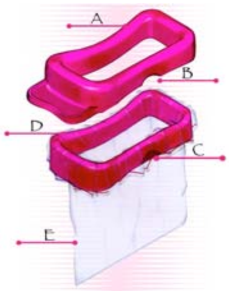

Figure 10. Sketch NI-K004

5. RESULTS

In this regard, and following the action of trial and error, we obtained an object consists of 3 parts, which is ergonomically designed to fit perfectly to the female genital area, ensuring the containment of urine during a download (100ml to 200ml). Beside a safe and comfortable grip for the user, or to an operator (parents).

This is a urine container manufactured by injection into low density polyethylene, which is easy to carry inside a purse, with the possibility of enabled from leaving home, or, following four simple steps (separate-insert-double-close), an action that involves no more than 15 seconds. And the content once used, can be discarded with confidence, thanks to seal it presents. Comment is that the cost of sale in a production of 100,000 pieces is at $ 95.00 pesos including its packaging and three sealed bags.

Figure 11. Base NI-K

Figure 12. NI-K Cover

Figure 13. Container armed

Figure 14. Colors of the container

Figure 15. Attaching the disposable bag.

Figure 16. Attaching the cover with the bag.

Figure 17. How to remove the cover.

Figure 18. Discard the bag.

6. CONCLUSIONS

With the above it may be remarked that this project has been designed by a health need, and that addressing these problems was not easy, because the parents are very demanding with regard to their children, and more on what is health concerns. In other words, to solve this project was more complex than planned, since it implied a thorough understanding anatomy and physiology aspects of the human being, which is not available at first hand.

Although during the development of the research was to identify that there are products designed to meet the need to urinate in public spaces or as one of them promotes "urine anywhere," none is focused on girls in the age range of 3 to 5 years of age, coupled with products that are seen as cold and lacking insurance gripping elements, which turns out to be important points for the user or operator.

Finely we have that, even if it is difficult to face the society, especially in areas that exceed the bounds of privacy, the product obtained satisfies the initial need, and offers the possibility to address similar situations who have teens and adult women to engage in outdoor recreation.

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THRESHOLD OF INHABITING: MINIMUM HOUSING OR CONFINED SPACE.

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Resumen:

El tamaño del espacio establecido, por normatividad y costumbre, para las viviendas mínimas, está por debajo del umbral de los requerimientos de los habitantes; la relación de las dimensiones_ alto, ancho, largo_ es inapropiada para la habitabilidad adecuada. Los desarrolladores y promotores de vivienda son favorecidos cuantitativamente, a costa del demérito en la calidad espacial para la vida de la población.

Se identifica por un lado, la responsabilidad de los expertos en espacio habitable que no pueden trascender los esquemas institucionales en política habitacional, por otro, un área de oportunidad en la desatención a las necesidades y características de los clientes-usuarios, justo en la brecha entre el diseño y la producción de vivienda mínima: el prototipo.

El empleo de simuladores a escala completa, y sus técnicas de valoración, brinda una oportunidad para recuperar el valor del factor humano en el proceso de diseño arquitectónico de vivienda mínima. Se exploran las impresiones de los usuarios potenciales de manera experimental, en prototipos construidos en al Campus universitario (FADU-UAT), para depurar los criterios de diseño, tanto en el conocimiento de necesidades reales, como para establecer programas arquitectónicos espacio-funcionales más amigables y satisfactorios.

Palabras clave: umbral, habitar, vivienda

Abstract:

The size of the established space, by norms and customs, for housing minimum is below the threshold requirements of the inhabitants; the ratio of the dimensions _height, width, length_ is not appropriate for adequate habitability. Housing developers are favored through the demerit in the spatial quality of life of the population.

It identifies the responsibility of experts in designing space for living, whom cannot transcend the institutional arrangements in housing policy. By other side, there is an opportunity area by neglecting needs and characteristics of clients-users, just in the gap between design and production of minimum housing: the prototype.

The use of full-scale simulators, and assessment techniques, provides an opportunity to retrieve the value of human factors in the process of architectural design of minimum housing. It explores the views of potential users on experimental prototypes built in the Campus to refine the design criteria, either for the real needs knowledge, or to establish functional space architectural programs, more kindly and for more satisfaction.

Keywords: threshold, inhabit, housing.

1. INTRODUCTION

The housing offer in both the public and the private sector, with the aim of production efficiency at lower construction cost, shrinks the size of living space by increasing the qualitative deficit. Housing demand fluctuate depending primarily monetary factors, not necessarily due to actual user requirements. The property is acquired, even when it is not sufficiently satisfactory for basic needs at the time of the purchase.

People buy poor quality houses, rather than habitable space quality. They continue acquiring minimum housing, accepting ranges of the metric threshold that experts define as adequate to live. Users buy a home thinking in a future modify, to set up a chain of spaces according to their expectations and needs. Users are buying homes, with no satisfactory habitability. They buy illusions, digitalized or in mock up, without notion, of what these housing images represent about space experiences.

Table 1. Housing prototypes surface.

INFONAVIT.			
Basic facilities.		**Period**	**M2**
Two bedrooms, alcove, living room, kitchen and bathroom.		1973 - 1981	68.7
Idem.		1987	60.3
Idem.		1993	55.5
Fonhapo.			
Finished house: bathroom, two bedrooms, kitchen, lounge-dining room and service area.		Present	55
Progressive Housing: bathroom, bedroom, multi-use area.		Present	35
TU CASA program.			
Basic Housing Unit	Multipurpose room, kitchen, bathroom, potential growth.		21
Housing Intermediate Unit	Recámara, cuarto de usos múltiples, cocina, baño, posibilidad de crecimiento.		34
Goal Housing Unit	Bedoom, multipurpose room, kitchen, bathroom, potential for growth.		47
Prepared by the author, based on Coulomb, R. (2007)			

1.1. The size of the house: Area of opportunity between habitable space and confined space.

In Quality Management Systems, Quality is defined as the degree to which a set of features, of a product or service, meets the needs and expectations of customers. In the customers eyes, the better the products characteristics, and less deficiencies, the higher the quality they will have. Customer satisfaction is the result achieved when the characteristics of the product meet customer needs. Usually it is synonymous with satisfactory product. (Juran, 1996)

However, in residential satisfaction studies conducted by the Sociedad Hipotecaria Federal (SHF, 2008) to purchaser population of new housing, through loans from banks, Sofoles, Infonavit and SHF, found vast areas of opportunity, as residents rated the flexibility to adapt and transform their homes, and the spatial and functional characteristics with values no greater than 6 of a maximum score of 10. It also detected the users intervention in their homes for various reasons. Require remodeling as much as expanding due the need to increase the size of the home. See Table 2.

Table 2. User's housing intervention.

Enlargement		**Remodeling.**	
Increase the size of home:	**30%**	Increase the size of home:	**21%**
Overcrowding:	**22%**	it is impaired:	19%
They like where they live:	18%	Overcrowding:	**17%**
Ampliar espacio más grande:	12%	They like where they live:	17%
They can not buy another house:	11%	They can not buy another house:	10%
For convenience:	6%	For convenience:	5%
Note: percentages do not add 100% because respondents could choose more than one option. SHF, 2008.			

The qualitative deficit emphasizes the lack of space. The user declares an initial satisfaction for the acquisition of its assets. "Acceptable level of satisfaction suffers as a clear change through the reported changes in the behavior of the members of the family, by the size and distribution of habitable spaces. In this respect, and contrasting the level of satisfaction, start recording negative changes related to the dispute of spaces and a sense of closure. This indicates that after the taste of new house, the reduced spaces never cease to affect family life, despite improvements that the family performs in the house." (Eibenschutz H., s/a). See table 3.

Table 3. According to the 3 sub-index of housing quality integrated into General Index

Requirements of breeding programs by size of city in the SUN (National Urban System). (percentage of deficit housing, by type of city)				
Needs				
City size	*Services*	***Space***	*Facilities and materials*	*Total* deficit housing
Metropolitan areas	77.3	**88.3**	88.6	2´948,719
Agglomerations	85.8	**85.6**	91.5	1´415,454
Medium cities	81.7	**84.6**	93.6	1´539,267
Small cities	90.7	**82.8**	95.6	1´655,096
Source: Esquivel-Villavicencio preparation from INEGI Census 2000.				

Housing as an object is the production process result developed with a limited vision. In total quality approach, corresponds to focus only in the product. Firms produce what they consider suitable to their interests, and have been dedicating to produce goods and services that reach the consumer apparently flawless. The customer has to select from what is available. It needs understand the phenomenon of appropriation of the object and its surroundings as a place to live. Through knowledge of users needs, adapting the architectural solutions of space to human activities, specifically, considering the variability of human characteristics.

				
Cuauhtémoc. **54 m2.** $ 1,590,000 MN	Cuajimalpa Yaqui. **133 m2.** $1,735,000 MN	Polanco Chapultepec. **115 m2.** $ 2,900,000 MN	Vista Bella. **112 m2.** $ 1,625,000 MN	Santa Fé. **85 m2.** 200,076 USD

Figure 1. Offer of housing habitability between 54 y 133 m2. The illusion of luxury with reduced spaces.

Housing is a system of welfare factors, whose quality depends not only on its aesthetic and commercial values, but also it seeks conditions for the realization of human activities, in a comfortable space. The dimensional relationships set an integral totality, a place where are synthesized various aspects of human nature, both subjective and concrete. Space is the environment through which we live, but user requirements are ignored by the housing developers. This situation occurs for high-income groups and for people of limited income. Compare residential spaces in luxury neighborhoods, seen on figure 1, with the prototypes offered by developers, seen on figure 2.

Garden Model

Description: Ground Floor: Living room, kitchen, half bathpreparation, service yard, backyard and parking.

First floor: 2 bedrooms with storage area and bathroom.

Growth Option: Extended Garden

Construction area : 79.78 m^2 parcel of land : 84.5 m^2

Figure.2. Housing prototype promoted by real estate company in Tampico, México. Sourcee: Digitized image obtained in www.casasgeo.mx

The offer of residential space is not consistent with the requirements. The facts show the incorrectness of a preset architectural program, without foundation in the needs of users. Neither experts nor normative are agreed about the appropriate dimensions.

According to Coulomb (2006) “Even when developers say handle a wide variety of housing prototypes, almost all the housing projects (75%) offer only one type of housing. There are different opinions between what is done and what should be done. The offer from the developers ranges from 21 m2 and almost 70 m2 for a house. Romero (2002) gives a range between 78m2 and 136 m2. Goya and Eibenschutz refer the allocation of Mercado: 45 m2 for a Mexican family of 4 members. How to determine what is right? If desired to establish a threshold with what criterion can be specified?

On the other hand, regulations in Mexico do not specify the size as quality factor. The National Housing Commission (Comisión Nacional de Vivienda), derived from the strategies of the National Plan Sustainable Human Development (Plan Nacional de Desarrollo Humano Sustentable) 2007-2012, developed a normative model called Housing Building Code (Código de Edificación de Vivienda,CEV) to guide the design and construction of housing. Section 808 provides a figure called the "Free Minimum Dimensions for living and auxiliary spaces”. It states that the spaces to stay, eat, and sleep have the same dimensions of 2.70 m., for the short side and long side. Section 809, is a table with the "Heights by Entity Spaces"; set heights between 2.30 and 2.70 meters.

Other regulations are based on these dimensions. It can be reviewing the INFONAVIT table "Minimum dimensions of housing in accordance with official rules and regulations”, also Construction Regulations for the State of Tamaulipas, for example. Meeting the needs of users stipulating the ergonomic suitability is not considered for buildings design or in the construction processes.

Currently, the floor area of some minimum housing prototype is already below 30 m2. Can we speak here of a decent and proper housing as promoted by the Federal Housing Act[1]? What will be reached as minimum dimensional relationships, toward the housing demand in coming decades? An example is the prototype in Fraccionamiento Nuevo Almaguer, in Guadalupe, Nuevo León. It has 16 m2. See figure 3.


CONSIGUEN CASA, AUNQUE SEA "MINI"

Fig. 3. Prototype of Asociación Gilberto and Consejo de Desarrollo Social. Nuevo León, México. 16 m2. Source: “El Norte” newspaper.

[1] Artículo 4 de la Constitución. Art. 2. Nueva Ley de Vivienda aprobada el 7 de marzo del 2006 LIX Legislatura. Cámara de Diputados.

Against this background, architects freely exercise their professional skills to develop tendentious proposals. They assume that the smaller model, most talented are. But these "new proposals" really are confined spaces decorated with architectural imagery. See figure 4.

Egg House	Daspark Hotel	Sleep Box	Voyager

Figure 4. The size of habitat.. En: http://laboratoriodelhabitarcontemporaneo.wordpress.com/

According to NORMA OFICIAL MEXICANA NOM-005-STPS-1998, confined space: is a sufficiently wide place, configured such that a person can perform a certain task within it, that has limited or restricted means for access or egress, not designed to be occupied by a person continuously, and in which specific tasks are performed occasionally. See figure 5.

Although the dimensions of the minimum living space (16 m^2) are not yet those from a confined space (1 – 2 m^2), see figure 5, size reduction affects inhabitants. Examples are the studies by Mercado (1995), Landazuri (2004) and others, in which ones is demonstrated in the very low degree of housing inhabitability in Mexico.

Fig. 5. Confined spaces

Habitability refers to the relationship of human beings to housing. The joy or pleasure felt by the inhabitants for housing according to their needs and expectations. (Mercado, 1998).

Habitability is a term that refers to the satisfaction one gets in a given scenario or set of scenarios; is the attribute of built spaces to meet the objective and subjective needs of individuals and groups who occupy them, that is, psychological and social spheres of the stable existence, that can be compared to the environmental qualities that allow the healthy physical, biological, psychological and social development of the person (Castro, 1999).

For the scope of this paper, housing size, it presents negative findings on three variables of habitability: functionality, operability and sociopetivity.

The sociopetivity refers to the characteristics of the housing directly related to the communication, which can be brought about or not depending socio-centrifugal or socio-centripetal spatial characteristics, ie, the scenarios that facilitate social interaction and socio-centrifugal scenarios to describe scenarios that hinder social interaction.

The operability is affected directly by the square meters and the safety of circulations, it is demonstrated that increase obstructions to movement within the living space, this causes the user operates less efficiently in the house; also, less space allows smaller distance between the furniture, sizes and furniture types, hindering a better performance.

The functionality has to do with the number of spaces, ie, to have possibility of furniture that allows the organization of activities and security which involves no risk to obstruct the behavioral pattern. The variables related to operational areas produce greater perceived functionality. For example, sometimes the kitchens are so small that two adults cannot be there at the same time, or meals are taken in the living room because the kitchen table is so small that there are only children.

When this primary territory does not serve our basic needs, may become so annoying that we let the peace of the house for the public territories. This is the gang boys case, who are expelled from their homes to the street; or husbands instead of going home with his family, they find peace at the bar. (Landázuri O., 2004)

1.2 Updating the prototype concept in the minimum housing design

The population is not familiarized with metric relations that determine habitable space size. Acquire their home with the illusion of reconfigure it through time, to suit their requirements. Similarly, it is like to acquire clothing of smaller size, thinking that after they make any changes needed to fit them. In fact, clothing is usually tested before paying for it.

In the real estate market, it displays a "house model" appropriate to promoter interests, including scenic gadgets, as furniture smaller compared to real objects, either for the sale prototype, or scale architectural models. That is not to prove the house. The experience of space involves confronting the user with everyday objects, according to their particular activities and their personal traits. Validate that the house and its features meet customer requirements. In real scale models that allow the previous experience of living space, to validate it.

Prototype is the “Original or first mold that is manufactured a shape or other thing. Most perfect exemplary model of virtue, vice or quality.” (RAE) A prototype is an instance in which previous testing and validation are done, to correct errors as inadequate size. But housing prototypes are developed under the second definition: the most perfect model of a vice.

It requires habitable product innovation. According (Cooper, 2001), the main factor of success is delivering a differentiated product with unique benefits for customers and higher value. In architectural process, the concept requires to test and to value the prototype, continuously, by the user.

On the requirements of regulation ISO 9001:2000, in clause 7 refers *Product realization*. Specifically in subclause 7*.3.6 Design and development validation.* “Validation is testing the product to verify that is able to meet the requirements for application or intended use. Normally design validation is performed on the resulting product and not on documents such as the verification. Normally the validation is performed by the client and must be carried out prior to the start of mass production or the official product release.”

Clearly, customers-users are unaware of regulations, and architects, developers or government authorities, prefer to ignore quality norms. The professional activity of minimum housing designer is subjected to real estate market interests. But it can offers alternatives that satisfy all stakeholders and customers, from greater understanding of users characteristics, through systems for early validation of the experience of living: full scale simulators. That would be design and build homes as quality products, not as substitute goods.

1.3 Proposal.

Is proposed as alternative solution an improvement in architectural design process, with which the architect can refresh their professional skills, and become closer to the real needs of users with respect to the size of living space.

a) The full-scale simulators where can assess the spatial experience of users,
b) The qualitative research, such as *spontaneous drawing* technique and users experience *narrative*; with which obtains a deep understanding of their needs.

Due to the high cost of generating short-term full-scale simulator, as exist in some countries of the world, as those grouped in the European Association of Full Scale Models (Martens, 1996), it will verifies the effectiveness of a prototype similar to the minimum housing models, built in Facultad de Arquitectura, Diseño y Urbanismo de la Universidad Autónoma de Tamaulipas (FADU). It has been developed as part of experimental sustainable project.

Figure.6. Prototype PET.

The prototype has one floor (35 m2), has four spaces: porch, living-dining room, bedroom and bathroom. See figure 6. The walls were built with PET (Polyethylene terephthalate**)** bottles instead of cement blocks walls**.** The PET bottles were filled with sand. The walls are coated with cement-sand mixture the roof beams is anchored in concrete enclosures, and covered with sheet of plywood with asphalt emulsion and asphalt cardboard. Its appearance is of a conventional one floor house, although it is not common to find houses built with wooden roof. It analyzes the functional criteria of minimum spaces, which is evident architectural design paradigm, mass housing in Mexico. It discards analyze any aspect of the sustainability project.

It validates the effectiveness of the prototype for later use as a simulator, according to the study of Abadí (1996), supplemented by a questionnaire of psychological impressions, and is used to respond to the heading of "validity" of the models[2] (La Scalea, 1995).

Is a questionnaire with eleven pairs of semantic differential adjectives, on a scale of seven levels, grouped under three factors:

Affective: relating to emotions produced by the perception of space. In this factor the adjectives used were: sad-happy, pleasant-unpleasant, interesting-boring, and warm- cold.

[2] *The psychological prints measurement test*

Social: refers to the values, beliefs and habits of the subjects. The objectives were: ordinary-refined, elegant- tasteless, vulgar-distinguished.

Dimensional: related to the shape, size and pressure from the space in the subjects. The adjectives were open-closed, oppressive-spacious, and clear-confused.

2. METHOD.

2.1 Sample.

It is chosen a group sample for convenience. The subjects of both sexes participating as students in the career of Interior Design, at advanced classes. Prototype elements and spaces are measured and drawn. Subjects experience the spaces and building elements.

2.2 Questionnaire.

A questionnaire was generated, according to the Likert scale with 5 levels, and based on Abadi & LaScalea indicators to validate the effectiveness of simulators. It includes a question regarding the adequacy of size of the house with the person. This questionnaire is applicated to the sample group.

2.3 Spontaneous drawing technique.

It consists in the drawing of the constructed object known as "home", which is associated with the issue of minimum housing. The spontaneous drawing is a study and analysis tool, and a technique of opening and discovery of the underlying mind. The free lines on paper are a resource to meet the needs from the inner being.

To apply this technique, are chosen three subjects with different size, small, medium and large, according to general somatotypes. They are asked to freely draw a suitable house, with their personal size. They used white letter-size sheets and pens with black ink. The objective is to provoke the expression of people trying to explore their inner needs.

The instructions are:

1 Draw a house suitable to your own measure.
2 Draw the distribution of the house interiors, suitable to your own measures. Write down what needed to define each location.
3 Write freely on the back of each sheet, the description of each drawing characteristics.
4 What are the positive qualities and / or attributes of the house?
5 What are the defects?

3. RESULTS.

3.1 Prototype effectiveness questionnaire.

The indicators of cost and time were not considered because the prototype is already built on campus. As shown in the table, the PET prototype is perceived as highly effective, It evokes some previous experience and lets imagine the spatial structure, but is low in the indicator Realism, or representation of a common house. The validity was low. Size was perceived as inadequate.

Table 4. Prototype effectiveness. Summary.

	PROTOTIYPE							
1	FLEXIBILITY: The prototype can easily change							Low
2	REALISM: The components represent the common room of a house							High
3	FAMILIARITY: It evokes some previous experience							High
4	ATTRACTIVE EXT: external visual appearance impacts mostly							Neutral
5	ATTRACTIVE INT: interior aesthetics appearance impacts mostly							Low
6	PROJECTION: Lets imagine the spatial structure							High
7	ATACHMENT: It is useful to test further simulations							High
8	INFO SELET: Provides information on how to install elements							High
	VALIDITY: psychological reactions.							
9	Space	Happy	Sad					Low
10	Space	Pleasant	Unpleasant					Low
11	Space	Interesting	Boring					High
12	Space	Warm	Cold					Low
13	Space	Refined	Ordinary					Low
14	Space	Elegant	Tasteless					Baja
15	Space	Distinguished	Vulgar					High
16	Space	Open	Closed					Low
17	Space	Spacious	Oppressive					Low
18	Space	Clear	Confused					High
19	Size						Not Adequate	

3.2 Spontaneous drawing.

In Graphoscopy[3] two axes are considered: being (vertical: up, conscious; down, unconscious) and time (horizontal: left, past; right, present). It reveals the following:

Subject size S, draw up and left, consciously with previous experiences. Draw seven spaces clearly divided into compartments, with a regular square form.

Subject size M, draw upward and to the right, consciously projecting in its present. Defines five spaces, denotes amplitude in living room, dining room and kitchen, relating them in a

[3] Narváez, 2011. Etnography Research Notes. Seminario Investigación Etnográfica.

large common area; clearly draws the limits of bedrooms and bathroom. Draw the set based on a combined configuration of rectangular and circular shapes.

Subject size G, draw towards the top and left, consciously from past experiences. Organize six spaces, in longitudinal rectangular arrangement. Four spaces marked with access to a corridor. Establishing a common area for kitchen, dining room, a proposal controlled mobile divisions.

All subjects drew more than the three spaces within the prototype PET (4).

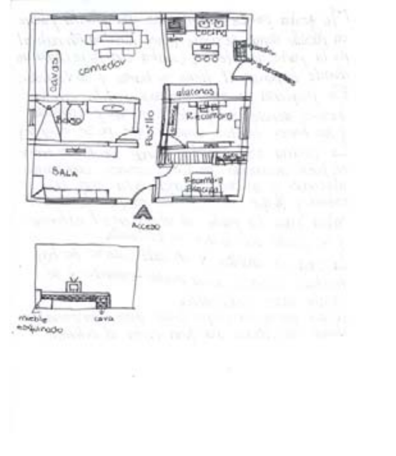	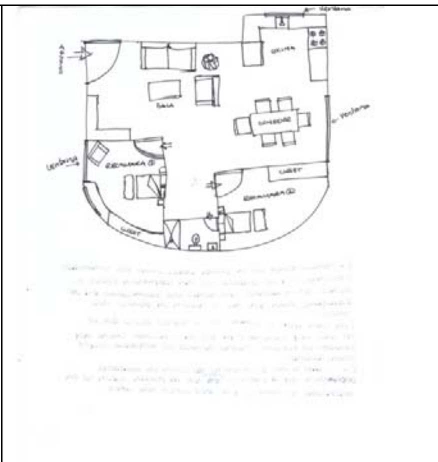	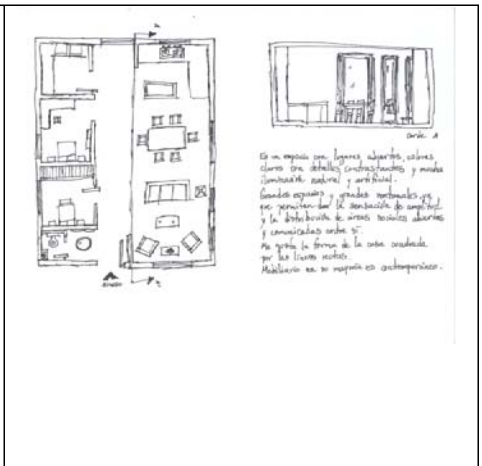
“Small” size subject (minor height).	“Medium” size subject (medium height)	“Large” size subject (greater height)

Figure 7. Spontaneous drawings by subjects of different size.

The subjects expressed in their narratives, a preference for suitable house, through comfortable and bright spaces. The size S subject divided all spaces with fixed walls. The size M subject and the size L subject drew a common area for living, dining and kitchen. All subjects expressed that the prototype is convenient for one person, they doubt about living with anyone else in there.

4. CONCLUSIONS.

The prototype PET built in FADU campus, meets with indicators of effectiveness as minimum space simulator, but should be reviewed with respect to their image, since the psychological impact was low.

The spaces in the minimum housing prototype, have not suitable size. It has low habitability grade, therefore not efficient their operability and functionality factors; the space, almost confined, is socio-centrifugal: is suitable for only one person.

The drawings allowed externalizing ideas about space requirements. The spontaneous drawing and techniques within visual anthropology are highly recommended tools to explore amicably together with future users of housing, possible solutions according to the persons requirements. This technique complements the information derived from the questionnaires.

Detailed measurements of anthropometric variable were not made related to the participants' somatotypes. But there were considered the differences in complexion and stature, both corporal indicators, to select subjects who prepared the drawings.

The exercise allows validate the minimum housing size in experimental prototypes. That is, in spatial structures not offered to society, but as objects of validation during the design process. It can expand the sample to groups representing users and housing developers. This procedure could validate sample households in housing complexes.

The full-scale simulators, is a useful tool to reconfigure the architectural design process of living spaces. Also, validate user's psychological prints through ethnographic techniques such as spontaneous drawing and narrative, is an excellent choice to go further the apparent needs, and establish codes of communication between specialists and users of minimum housing.

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INDUSTRIAL DESIGN: A STRATEGIC PARTNER ERGONOMIC INTERVENTION IN BUSINESS CONDITIONS

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Resumen: Los factores de riesgo relacionados con la organización del trabajo y el diseño de los medios utilizados para el desarrollo de las actividades, pueden afectar la salud individual o colectiva de la población laboral. Además, es importante destacar que la salud y el bienestar del empleado inciden positivamente en la competitividad de la empresa y que buena parte del éxito del empleado en el desempeño de su trabajo está dado por el grado de adaptación a su puesto y su entorno; es fundamental que las empresas que busquen equilibrar y encontrar un acoplamiento óptimo en este sentido. De aquí, se desprende una oportunidad importante para la aplicación del enfoque sistémico y participativo del diseño industrial, que permite proveer intervenciones con el fin de mejorar las condiciones de las personas en sus puestos de trabajo, obteniendo también un mejor desempeño productivo en la empresa. Por esta razón, desde la Universidad Nacional de Colombia en Palmira, se realizo un estudio en empresas productivas del Valle del Cauca, interesadas en implementar procesos de seguridad industrial y ergonomía, cuya experiencia resulto en adecuaciones de puestos y herramientas de trabajo, considerando la descripción y el análisis de las actividades realizadas, pero sobre todo, la vinculación del personal interesado en el proceso de formulación de las propuestas de intervención.

Abstract: Risk factors related to work organization and design of the means used for development activities may affect the individual or collective health of the workforce. It is also important to note that health and employee wellness positive impact on the competitiveness of the company and much of the success of the employee in the course of their work is given by the degree of adaptation to their place and their environment is essential for companies seeking find a balance and optimal matching in this regard. Hence, it follows a important opportunity to implement the systems approach and participatory design industrial, which allows to provide interventions to improve the conditions of the people in their jobs, obtaining better performance also productive the company. For this reason, from the National University of Colombia in Palmira, is conducted a study in productive enterprises in the Cauca Valley, interested in implementing processes of industrial safety and ergonomics, whose experience resulted in adjustments of posts and tools, considering the description and analysis of activities, but above all, the link for the staff involved in the process formulation of proposals for action.

1. INTRODUCTION

Any product that has to do with human beings involves the use of ergonomics. It same goes for the environments in which life unfolds daily work and men and women, as our relationship with the environment involves a contact gives result in a state of satisfaction, comfort, discomfort, dissatisfaction, distress or even Pain.

It is precisely the union of the ergonomic design which provides a material culture designed to meet the needs and solve the problems we face daily. Unfortunately this assumption is not met frequently and live in connection with things that do not fulfill the function for which they were designed, or even force the user to have to adapt to them when it has no other possibility, as commonly happens with a huge number of objects and spaces, if any product
involves the use of ergonomics, all objects would infallible. In fact they are in lot and every day we continue to be poorly designed products whose processing does not contemplate the analysis and application of this discipline.

In Colombia, as in all Latin American countries and in most countries the world, the domain of study of ergonomics that has been most studied and developed has been on the physical plane. That is, the related working postures, the movements, the physiological capacity of the person and the application of core strength.

Even within this, the emphasis has been primarily on three factors: posture, motion and strength. In this framework of ideas, it is understandable that the main ergonomic problems have been found in the workforce Colombia are given by the biomechanical conditions of work, the result of exposure is expressed through the appearance and diagnosis of lesions in the bone marrow -muscle.

2. HYPOTHESIS: THE ERGONOMICS IN DESIGN

Today, it is necessary to specify that the idea of "ergonomic design" should be understood as
an inherent quality of objects and created for, facilitate, enable or optimize a specific activity or function. Ie excluding those objects of an decorative, or over which the designer deliberately want to print a character subjective and personal, so-called "ergonomic design" can be understood as a redundancy because it is difficult to understand the creation of a product or object specific purposes (with respect to a human activity) have been provided without the human factors-ergonomics - of the target population, or users who have relationship with him, so these factors to define and establish some of the determining design.

From this perspective, the ergonomic design of the projection of a product can still be used only as a marketing strategy. By Instead, using ergonomic concepts in project development should understood as a minimum condition necessary to ensure the success of such products, on the other, as yet can not be said that currently exists in our country a culture of design alone can speak of a culture of ergonomics. However, if it is perceived that is emerging awareness of the relevance of these two disciplines as complementary and essential tools in solving needs through product development.

We must also clarify that this process of awareness, understood as a first stage in the generation of culture - whatever that is - has not been so natural. In other words, is not strictly the result of an evolution, a process own, has produced forcibly from the opening and globalization of markets as an economic strategy used by some governments. Without analyzing the social, cultural and economic state measures can be that saturation point has accelerated, among other things, awareness – by comparison - of the population regarding the intent, characteristics, advantages and / or deficiencies of the resulting objects design processes with or without ergonomic character.

3. JUSTIFICATION

In order to improve working conditions and health of the working population of the company initiated a consultancy study with the research group of factors Human Ergonomic Design of the National University of Colombia in Palmira, through the project "Implementation of Safety Management Process Industry and Ergonomic Risk "would open a space for students to link the race Industrial Design as interns to analyze and make proposals to improve their jobs. Thereby obtaining a better productive performance and minimizing the risk of accident or illness that may arise in the company.

To achieve the proposed is important to note that "Much of the competitiveness of the company resides in the employee welfare ", beyond wanting to name trite, it that seeks to highlight the importance that experience has shown that a good success of the employee's job performance is given by its degree of adaptation to the post and its environment, is essential for companies who want to advance seek balance and find a coupling between employee and job, apparently is not yet clear that productivity is not synonymous with time spent in the workplace, now need to place the person in front of the organization, and therefore the worker performs his work well and of course this form the organization obtain higher productivity from the worker, therefore, the adaptation of the workplace is the result of the union of several factors that have to do with good design, analysis and description of activities to do in it.

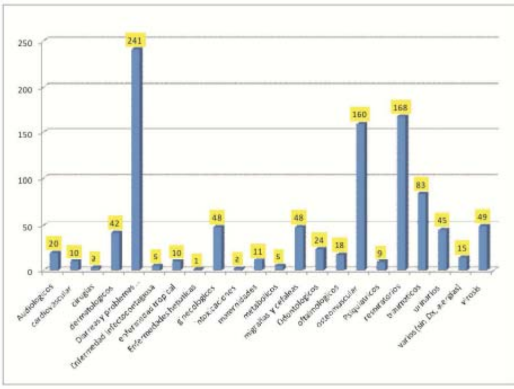
4. DIAGNOSTIC METHOD

The population consists of people working in a manufacturing company sector in the Valle del Cauca, which has about 500 workers, which 300 of them were hired directly by the corporation and the other 200 are linked through employment agencies.

Figure 1. Working population, manufacturing company.

4.1 Absence from Work.

This is one of the main problems facing the company, becoming a factor that should try to be minimized, since at high levels can to become a source of loss



Clasificación	
Audiologicos	20
cardiovascular	10
cirugias	3
dermatologicos	42
Diarreas y problemas gastrointestinales	241
Enfermedad infectocontagiosa	5
enfermedad tropical	10
Enfermedades hepaticas	1
ginecologicos	48
intoxicaciones	2
maternidades	11
metabolicos	5
migrañas y cefaleas	48
Odontologicos	24
oftalmologicos	18
osteomuscular	160
Psiquiatricos	9
respiratorios	168
traumaticos	83
urinarios	45
varios (sin Dx, alergias)	15
virosis	49
Total	1017

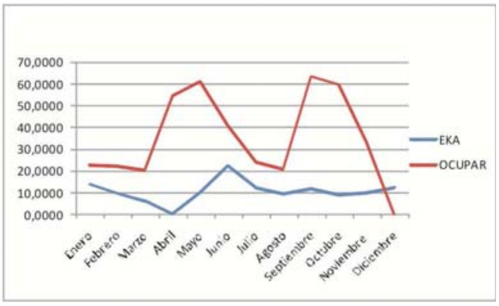
Graph 1. Incidence labor manufacturing company.

4.2 Accident Index

Index comparative frequency and severity in 2011.

INDICE DE FRECUENCIA

MESES	EKA	OCUPAR
Enero	13,6871	22,82
Febrero	9,5112	22,24
Marzo	5,9564	20,19
Abril	0,0000	54,22
Mayo	9,7967	60,82
Junio	22,3075	40,38
Julio	12,1591	23,99
Agosto	9,4803	20,86
Septiembre	11,6158	63,15
Octubre	9,0209	59,34
Noviembre	9,9746	33,06
Diciembre	12,4659	0,00



Graph 2. Accident Index Manufacturing Company.

5. CONCEPT: THE ERGONOMICS IS A VALUE ADDED?

All activities and studies are based around the ergonomics of man, your convenience, for better performance, for better performance, etc.. the design Industrial handles objects adapted to man in order to improve performancethe human being. Ergonomics is based on three key objectives are: -product planning, process, activity or task. - Correction of errors after use and, finally, - The reduction of effort, so that the human is in the best conditions, in any activity that takes place. With Regarding this last point is worth mentioning that, an ergonomic product, or more degree of ergonomics (ie, that fits the needs of the user, in a given context, and that the action for which it is addressed may perform efficiently and comfort) allows the operator to improve their conditions of work and maintain a physical and mental balance. It follows from all this in social terms that ergonomics helps to facilitate and make more effective the tasks performed by the persons. This means, in a work environment, the incorporation and application of new technologies, social spending cuts through accident prevention and occupational diseases, improving the integration of human endeavor in production processes, reducing levels of conflict. All this leads to an improvement productivity.

6. Phase: Design and Designing

6.1 Ideal Workstation

P.T Selected: Teeth
· In this position performing a manual process.
· The workspace has little room to perform the activity.
· Due to overcrowding, poor posture are presented.
· The activity presents repetitive movements, especially in upper (hands).
· In general we can say that has poor development of the activity.

Figure 2. Teeth and Workplace Activity Sequence.

6.2 Development Proposal Design Workstation Ideal

With the creation of this position whose main characteristic possibility of easily adapted to suit the users, thus making this type of seats can be used by smaller percentile as the largest working population, since the aim is that this type of system can be adjustable adapted to other types of items that require the company to become well a possibility to be used in other environments such as school desks, chairs for seniors and other places where it may become useful.

One of the most important and satisfactory answers provided by the design of this post work is its ranking system flexible but accurate, you can adjust both the as the seat table, by hooks superimposed on the metal structure. Also incorporates a number of details of design, comfort and ergonomics improve levels of effort to carry out the activity:
- The item is designed to be used by one person making so optimize space, thanks to a special design without front legs on the chair and back on the table which is sufficient to successfully perform the activity, allowing them to easily enter and leave the job by reducing the

effort and even the risk of falls.
- The new work surface allows the worker to do a better way activity, for this has
- A hole through which enters the rack.
- An uneven surface where the zipper down.
- The chair in addition to the grading system also has a hinge system that allows you to mount and dismount the arm with which account.

Figure 3. Workplace Design New Teeth.

The mechanism designed to raise and lower both the tabletop and seat hanging from the hooks arranged in the metal structure and adjusting work at the level the individual. The worker can make several moves by placing it in one of the three hooks play with the relationship of height, as shown in the figure 4 below.

Another important design feature is that both the seat and back are double curvature, horizontal and vertical, based on the shape that has the column cord of man, this so during the long hours of work, areas rest compromised, as this is what supports the weight and pressure of the body as shown in Figure 5.

6.3 Teeth job ... It came true!

Since starting the design idea of the job "teeth" of the company, had to travel a difficult road in search of finding the support for making the job work, a path often loaded as negative, but that was a major turn when it was shown that the benefits could reach the design of this proposal. The idea was interesting for the company who immediately accepted and made available Designer all your technical team

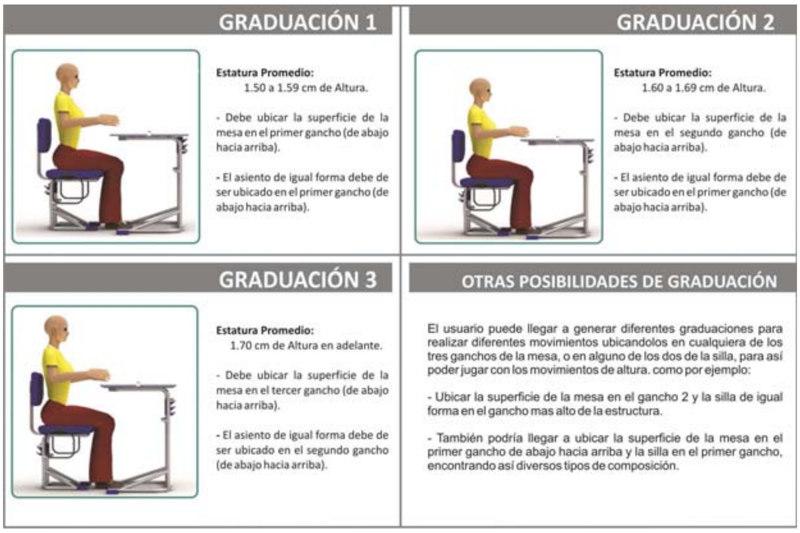


Figure 4. Graduations permitted by the system of job.

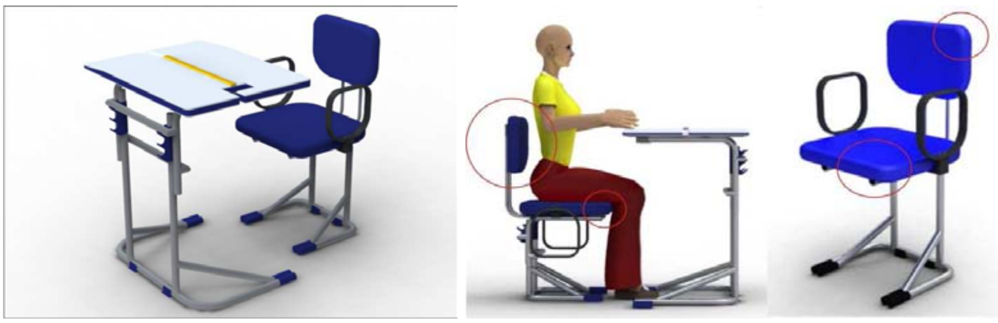


Figure 5. Features of the New Workplace Teeth

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Figure 6. Teeth job came true!

6. CONCLUSIONS

This work I collect each of the aspects developed to carry out the spread practice of industrial design in a productive enterprise the reamanufacturing in the region. The results are less than satisfactory: the achievement workers aware of the importance of health care, but it was
critical awareness among managers, area managers, supervisors, the importance of provide spaces to ensure the welfare of those who are considered "experts workplace ", such as the development of active pauses program also achievement is the implementation of an ideal job, "faithful to the objectives ergonomic Fast, easy to manufacture and produce, at a low cost; Finally we conclude that:

• The development of the project "Improvement of working conditions," always demanded and must continue to demand the support interdisciplinary areas such as health occupational therapy and ergonomics at work, besides the participation of these professionals is vital to include the participation of experts (workers), which provide their experience and knowledge gained through the development of their work, thus achieving that designers can realize all the recommended and ultimately to achieve to meet the needs of the user.

• ALL KNOWLEDGE GAINED THROUGH EXPERIENCE, the understanding of terms and concepts used by professionals who advised the project was very important for the development of research, because it allowed a better communication between advisers - designer - workers.

• The proposed design for the workplace improvement of working conditions, increases productivity, reduces fatigue and prevents worker injury medium and long term cumulative trauma in the muscular skeletal system. With this proposed intervention is to positively affect the health and welfare workers, improve their quality of life, prevent cumulative trauma illness, achieve increased productivity for businesses, increased worker efficiency and provide the gathering information on working conditions in Colombia. However is important to say that this project includes some of the factors surrounding the worker in the aspect of occupational health concerns and how this relates to interdisciplinary way with Industrial Design; Therefore it is an input and a first approach in building a real and complex diagnosis in which variables emotional condition, mental and physical performance directly influence
activities by workers, are taken into account and subsequently deeply examined under the criteria of multidisciplinary work.

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COGNITIVE ERGONOMIC AND HUMAN-COMPUTER INTERACTION STATE OF THE ART ANALYSIS INTO IT EDUCATION AT MEXICO: THE NEED OF HCI FORAY INTO THE CURRICULUM OF HIGHER EDUCATION

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Resumen: Las interfaces de usuario -en cualquier tipo de dispositivo o herramienta- tienen un enorme impacto dentro de la sociedad actual, a nivel económico, social e incluso cultural. La interfaz es la vía de “comunicación” e interacción entre el usuario y la máquina. La interfaz afecta directamente el desempeño de los usuarios, y dependiendo de su diseño puede aportar grandes beneficios o provocar errores humanos de graves consecuencias. Para que las interfaces impacten positivamente en sus usuarios es indispensable que dispongan de un diseño ergonómico, en especial en el aspecto cognitivo; para ello se aplica la Ergonomía Cognitiva.

El proceso cognitivo determina la forma en que una persona piensa, comprende, razona y actúa, y se ve influenciado por numerosos y variados factores, tanto internos como externos. Cuando el proceso cognitivo es afectado por factores negativos se torna deficiente, la toma de decisiones se turbia y aparece el error humano. Reducir el error humano, así como mejorar el desempeño y maximizar la productividad, son algunos de los objetivos de una interfaz ergonómica. La disciplina Interacción Humano-Computadora (IHC) estudia el diseño, evaluación e implementación de sistemas informáticos interactivos para uso humano, y los fenómenos más importantes que los rodean, y busca mejorar la ergonomía, seguridad, utilidad, efectividad, eficiencia y usabilidad de cualquier máquina o sistema que incluya algún tipo de software; para alcanzar sus objetivos, la IHC se relaciona con la Ergonomía Cognitiva, la Ingeniería de la Usabilidad, la Psicología Cognitiva y el Diseño Gráfico. En la actualidad es indispensable que los profesionales de TI apliquen la Ergonomía Cognitiva y la IHC en el diseño de interfaces gráficas de usuario. Por desgracia en México la Ergonomía se aplica poco, ya que se considera un gasto y no una inversión; en el ámbito educativo la situación es similar: en las Instituciones Nacionales de Educación Superior existe un desconocimiento general de la IHC y la Ergonomía Cognitiva, ya sea porque éstas no son incluidas en los planes de estudio o porque se ofertan con carácter optativo.

El presente artículo tiene como objetivo difundir la necesidad de la inclusión de la IHC y la Ergonomía Cognitiva en los planes de estudio de las especialidades relacionadas con TI. Se presentan los resultados de una investigación sobre el índice de universidades nacionales que ofertan asignaturas vinculadas con la Ergonomía Cognitiva y la IHC, y de una conocer su grado de conocimiento sobre IHC y Ergonomía Cognitiva.

Para conocer el grado real de conocimiento de la IHC y la Ergonomía Cognitiva en educación de nivel superior, se analizaron los planes de estudio de las especialidades afines a TI, de las 30 universidades nacionales más importantes, y se realizaron dos series de encuestas, una tipo Lickert y otra con afirmaciones positivas/negativas, a estudiantes de esas universidades.

Los resultados reflejan el enorme grado de desconocimiento de la IHC y la urgente necesidad de su incursión en la educación de nivel superior.

Palabras claves: Ergonomía cognitiva, Interacción Hombre-Computadora, TI en educación Superior

Abstract: User interfaces –in any type of device or tool- have an enormous impact in today's society, in economic, social and even cultural scope. The interface is the way of "communication" and interaction between the user and the machine. The interface directly affects user performance and, depending on its design, it can either bring great benefits or provoke human error of serious consequences. For interfaces to have a positive impact on its users, interfaces must have an ergonomic design, especially in the cognitive aspect; to achieve this, Cognitive Ergonomics is applied. The cognitive process determines the way a person thinks, understands, reasons and acts, and is influenced by numerous and varied factors, both internal and external. When negative factors affect the cognitive process, it becomes deficient, the decision-making process disturbs, and human error appears. Human error reduction, user performance improvement, and productivity maximization are some of the objectives of an ergonomic interface. Human-Computer Interaction (HCI) is a discipline that studies the design, evaluation and implementation of interactive computing systems for human use, and the most important phenomena that surround them; it also seeks to improve the ergonomics, safety, utility, effectiveness, efficiency and usability of any machine or system that includes any kind of software. HCI relates to Cognitive Ergonomics, Usability Engineering, Cognitive Psychology and Graphic Design. Today, it is essential that IT professionals apply both Cognitive Ergonomics and HCI when designing graphic user interfaces. Unfortunately, Ergonomics is poorly applied in Mexico due to it being considered rather as an expense than an investment. There is a similar situation in the educational field: there is a general lack of knowledge about HCI and Cognitive Ergonomics, either because National Higher Education Institutions do not include them in their curricula or because they offer them on an optional basis. This article aims to spread the need for HCI/Cognitive Ergonomics inclusion in the curricula of IT-related specialties. It presents both the research results on the national universities rate that offer Cognitive Ergonomics/HCI related subjects, and those of a surveys series on students of IT-related fields, to assess their knowledge degree about HCI and Cognitive Ergonomics. To know the real degree of knowledge about HCI and Cognitive Ergonomics, curricula of IT related specialties of the top 30 national universities were analyzed, and two series of surveys were applied, one Lickert type and one with positive/negative assertions, to students of those universities.
The results reflect the high degree of ignorance about HCI and the urgent need for its foray into higher-level education.

Keywords: Cognitive Ergonomics, Human-Computer Interaction, IT in Higher Education

1. INTRODUCTION

From the SketchPad inception in 1963 (Sutherland, 1963) to the iPad 3 release in 2012 (Zeman, 2012), there has been a clear evolution in user interface design. Nevertheless, despite the many changes in those interfaces, the goal of these is similar: to optimize the "understanding and communication" between the user and the machine, in order to exploit the last in the best way possible.

Human-Computer Interaction (HCI) is a discipline that studies the human interaction with computers. HCI is not limited to computers: nowadays most tools, devices and appliances, including the related with non-productive activities, have user interfaces, mostly graphic.

One main goal of HCI is to maximize user interfaces usability. Usability is a very important aspect in a work tool, and a highly desirable goal in its design. To achieve high levels of usability it's essential that users experience high levels of comfort, both physically and psychologically, when performing their tasks. HCI relates to other disciplines such as Cognitive Ergonomics, Psychology, Graphic Design, and Usability Engineering.

Trough Ergonomics (mainly Cognitive), HCI seeks to suite user interfaces to the characteristics, requirements and needs of its users, to optimize their effectiveness, safety and comfort (Bayo Margalef, 1987).

Unfortunately, in Mexico, HCI is very little applied in the development of user interfaces, among other reasons, because of the view of Ergonomics as an expense and not as an investment (Martinez de la Teja, 2007), and because of the scarce knowledge about Cognitive Ergonomics/HCI, within the academic formation of IT professionals.

In order to communicate the need for Cognitive Ergonomics/HCI inclusion in the curricula of IT related specialties, this article aims to show, in a general way, the current state of Human-Computer Interaction in the IT education in Mexico.

1.1 Importance of User Interface

One of the biggest milestones in the last 20 years has been the emergence of graphic user interfaces, which has revolutionized the way in which a user interacts with machines.

User interface is the communication channel between the user and machine.

User interfaces –in any kind of device or tool- have an enormous impact in today's society at economic, social, and even cultural levels. Some interfaces radically changed the way humans interact with machines, laying the foundations of actual interfaces. An example is the Windows OS interface, which, despite its evolution, is still based on the same interaction paradigms (windows, buttons, icons and dialog boxes).

It's imperative to realize that a computer, just as any other machine, actually do not does what the user wants it to do, but rather what it's ordained to do; in the same way, the user does not get the information he wants, but rather what the machine gives. This implies that there may be a large gap between what people desires and what they actually obtains.

To resolve these "communication" dilemmas it is necessary to design high quality interfaces. The quality of user interaction is of paramount importance in any machine, even more in information systems. The design must be the most intuitive and easy to understand possible. Some of the reasons for developing high quality interfaces are (Constantine, 1995):

- The more intuitive the user interface is, the easier to use it results.
- The more user-friendly the user interface is, the most usable it results.
- The better the user interface is, the cheaper it results (it reduces training costs).
- The better the user interface is, the higher level of satisfaction it will offer.
- The more satisfying the interface is, the greater number of users who will like to use it.

Just as there is a direct and proportional relationship between the user interface quality and interaction quality, there is also a direct relationship between interface design and user performance.

1.2 Human-Computer Interaction

To design a user interface in the best way possible, it is necessary to make use of the Human-Computer Interaction (HCI) discipline; HCI studies the design, evaluation and implementation of interactive computing systems for human use, and the major phenomena surrounding them (ACM, 2011). HCI seeks to improve the ergonomics, safety, utility, effectiveness, efficiency and usability of any machine or system that includes any kind of software (Diaper, 1989).

HCI was born in the late 70's with the emergence of personal computers, as developers and psychologists were becoming interested in the psychological aspects related to information systems, as well as in the cognitive processes taking place when a user interacts with a computer (Carroll, 2009).

HCI implementation is not restricted to computers: collection terminals in a grocery store, a bank ATM, a cell phone or a neonatal incubator, all of them, to a greater or lesser extent, include user interfaces. Thinking of HCI as confined to computing is a common yet terrible mistake: HCI is highly related to Cognitive Ergonomics, Philosophy, Usability Engineering, Psychology, Graphic Design, and other areas of study.

To develop high quality user interfaces it is necessary to consider the user's psychological characteristics such as information processing, memory, decision making, and in some cases, customs and culture. Because HCI provides the guidelines to achieve this, it is therefore essential to use HCI.

The emergence of new certification standards designed to control and to improve the quality of user interfaces, such as ISO 9241-210, supports the growing importance of HCI.

1.3 Cognitive Ergonomics

Ergonomics is the scientific discipline relevant to the knowledge of the interaction between humans and other elements of a system. Ergonomics is also the profession that applies theory, principles, data, and design methods to optimize human well-being and overall system performance (SEMAC, 2011). The purpose of Ergonomics is to design, suite and tailor products, services and work tools to the characteristics, limitations and needs of its users, to optimize their effectiveness, safety and comfort (Gomez Conesa, et al, 2002).

Comfort has a direct impact in human performance. If a person is uncomfortable, or some factor of his environment bothers him, his performance worsens. It is more difficult to concentrate; bad mood is induced; motivation decreases; and the levels of stress, anxiety, and frustration increase; on the contrary, when a person feels comfortable with his environment, he tends to relax, his productivity increases, his mood improves, and he becomes more efficient and has more chances of success in his activities.

In the design of everyday user interfaces, either in work tools or in ludic applications, it is very important to ensure that the user experiments the most comfort possible, both physically and mentally. That is why HCI is highly related to Ergonomics, particularly to Cognitive Ergonomics.

Cognitive Ergonomics is the branch of Ergonomics that studies mental processes -such as memory, reasoning, and perception- related to the interaction of humans and their environment

(Niebel, 2004). It also studies all human activities related to knowledge and information processing that influence, or are influenced by, the design of machines and objects that people use, related to work processes and the environment (Romero Medina, 2006).

Because Cognitive Ergonomics refers to the ways a person learns, thinks, reasons and acts, HCI makes use of it to design interaction mechanisms such as messages, windows, icons, and buttons. Cognitive Ergonomics take account of aspects such as color use, number and distribution of the objects displayed, font selection, and alarm design.

It is essential to apply Cognitive Ergonomics in the design of user interfaces to achieve high usability levels on the machines they belong to, and to reduce human error rates.

1.4 Usability

A well-designed user interface it is not only aesthetic or visually striking, it's also easy to use, understandable, user friendly, and above all, it must fulfill an essential good human-machine interaction feature: Usability.

Usability is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a context, determining the effectiveness of use and satisfaction with which people are able to perform their tasks with the use of the product that they're working with" (Nielsen, 1993).

The quality of a work tool depends largely on the usability it offers to the user; this applies to all range of tools, from a hammer or a backhoe, to a web server or the navigation controls of an airplane. Interaction quality is the central point of usability.

Usability is a very desirable goal because it reduces the level of anxiety, stress and mental workload; increases concentration, focus, and productivity; facilitates compression and accelerates learning; all this through the application of Ergonomics, because user's performance level increases along with the user's comfort.

A highly usable user interface guides the user in performing their tasks, by leading him to take the more appropriate actions and providing him with appropriate feedback, on either success or error. It seeks to minimize the amount of stimuli to address simultaneously, does not require a large holding capacity nor to remember many details in short periods, provides the most information possible for the user to make decisions, and streamlines the cognitive process by using mental models.

Unfortunately, a lot of today's technological innovations, despite being aesthetic and technologically advanced, are limited to create or follow interaction trends, and are driven by a user interface with a novel, elegant and sometimes unconventional design, but are not always ergonomic nor highly usable (Puri, 2011).

Usability in user interfaces is essential and extremely important, because of its direct and huge impact on user performance.

1.5 Impact of user interface on performance

Throughout history, there have been innumerable cases where the user interface had great influence on the results of its use. In some cases, it met user needs and generated positive consequences such as saving resources and increasing economic gains; in other cases, it caused the failure of an application or device, and brought property damage, economic losses, and even human casualties.

Examples of poorly designed user interfaces, that provide low-quality interaction, are the Bob program for Windows 3.1, the Windows Vista OS, or an application that cost $3'000'000 to an insurance company. In the first two cases, users did not receive well the software, and technologies were not adopted successfully; in the latter case, agents of the insurance company refused to use the application because it was impossible to use and learn (Sanz Verdu, 1995). In all three cases, big economic losses occurred.

Other cases of problems caused by poor interface design are:

- The Japanese company Ricoh found that 95% of users surveyed never used the three key features designed to make their product more attractive, either by ignoring its existence, not knowing how to use them, or not understand them (Nussbaum, and others, 1991)
- The e-commerce sites lose almost half their potential sales because users cannot use the site easily. It's estimated that increasing the ergonomics and usability of these sites could increase traffic levels -and more important, sales- up to 79% (Nielsen, 2001)
- 80% of maintenance requirements are due to unintended users, with the remainder percentage due to faults and errors (Pressman, 2004)
- 63% of all software development projects exceed their budget, being the four most important causes are attributed to usability (Lederer, and others, 1992)

There are also reports of user interfaces that due to its ergonomic, friendly, easy to learn, and highly usable design, generated great benefits:

- The company NCR showed a production increase of 25% and a further reduction in the number of errors in 25%, because of the new design of user interfaces (Dray, 1995).
- The savings achieved by a good user interface were US$ 41'700 in a simple application used by 23'000 employees, and US$ 6'800'000 for a complex application used by 240'000 employees. This is due to a decrease of errors, misbehavior of users, and time taken to perform the tasks, elimination of training, reduced workload of the support team, and no subsequent changes to the software (Karat, 1990).
- In 1999, InfoWorld presented a study that showed that after redesigning its Web site with special emphasis on usability and ergonomics, IBM increased traffic by 120% and increased its sales by 400% (Battey, 2001).
- IBM reduced the training time from a week to one hour, thanks to changing the interface design (Sanz Verdu, 1995).
- In 2002, the Claro Studio company completely redesigned La Caixa's intranet, which generated a considerable increase in employee productivity by increasing the number of transactions made by them (Atxondo et al, 2003).
- A mathematical model based on 11 studies suggests that the use of software that has been designed using HCI, Ergonomics, and Usability Engineering saves US$ 39'000 in a small project, US$ 613'000 in a medium-sized project, and US$ 8'200'000 in a large- scale project (Landauer et al, 1993).

- Considering all costs associated with Usability Engineering, another study found that the benefit-cost relationship of developing a good user interface could be more than 5,000 to 1 (Phillips, et al, 1993).

If a program is difficult to use, or have limited acceptance / satisfaction among its users, it's likely that it may not be used regardless of whether it is technologically advanced (faster processes, better utilization of resources, additional features, etc.) or visually striking. When users find confusing or difficult to use an application, they may feel frustrated and even angry at it; this implies little use of the application and a decrease in productivity.

It is common to find users who prefer certain applications to others, because the former seem more "understandable" and easy to use. Sometimes, users even prefer old, limited or inadequate programs (for example Paint instead of CorelDraw or Photoshop).

User interface has an impact on performance so huge, that even human error is attributably, at least partially, to its design.

1.6 Human error

An error is an action that fails to produce the expected results, leading to unintended consequences (Hollnagel, 1998). Human error is the difference between the requirements and demands of a system, and the actions taken by the human operator (Fuller, 1990); it's the generic term for all occasions in which a planned sequence of activities, whether physical or mental, fails to obtain the desired result because of a human being (Reason, 1991).

Because cognitive process determines the way a person thinks, understands, reasons and acts, cognitive factors play an important role in the appearance of human errors (Sternberg, 2002). The cognitive process is affected by numerous and varied factors. These factors can be classified as internal or external, and in turn, are divided into internal emotional (stress level, mood, emotional/psychological state), internal rational (knowledge degree, experience level, ability), external direct (machines and work tools design) and external indirect (noise, lighting, temperature, work environment). It is important to note that external factors have great influence on the internal ones, even on the rational.

When external factors have a negative impact on internal factors, the cognitive process tends to fail, decision making process becomes poor, and the execution of wrong decisions resulting in human error, regardless of the type (error or slip; (Reason, 1991)).

Human errors examples, caused by non-ergonomic user interfaces are:

- The nuclear reactor core partial melt at Three Mile Island in 1979 (Schultz, et al, 1988)
- The patients' death due to massive doses of radiation in the use of medical therapy machine Therac-25 (Leveson, 1995)
- The American Airlines Flight 965 in 1995 (Landsberg, 2001), the China Airlines Flight 006 in 1991, the Airbus Flight 320 in 1990, and the Iranian Air Flight 655 in 1992. All of them resulted in numerous casualties.

In contrast, an ergonomic user interface, as a direct external factor on the cognitive process, may optimize internal rational factors, mitigate the effects of internal emotional and external indirect factors when they are negative, and increase the effects when they are positive. Since high quality cognitive process decreases the likelihood of human error occurrence, it is essential to design ergonomic user interfaces.

2. OBJECTIVES

- To know the current state of HCI and Cognitive Ergonomics in the curriculum of IT-related specialties on Higher Education Institutions in Mexico.
- To know the degree of knowledge about HCI and Cognitive Ergonomics by students of IT-related specialties in Higher Education
- To inform of the foray need of HCI and Cognitive Ergonomics in the curricula of IT-related specialties, by Higher Education Institutions in Mexico.

3. METODOLOGY

The top 30 universities in Mexico (according to the QS World University Ranking 2011 (Symonds, 2011)) were selected to analyze the curriculum of their IT related specialties, in order to know which and how many universities offer courses related to HCI and Cognitive Ergonomics. A series of surveys were also performed (during December 2011 and January 2012) in five universities of the previously selected group, with 30 respondents per institution. The survey consisted of two sets of questions (one with Lickert scale, and other with positive / negative statements). Both sets analyzed performance on the dimensions HCI, Cognitive Ergonomics, and Usability. The objective of conducting the surveys was to obtain firsthand information on the extent of knowledge about HCI and Cognitive Ergonomics.

4. RESULTS

Of the 30 universities selected, only 19 (63.33%) include any subjects related to HCI in the curriculum of IT related specialties. However, only five do it in a mandatory basis. This is a huge problem because there is a high probability that the students decide not to pursue subjects related to HCI and Cognitive Ergonomics, among other reasons, due to the ignorance of the importance and the necessity for them in the development of user interfaces. The results of the surveys support the previous statement:

- 77% ignored completely Cognitive Ergonomics
- 62% considered Ergonomics unimportant
- 81% never use Cognitive Ergonomics
- 61% have little knowledge of HCI
- 52% think that HCI have moderate importance in the design of user interfaces
- 63% believe that HCI has a moderate impact on user performance
- 49% devoted few resources to improve the quality level of user interaction

- 54% have little knowledge of Usability
- 44% devoted few resources to improve usability
- 89% indicate that Cognitive Ergonomics is not included in their curriculum
- 68% indicate that HCI is not part of their curriculum
- 81% received no information on the relationship between HCI and human error
- 10% indicated that they were taught how to design ergonomic user interfaces

5. CONCLUSIONS

Information systems today have an undeniable impact on all areas of society. In any machine or device, the user interface must be designed with special care, as it provides the mechanisms that allow communication between man and machines.

HCI, along with Cognitive Ergonomics, Cognitive Psychology and Usability Engineering are very important areas of study, and provide insights into the way the users think, reason, learn and perform with their environment, particularly with the machines. This supply the information needed to design ergonomic and highly usable user interfaces.

In Mexico, even though HCI can be found in more than 50% of the universities curricula, less than 30% know well HCI and more than 80% never apply Cognitive Ergonomics. One of the main reasons for this is that the related subjects are optional, not mandatory.

Considering that today's students are tomorrow's professionals, it is very important that the students of IT related specialties are aware of the importance of both HCI and Cognitive Ergonomics, and that acquire the necessary knowledge about them.

In order to improve the quality of the design of user interfaces, it is strongly recommended that higher education institutions include HCI in their curricula of IT-related specialties, trough at least one undergraduate course (for basic concepts) and one more in a higher degree (for advanced concepts), both on a mandatory basis. These courses must include concepts about Cognitive Ergonomics, Cognitive Psychology, Usability and Graphic Design.

It is further recommended that the subject is also aimed at sensitizing the students of the importance of Ergonomics and its contribution in reducing human error.

As support material for the subject proposed above, we propose the use of an interactive guide that includes a series of recommendations and considerations for designing ergonomic interfaces, such as proper use of colors and fonts, the distribution of different elements, the design of alarms and messages, the inclusion of pictograms, icons, and mental models, etc.

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LET US WALKTOGETHERTO REDUCE ACADEMIC-SCHOOL STRESS ON STUDENTS ATCBTIS128¨CIUDAD JUAREZ, CHIHUAHUA

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Resumen

Este trabajo tiene como objetivo verificar que un paseo por la mañana de 40 a 45 minutos en gran medida reduce la tensión, el estrés acumulado en el estudiante, también una posible conexión con la escuela el rendimiento académico. Fue considerado para el estudio de una muestra de 300 estudiantes de la escuela secundaria, Bachillerato Tecnológico Industrial y Centro de Servicio n º 128, donde 150 estudiantes se encuentran en tercer semestre y 150 en el quinto semestre. Fue utilizado como un instrumento de medición un cuestionario (NuslyMaira Navas Moreno, y otros, 2010). También se basó en un marco teórico de diferentes autores, obras que sugieren que las estrategias para copiar con el estrés y el rendimiento académico en estudiantes universitarios y la literatura técnica del estrés laboral y de neurotransmisores.

Palabras clave: Educación, estrés académico, estrés laboral, el rendimiento académico, los neurotransmisores.

Abstract

This work aims to verify that a morning walk for 40 to 45 minutes largely reduces the tension-stress accumulated in the student, also a likely connection with school academic performance. Was considered for study a sample of 300 students from high school, Bachelor of Industrial Technology Center and Service No 128, where 150 students are in third semester and 150 on fifth semester. It was used as a measuring instrument a questionnaire (NuslyMaira Moreno Navas, and others, 2010). Also relied on a theoretical framework of various authors, works that suggest strategies for copying with stress and academic performance in college students and technical literature of work stress and neurotransmitter.

Keywords: Education, academic stress, work stress, academic achievement, neurotransmitters.

Introduction

The General Law of Education, in its second article states that education is an ongoing process that contributes to the development of individual and societal transformation, and is a determining factor in the acquisition of knowledge to train the man so that makes sense of social solidarity. Education is the general means by which society ensures that its members gain social experience accumulated historically and culturally organized.

Through education, establishing the process by which it is transmitted to individual knowledge, skills, attitudes and values that allow you to integrate into society. This process, which begins in the family, affecting both the physical and the emotional and moral, and extends throughout human existence.

Martinez (2008), notes that the new "scenario" academic university that comes with the European Higher Education Area (EHEA), focusing on learning and the development of multiple skills by students, autonomy, quality and academic achievement is a unique setting for the study of academic stress. In this regard we must remember that the resulting methodological changes needed in teaching and learning processes associated with the EHEA (planning, activities and tasks, evaluation, interaction, etc.). Processes require adaptation by students to achieve academic goals and adapt to the new system, all of which contribute to generate stress.

Let us first recall that for them the emotional stress is the physiological negative implications resulting from a process perceived imbalance between environmental demands and personal resources. For them and for other researchers cited by Martinez (2008), (Hernandez, Olmedo and Ibanez, 2004) a person will experience stress if they perceive that the personal resources to respond to a significant situation are insufficient, ineffective or inappropriate. For (IMSS 2008) reported that job stress affects 20% of workers (2008), says that ¨ Stress is the response people have when demands and work pressures exceed their ability to handle them. ¨ For the learner , daily activities in school performance, just like any worker, the pressure is a natural part which is subjected by their activity.

(IMSS, 2008) argues that when this pressure becomes excessive labor or uncontrolled stress it causes, ends up affecting the worker's performance, which affects both the company and employee health. This conclusion follows similarly that the stress to which the student is subjected, (more so in times of assessments) can cause and affect their performance in natural, therefore their academic performance and health, could decrease.

It is common during periods of assessment, is observed in young people, who are prey to nervous-emotional instability. The requirement of a schedule, the number of credits per subject, the number of subjects in the program, the distance from home to school, insecurity rampant in this city, the demands required by some of the specialty subjects of the curriculum and the possible requirement for teachers and parents, moreover, the school rules regarding academic performance, lack of time to meet with school, overcrowded classrooms, ... these are the possible causes that could cause stress to the learner, therefore diminishing the quality of student learning for this and other reasons, I present this proposal ¨ morning walk program to reduce stress ¨ school once a week for 30 to 40 minutes.
luislioi, 02/04/2011, argues that this type of exercise you can do every day for 15 to 60 minutes, (referring to the walk). Also included as examples of aerobics the following: walking, running, skating, cycling, skiing, rowing, swimming, jumping rope, climbing to, among others.

Justification

It is troubling circumstances and vicissitudes that nowadays society in general and learners throughout the state of Chihuahua daily living, rampant insecurity and extreme in Ciudad Juarez, the chilling news on the most cruel and merciless killings , one must add the extortion, kidnapping, assault, abuse of police authority, and other academic-school character. Believe are unnecessary reasons to justify this work as soon as written, (Introduction). This research is aimed, first, that the local academy will accept and implement it in C, T, S and VI, II, III. Second, the state academy, also it compulsory in all schools of DGETI.Thirdly, the SEMS it compulsory in all schools that depend on it.

Objective

The objetive of this study is to verify that a walk for 40 to 45 minutes a day a week, reduces stress on the students, also the likely figure out a possible relationship between the stress of students and their academic performance and make a proposal to the various academies local, state of the subject C, T, S and VI, II, III to consider this proposal.

Theoretical Framework

Academic performance refers to the assessment of knowledge acquired at school. A student with good academic performance is one that gets positive ratings in examinations to be held over a curse. In other words, academic performance is a measure of the capabilities of the student, expressing what he has learned over the training process. It also involves the student's ability to respond to educational stimuli. In this sense, academic performance is linked to fitness.

There are different factors that affect academic performance. Since the inherent difficulty of some subjects, to the large number of tests that can match at a time, through the wide expanse of certain educational programs, many reasons that can lead a student to show poor academic achievement. (No author), http://definicion.de/rendimiento-academico/

Academic Performance Indicators.

Quantitative indicators (Garcia, Hood, and others no date of publication), are required relating to the different dimensions, variables and criteria that take into the methodology of evaluation and accreditation of educational quality, and are valuable tools and important theoretical, methodological and practice in the scientific management of the substantive processes of professional training in universities.

Among the quantitative performance indicators as benchmarks of quality and efficiency of a vocational training program or course of a specific subject may include: retention and dropout rates, academic promotion on the initial and final registration, qualification or note by subject , grades between different subjects and for the training cycle, number of graduates and academic efficiency internally.

(Martinez 2008) refers to and quotes Lazarus and Folkman (1985) who described two basic strategies for coping with stress: on the one hand, cognitive-behavioral efforts focused on solving the problem, otherwise, search for relationships and support others with great affective content. This model says Martinez (2008) that includes all the efforts that the student starts to handle events that are perceived as stressful and restore balance. Many studies agree that active coping strategies are functional options, adaptive and successful, while the passive forms of avoidance are considered less successful, dysfunctional and maladaptive

Stress at work.

The National Institute for Occupational Safety and Health (NIOSH). This federal agency responsible for conducting research and making recommendations for the prevention of diseases and injuries associated with work, published an article entitled, stress at work.

As part of its mandate, (Sauter, Murphy, and others, no publication date), the U.S. Congress ordered NIOSH to study the psychological aspects of occupational safety and health, including stress in the workplace. NIOSH collaborates with industry, labor, and universities to better understand the stress of modern work, the effects of stress on health and worker safety, and ways to reduce stress in the workplace. This article was prepared by a working group of NIOSH

The nature of work is changing with the rapidity of a whirlwind. Perhaps now more than ever, the stress caused by work is a threat to the health of workers and, therefore, to health organizations. For its research program on job stress and instructional materials as this booklet, Job stress can be defined as the harmful physical and emotional reactions that occur when the requirements of the job do not match the capabilities, resources, or worker's needs. Job stress can lead to poor health and even injury.

The concept of stress (NIOSH) of work is often confused with challenge, but these concepts are not equal. Challenge energizes us psychologically and physically, and are motivated to learn new skills and master our jobs. When we find a challenge, we feel relaxed and satisfied. So the challenge is an important ingredient of healthy and productive work. Probably the importance of challenge in our life's work refer those who say "a little stress is good." NIOSH is dedicated to providing organizations of knowledge to reduce this threat.

Fernandez, Marley, Noriega. (2008-73.74), mention that the psychophysical approach is applied to study the feelings of human beings that are associated with external stimuli, so that the objective of the studies that apply the psychophysical approach is to determine the subjective tolerances associated with stress occupational. Also mention that there is a set of indicators to measure the demand for energy, including energy expenditure, oxygen consumption, heart rate, pulmonary ventilation, blood pressure and lactic acid. Fernandez (2008-53) et al. Energy expenditure defined as the amount of energy produced and worn during the execution of a task, which is the main indicator for measuring the physiological work it.

Neurotransmitters in the brain. They are called neurotransmitters to chemicals that are responsible for transmitting information between different parts of the body. Hormones, eg transmitters are traveling through the blood. And neurotransmitter called transmitters that carry the messages to different parts of the nervous system (brain, spinal cord and nerves). Well, the neurotransmitters more "important" are the brain of the control exerted on neurons. And so are also the most studied. This applies to:

-The acetylcholine. This neurotransmitter regulates the ability to retain information, store it and retrieve it when necessary. When the system uses acetylcholine is disrupted are memory problems and even, in extreme cases, dementia.

-Dopamine. Create a "breeding ground" for the pursuit of pleasure and emotions as well as alertness. Power also sexual desire.Conversely, when its synthesis or release may appear difficult discouragement and even depression.

-Norepinephrine is responsible for creating a breeding ground for attention, learning, sociability, sensitivity to emotional cues and sexual desire. On the contrary, when the synthesis or release of noradrenaline are disturbed appears demotivation, depression, loss of libido and self-confinement.

Effects on mood The high or low level of neurotransmitters has a significant influence on mental function, behavior and mood. Let us schematically some of these effects:
-High levels of acetylcholine enhance memory, concentration and learning ability. Causes a low level, however, loss of memory, learning and concentration.

Dealing with stress

In the article (Melgosa, 2011) proposes the following:

1. Know thyself. A basic source of stress is self. There are individuals who, because of his own personality, are more susceptible to stress than others under the same amount of pressure. (It is noteworthy that "Know thyself is one of the important dimensions of ¨ T ¨ Build Program) (Melgosa, luislioi 2011), states that exercise, by itself, and is a powerful tool to avoid stress. Based on the release of hormones such as endorphins that produce a feeling of comfort and pleasure. Specifically, physical activity that is somehow relaxing and allows the muscle strain is of low intensity or consisting of muscle stretching and body awareness. It also clarifies that this type of exercise you can do every day for 15 to 60 minutes. Examples of aerobic are: walking, running, skating, cycling, skiing, rowing, swimming, jumping rope, climbing to, among others.

Garcia Hernandez. (2012), argue that physical inactivity is one of the predictors of obesity. Mexico ranks second worldwide in childhood obesity (24.2%), a figure that requires academic and government decision makers to consider ways to change that trend, especially due to the high comorbidity of obesity with other public health problems of high cost for the country. Garcia and Hernandez also cite and emphasize to (Strong, Malina, Blimkie, Daniels, Dishman et al. 2005; Janssen & Leblanc, 2010). That obesity has negative health consequences in childhood and in the long run. These consequences include: difficulty breathing, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance, and psychological effects such as depression, anxiety, negative perception of the self-image and socialization problems. to the high comorbidity of obesity with other public health problems of high cost for the country.

A number of surveys indicate the severity of the problem:

• The Program REDEA, quotes IMSS who reported that work stress affects 20% of workers (2008)
• The number of employees who become disabled by factors associated with stress tripled from 1996 to 2000 (American Institute of Stress).
• 63% of workers say their personal lives have been affected by stress (Harris poll).
• 80% of employees feel stressed at work, more than half of them say they need help to manage stress (Gallup poll).

Work stress is the response people have when demands and work pressures exceed their ability to handle them. The pressure is a natural part of any job, and helps employees stay motivated. When this pressure becomes excessive or uncontrolled, causing stress eventually affect the performance, which affects both the company and employee health. Research shows that job stress can occur at any level in the organization, and some signs that the employee is stressed are:

• Changes in behavior
• Indecision
• Increased absenteeism due to illness
• Decrease in performance, eg, inability to concentrate
• Work in excess of or inability to delegate
• Relationship problems
• Smoking or drinking to excess.

METHODOLOGY

The campusCBTIS128,workingtwo shifts, with a total population ofalumnado1400the morning shift and afternoon shift1307, 2707 in total, I note that for this research was not considered and the morning shift or the evening, since the program ¨Walk Together¨ (Walk Morning) implements it only six groups, three of the third semester and May 3rdsemester, why was performed only in these groups is that they are only in which I teach in the subject ¨Science, Technology, Society and Values, II, III 'means anytime the program¨¨Walk Together I set to tie the program ¨T¨ Build in healthy Living ¨dimension. ¨Now if you consider the total population of students, there representative sample size would be, 11.27%, which is okay, now I just think the morning shift would be the representative sample is 21.78%, even more representative, right now, if I take into account as population the total number of students who will impart this course305, this is then 100% of the population and100% of the sample, of course not justified this action, since it satisfies the rules and basic tools of statistics. ToStagliano2005, saysthat to understand people, we often need these large, and also ensures that these often prove impractical or impossible to work with a large population, and argues that a statistical sampling gallows us to obtain useful information about the population, without seeing all the entities that comprise it.

The reference used was the measurement instrument used in the work of NuslyMoreno, Helmet, Trimarchi (2010)

INSTRUCTIONS: Below is presented with a scale with values indicating the degree of stress that such situations can generate where (with 1 representing no stress, 2 next to nothing, 3 Little, 4 and 5 often much stress). Mark with X the number you see fit

A. - Examinations.
2. - Exhibition of class work.
3. - Intervention in the Classroom (responding to a question from the teacher, ask questions, participate in discussions.
4. - On course load (excessive number of credits, etc. compulsory labor.
5. - Overcrowding of classrooms
6. - Failure to time to meet with school
7. - Competitiveness between partners.
8. Implementation of compulsory to pass the course (finding the necessary materials, drafting work, etc...)
9. - the task of study.
10. - Work in group
11. Do you think the school activity as the primary cause of stress in your life?

Sample Size**.**

The universe seen in the morning shift is 1400for this study were6 groups with a total of 305 students, was considered only6 groups of the morning shift, since only they were subjected to the morning walk35 to 40minutes once a week, the sample sizeis21.78% which is sufficiently representative.

Analysis of Results

Measurementsurveyinstrumentapplied 3º I

	Situación	*1*	*2*	*3*	*4*	*5*
1	*Realización de exámenes.*	*9.43%*	*24.52%*	*28.30%*	*1.88%*	*18.86%*
2	*Exposición de trabajos en clase*	*26.41%*	*24.52%*	*24.52%*	*28.30%*	*15.09%*
3	*Intervención en el aula (responder a una pregunta del profesor, realizar preguntas, participar en coloquios.*	*24.52%*	*18.86%*	*9.43%*	*9.43%*	*13.20%*
4	*Sobre carga académica (excesivo número de créditos, trabajos obligatorios etc*	*22.64%*	*28.30%*	*9.43%*	*9.43%*	*28.30%*
5	*Grupo numeroso en aula chica, muy amontonados*	*18.86%*	*24.52%*	*18.86%*	*9.43%*	*24.52%*
6	*Falta de tiempo para poder cumplir con las actividades académicas.*	*30.81%*	*28.86%*	*24.52%*	*9.43%*	*33.92%*
7	*Competitividad entre compañeros*	*13.20%*	*15.09%*	*9.43%*	*9.43%*	*33.94%*
8	*Realización de trabajos obligatorios para aprobar la asignatura (búsqueda del material necesario, redactar el trabajo, etc.)*	*33.96%*	*18.86%*	*5.66%*	*3.77%*	*9.43%*
9	*La tarea de estudio.*	*5.66%*	*9.43%*	*15.09%*	*15.09%*	*9.43%*
10	*Trabajar en grupo.*	*22.64%*	*18.86%*	*24.52%*	*9.43%*	*18.86%*
11	*¿Consideras la actividad escolar como la causa primera del estrés en tu vida?*	*24.52%*	*37.73%*	*22.64%*	*24.52%*	*9.43%*
12	*Ahora, fíjate bien, al contrario de las anteriores, marca con un 1 ( ) sí consideras que la caminata matutina no te disminuye nada de estrés, 2 ( ), casi nada me disminuye el estrés, y así sucesivamente… 5 te disminuye mucho el estrés.*	*24.52%*	*18.86%*	*18.86%*	*28.30%*	***39.96%***
Observaciones						

Measurement survey instrument applied 3ºG

	Situación	1	2	3	4	5
1	Realización de exámenes.	9.45%	23%	15%	14.6%	19.5%
2	Exposición de trabajos en clase	28.4%	17.4%	21%	26%	18.4%
3	Intervención en el aula (responder a una pregunta del profesor, realizar preguntas, participar en coloquios.	24.5%	13.7%	19.5%	15.3%	13.20%
4	Sobre carga académica (excesivo número de créditos, trabajos obligatorios etc	*22.64%*	*28.30%*	*9.43%*	*9.43%*	*28.30%*
5	Grupo numeroso en aula chica, muy amontonados	*9.43%*	*7.54%*	*9.43%*	*18.86%*	*9.43%*
6	Falta de tiempo para poder cumplir con las actividades académicas.	*17.86%*	*24.52%*	*18.86%*	*9.43%*	*23.52%*
7	Competitividad entre compañeros	*31.81%*	*27.86%*	*2352%*	*9.43%*	*33.92%*
8	Realización de trabajos obligatorios para aprobar la asignatura (búsqueda del material necesario, redactar el trabajo, etc.)	*13.20%*	*15.09%*	*9.43%*	*9.43%*	*31.92%*
9	La tarea de estudio.	*33.96%*	*18.86%*	*5.66%*	*3.77%*	*9.43%*
10	Trabajar en grupo.	*23.64%*	*18.86%*	*24.52%*	*19.43%*	*19.86%*
11	¿Consideras la actividad escolar como la causa primera del estrés en tu vida?	*17.02%*	*10.63%*	*6.38%*	*21.27%*	*31.91%*
12	Ahora, fíjate bien, al contrario de las anteriores, marca con un 1 ( ) sí consideras que la caminata matutina no te disminuye nada de estrés, 2 ( ), casi nada me disminuye el estrés, y así sucesivamente… 5 te disminuye mucho el estrés.	*24.52%*	*18.86%*	*18.86%*	25.9%	***48.5%***
Observaciones						

Measurement survey instrument applied 3ª B

	Situación	1	2	3	4	5
1	Realización de exámenes.	0%	0%	13%	30%	51%
2	Exposición de trabajos en clase	1.81	4.81%%	42.59%	24%	9.2%
3	Intervención en el aula (responder a una pregunta del profesor, realizar preguntas, participar en coloquios.	11.11%	29.62%	35.18%	14.81%	1.8%
4	Sobre carga académica (excesivo número de créditos, trabajos obligatorios etc	0%	1.8%	1.8%	25.93%	61.11%
5	Grupo numeroso en aula chica, muy amontonados	12.90%	24.07%	27.7%	16.6&	11.11%
6	Falta de tiempo para poder cumplir con las actividades académicas.	0%	1.8%	7.4%	16.66%	64.81%
7	Competitividad entre compañeros	18.51	25.93%	37.03%	9.25%	3.7%
8	Realización de trabajos obligatorios para aprobar la asignatura (búsqueda del material necesario, redactar el trabajo, etc.)	3.7%	9.25%	11.11%	33.33%	37.03%
9	La tarea de estudio.	11.11%	20 37%	25.92%	24.07%	12.96%
10	Trabajar en grupo.	24.07%	24.07%	29.62%	9.25%	5.55%
11	¿Consideras la actividad escolar como la causa primera del estrés en tu vida?	3.7%	7.4%	14.81%	24.07%	44.44%
12	Ahora, fíjate bien, al contrario de las anteriores, marca con un 1 ( ) sí consideras que la caminata matutina no te disminuye nada de estrés, 2 ( ), casi nada me disminuye el estrés, y así sucesivamente… 5 te disminuye mucho el estrés.	7.4%	3.7%	7.4%	33.33%	***49.88%***

Measurement survey instrument applied 5ª B

	Situación	1	2	3	4	5
1	*Realización de exámenes.*	*28.88%*	*44.44%*	*11.11%*	*11.11%*	*0%*
2	*Exposición de trabajos en clase*	*15.55%*	*15.55%*	*11.11%*	*11.11%*	*15.55%*
3	*Intervención en el aula (responder a una pregunta del profesor, realizar preguntas, participar en coloquios.*	*17.77%*	*17.77%*	*11.11%*	*26.66%*	*33.33%*
4	*Sobre carga académica (excesivo número de créditos, trabajos obligatorios etc.*	*26.66%*	*6.66%*	*15.55%*	*22.22%*	*8.88%*
5	*Grupo numeroso en aula chica, muy amontonados*	*17.77%*	*17.77%*	*17.77%*	*0%*	*17.77%*
6	*Falta de tiempo para poder cumplir con las actividades académicas.*	*15.55%*	*11.11%*	*17.77%*	*26.66%*	
7	*Competitividad entre compañeros*	*15.55%*	*6.66%*	*22.22%*	*15.55%*	*11.11%*
8	*Realización de trabajos obligatorios para aprobar la asignatura (búsqueda del material necesario, redactar el trabajo, etc.)*	*11.11%*	*17.77%*	*15.55%*	*11.11%*	*11.11%*
9	*La tarea de estudio.*	*15.55%*	*17.77%*	*17.77%*	*17.77%*	*17.77%*
10	*Trabajar en grupo.*	*22.22%*	*15.55%*	*0%*		*15.55%*
11	*¿Consideras la actividad escolar como la causa primera del estrés en tu vida?*	*17.77%*	*15.55%*	*26.66%*	*15.55%*	*22.22%*
12	*Ahora, fíjate bien, al contrario de las anteriores, marca con un 1 ( ) sí consideras que la caminata matutina no te disminuye nada de estrés, 2 ( ), casi nada me disminuye el estrés, y así sucesivamente… 5 te disminuye mucho el estrés.*	*15.55%*	*17.77%*	*0%*	*11.11%*	***42.22%***
Observaciones						

Measurement survey instrument applied 5ª G

	Situación	*1*	*2*	*3*	*4*	*5*
1	*Realización de exámenes.*	*7.54%*	*3.77%*	*18.86%*	*9.43%*	*9.43%*
2	*Exposición de trabajos en clase*	*9.43%*	*9.43%*	*9.43%*	*9.43%*	*9.43%*
3	*Intervención en el aula (responder a una pregunta del profesor, realizar preguntas, participar en coloquios.*	*9.43%*	*9.43%*	*9.43%*	*9.43%*	*9.43%*
4	*Sobre carga académica (excesivo número de créditos, trabajos obligatorios etc*	*9.43%*	*12.76%*	*18.86%*	*9.43%*	*9.43%*
5	*Grupo numeroso en aula chica, muy amontonados*	*9.43%*	*7.54%*	*9.43%*	*18.86%*	*9.43%*
6	*Falta de tiempo para poder cumplir con las actividades académicas.*	*9.43%*	*9.43%*	*9.43%*	*9.43%*	*9.43%*
7	*Competitividad entre compañeros*	*9.43%*	*9.43%*	*9.43%*	*9.43%*	*22.64%*
8	*Realización de trabajos obligatorios para aprobar la asignatura (búsqueda del material necesario, redactar el trabajo, etc.)*	*18.86%*	*9.43%*	*9.43%*	*24.52%*	*18.86%*
9	*La tarea de estudio.*	*27.65%*	*9.43%*	*9.43%*	*15.09%*	*9.43%*
10	*Trabajar en grupo.*	*8.51%*	*9.43%*	*9.43%*	*15.09%*	*9.43%*
11	*¿Consideras la actividad escolar como la causa primera del estrés en tu vida?*	*4.25%*	*9.43%*	*9.43%*	*9.43%*	*18.86%*
12	*Ahora, fíjate bien, al contrario de las anteriores, marca con un 1 ( ) sí consideras que la caminata matutina no te disminuye nada de estrés, 2 ( ), casi nada me disminuye el estrés, y así sucesivamente… 5 te disminuye mucho el estrés.*	*9.43%*	*9.43%*	*9.43%*	*9.43%*	***53.20%***
Observaciones						

Measurement survey instrument applied 5ª I

	Situación	1	2	3	4	5
1	*Realización de exámenes.*	28.88%	44.44%	11.11%	11.11%	0%
2	*Exposición de trabajos en clase*	15.55%	15.55%	11.11%	11.11%	15.55%
3	*Intervención en el aula (responder a una pregunta del profesor, realizar preguntas, participar en coloquios.*	17.77%	17.77%	11.11%	26.66%	33.33%
4	*Sobre carga académica (excesivo número de créditos, trabajos obligatorios etc.*	26.66%	6.66%	15.55%	22.22%	8.88%
5	*Grupo numeroso en aula chica, muy amontonados*	17.77%	17.77%	17.77%	0%	17.77%
6	*Falta de tiempo para poder cumplir con las actividades académicas.*	15.55%	11.11%	17.77%	26.66%	
7	*Competitividad entre compañeros*	15.55%	6.66%	22.22%	15.55%	11.11%
8	*Realización de trabajos obligatorios para aprobar la asignatura (búsqueda del material necesario, redactar el trabajo, etc.)*	11.11%	17.77%	15.55%	11.11%	11.11%
9	*La tarea de estudio.*	15.55%	17.77%	17.77%	17.77%	17.77%
10	*Trabajar en grupo.*	22.22%	15.55%	0%		15.55%
11	*¿Consideras la actividad escolar como la causa primera del estrés en tu vida?*	17.77%	15.55%	26.66%	15.55%	22.22%
12	*Ahora, fíjate bien, al contrario de las anteriores, marca con un 1 ( ) sí consideras que la caminata matutina no te disminuye nada de estrés, 2 ( ), casi nada me disminuye el estrés, y así sucesivamente… 5 te disminuye mucho el estrés.*	15.55%	17.77%	0%	11.11%	***42.22%***
	Observaciones					

3º B	**49.88%**
3oG	**48.50%**
3oI	**39.96%**
5oB	***46.17***
5oG	***53.20%***
5oI	***42.22%***

Conclusions.

1-The morning walk helps greatly reduce the tension-stress accumulated during the day-school academic activities in the student body, as shown in the results of question 12:
2-In this work was primarily interested in knowing if the relaxation causes a morning walk and a low-stress accumulated tension, which does not mean that other responses to the questionnaire are of lower or zero importances.
3-The morning walk helps greatly reduce the tension-stress accumulated during the day-school academic activities at the institute, as shown in
4-Melgosa's article gives firmness to the program proposed by ¨ T ¨ Build on the dimension ¨ ¨ Know yourself and Dimension ¨ ¨ Healthy Living, therefore, the morning walk also contributes something to tension-stress decrease in the pupil.
5-This program implemented in the course ¨ Science, Technology, Society and Values, should be considered strongly by DGETI to put into practice all EMS subsystem of this technological direction, not just in the subject C, T, S, and V of this campus.
6 - The work published by Fernandez, Marley, Noriega, (2008, 53) gives support to this proposal, regard for the execution of a task, oxygen consumption, heart rate produced by walking, energy consumption, pulmonary ventilation required daily, a morning walk endorses the above.
7-The authors cited, Fernandez, et al (2008, 133-134) developed a job based sitting produces some distortions in the spine also can happen to a student with 7 to 8 hours of sitting, but with breaks between class and class (15 weeks per semester), however the morning walk helps in part to reduce fatigue to the submission of the spine.
8-also a seated person, body fatigue is less, provided the school chair (chair) this ergonomically well designed.
9-It appears that these seats and chairs are not ergonomically designed school so that students feel uncomfortable and this constantly moving, not you drowsy.
10-It is proposed a breathing exercise and low-impact body movements, 5 minutes before each class or end of it, to decrease the state of drowsiness and fatigue.
11-It seems if there is little correlation between the strategies of the morning walk and academic achievement-school students in this school.
12-In relation to student achievement, according to the student services department, said if a nonsignificant increase may not necessarily be attributed to the hike.
-Remember forever. Healthy mind in healthy body. –

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ERGONOMIC SITTING CHAIR ON THE INSTITUTE TECHNOLOGIC OF MEXICALI.

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1. INTRODUCTION

1.1.ERGONOMICS AND THE AREAS OF THE INSTITUTO TECNOLOGICO DE MEXICALI.
Do some work places give the eye strain and muscle fatigue? Such human skin irritation and discomfort are not inevitable - ergonomics is an approach that puts human needs and capabilities in the design of technological systems Center. The aim is to ensure that human beings and technology work in complete harmony with the team and the tasks will be joining human characteristics. Our institution is the design of technological systems Center therefore the relationship with the human aspect is what we should resume in our classrooms, the student is our client if we see it from the point of view of quality, and the service that we are providing and for which we are trainers and above all to take the process of teaching and learning based on the new method by competencies.

2. OBJECTIVES.

2.1.-AREA SPECIFIES WHERE THE WORK IS DEVELOPED. Institute of technology is a public company belonging to the Federation which cater to students of higher level and where the staff as a student interacts with their environment which is the Chair with your table or Chair with your porta-cuaderno or your desk, as well as the Blackboard and / or overhead projector canon with its screen otherwise. The studies I did are based on study anthropometric pupils in a sample of 100 students of the career of engineering which means more than 95% of level of reliability and less than 4% of error which gave the following results, as well as the area of laboratory analysis of computation that she is also included in the dynamics of risk analysis of the technological. The Department or area where development work is in the laboratory of Industrial Engineering in the Department of Industrial engineering that is primarily... It is to give the pattern with other air technology and put into practice the knowledge and experience of this science or say discipline multidisciplinary and integrative in this race. where are working under the same conditions inadequate, insecure, and fully equipment for many years and had not taken into account to make decisions based on science. This is a research to justify the purchase of new furniture to be used in the classrooms of the Institute that it counts a total of 1700 between tables/chairs, desks etc, this change of furniture based on ergonomics is with the aim of securing a teaching-learning process appropriate for the student, allowing for them to have greater comfortless stress after a day of hard work and that at the time of use the classrooms have an environment adequate and equal to have a picture with an avant-garde change, ade...

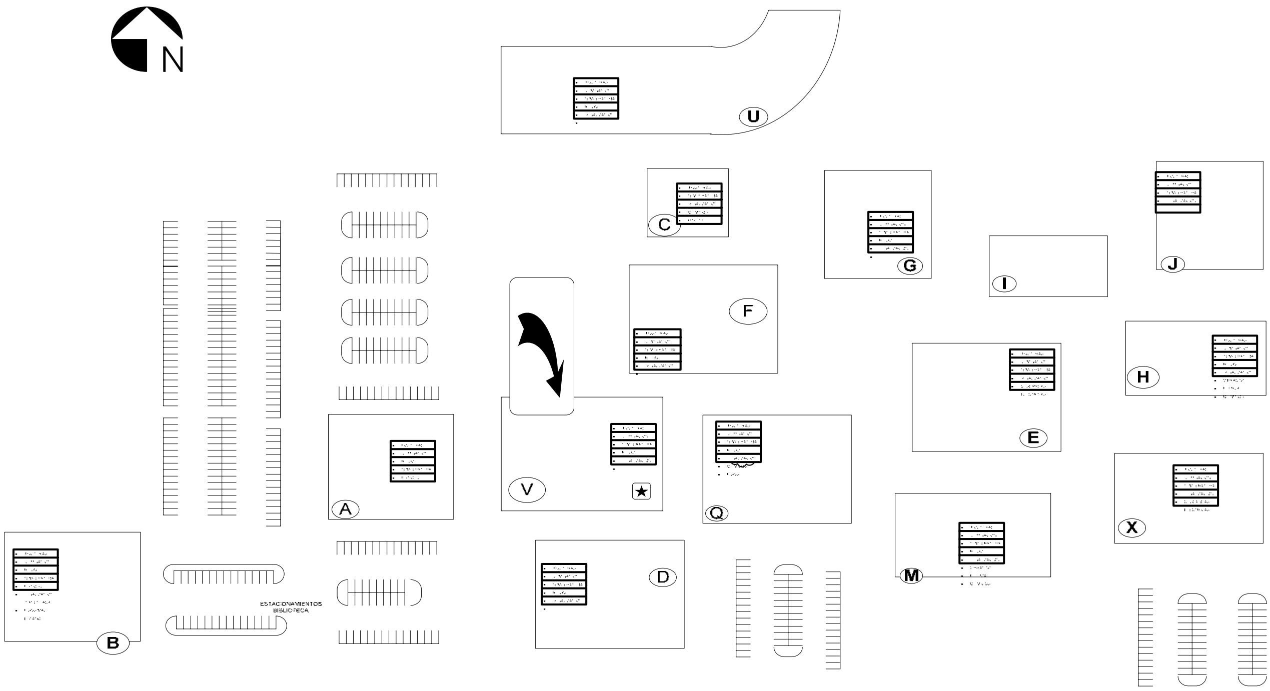
2.2. OPPORTUNITIES FOR IMPROVEMENT IDENTIFIED. Approach to the problem. On the basis of the temporary ergonomics that analyzes the working hours, duration and distribution of pauses or breaks, in the areas that were analyzed is can aware that classrooms as administrative staff need a good conditioning in every area where it is developed. Due to the need of the population of the technology have an area with a higher degree of comfort is to various analysis for a better area of attention, because, as hours of continuous use of a student in the classroom is more than 6 hrs daily, taking only 10 minutes between each class to change room Occasionally there is possibilities that a master spread her class a few minutes more of his time and this implies that students have a problem of risk of any pain in your spine, neck etc., during those 50 minutes available on the timetable of cla... Adding these average 6 hrs of exposure of the student who works, goes to work at 7: 00 a.m and comes out at 4 p.m. sitting in a chair with a monitor, and sumarizando the 9 hrs and the 6 hrs of their classes at the technological, and adding the rest of hrs in their homes are sitting in his chair and not comfortable, until bedtime doing tasks of classes, chatting, playing, etc., this would roughly 93% of his time awake they spend sitting in a wheelchair at a computer or in a desk or Chair/table, etc. And this general analysis, which I did by logic was reaffirmed at the website of the Group of researchers of Herman Miller Group., www.hermanmiller.com.mx where they specialize in designing the best furniture for offices with the purpose of reducing fatigue, stress, and the discomfort of people. Therefore the area of improvement is the technologic de Mexicali an area of opportunities to improve Ergonómicamente environment of teaching received by our customers, the student of higher technological level. In addition to the support staff that interacts in the context. So one of the reasons most determinants for change and improvement design is to change the distribution and equipment of classrooms for which is determined by the studies and research carried out in this project...

3. METHODOLOGY

3.1.ANALYSIS OF THE ERGONOMICOS RISKS IN THE DEPARTMENTS OF THE ITM IN ACCORDANCE TO THE WHOLE PLANE. To analyze the possible ergonomic risks on a daily basis are students, teachers and administrative staff to use the facilities of the Institute, the following ergonomic risks were detected according to each building and with regard to the activity that in the takes place: the types of ergonomic risks presented in the technological Institute will be defined as follows:

Positions.
Lighting.
Noise.
Temperature.
Psychological.
Bad signs.
Flats in poor condition.
Chemicals.
Hygiene (health and meals area).
Electrical.
Mechanical, such as vibration, force, etc. Stairs

FIG.LAYOUT OF THE ARCHITECTURAL PLANT OF INSTITUTO TECNOLOGICO DE MEXICALI



Building A.-the activities of this building are in administrative, keeping only your workstation and environment at a computer and your desktop.
Building B-are administrative activities of study, library, study cubicles, and classrooms for the teaching of classes.
Building D-their activities are properly combined administrative, pupils with attention to them of exposure classes and computer. BUILDING U -equally activities such as the D
Building F-activities of classrooms and computer center.
BUILDING V-administrative activities, classrooms, and laboratories

BUILDING Q-activities administrative, exhibition of classes, laboratories and computer rooms. SUBSEQUENT buildings-the rest of the buildings has the same pattern of activities with the exception of C and H.

Note: El C and H does not have classrooms.

Table of ergonomic risks of the sketch of the plant of the ITM.

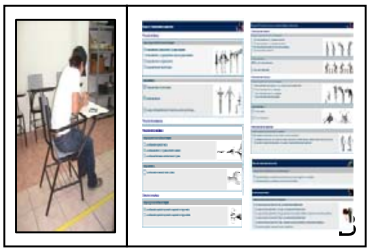
TIPO DE RIESGO	B	A	D	V	F	Q	M	E	X	U	**C	G	**I	H	J
1.	√	√	√	√	√	√	√	√	√	√		√		√	√
2.	√	√	√	√	√	√	√	√	√	√		√		√	√
3.	√	-	√	-	√	-	-	-	-	-		-		√	-
4.	√	√	√	√	√	√	√	√	√	√	√	√		√	√
5.	√	-	√	-	√	-	-	-	-	-		-		-	-
6.	√	√	√	√	√	√	√	√	√	√	√	√		√	√
7.	√	-	-	-	-	-	-	√	-	-	-	--	-	-	-
8.	-	-	-	-	-	√	√	-	√	-	√	-	-	√	-
9.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
10.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
11.	-	-	-	-	-	-	√	-	-	-	-	-	-	-	-
12.	√	-	√	-	√	-	-	-	-	√	-	√	-	-	-

This risk analysis was performed to forward to an initial variable with which we can decide the best Chair/table or desk. This research justifies the urgency that exists to change the old furniture with a new one that meets the characteristics of being adaptable, secure and with a minimal risk of suffering or cause problems in the spine, neck and back pains, or carpal tunnel syndrome, diseases that silently gestate in a classroom at not-too-distant future. If it is accepted the project for better quality of service to be used in the classrooms of the Institute, benefiting a total of 1700 individuals distributed in all its buildings covering two morning and afternoon shifts totaling to the more 3000 registered in their school enrolment. This change is intended to ensure a teaching-learning process appropriate for the student that provide a healthy environment, comfort favoring this process of... teaching-learning reaching an avant-garde system within their classrooms and with quality of life.

3.2.-ANALYSIS OF POSITIONS OF DIFFERENT TABLES/CHAIRS AND DESKS AVAILABLE AND USED AT THE INSTITUTE BY OF THE RULA METHOD

The photos are the only alternatives of table/Chair, or desk that exist in the technology which were assessed their positions and the results of evaluation of the ergonomic method "RULA", also a first option of buying also was assessed which is (F) and the following diagram shows the level of final performance that was obtained.

A



B

C

D

E

F

Table of results of RULA evaluation of different operations:

	DESCRIPTION OF THE CYCLE OR TIME OF EXPOSURE	week	Maxim frequency	I/D	and
CHAIR/TABLE (A)	Approx. One hour sitting changing within the next hours.	Approx. four hour sitting changing within the next 6 hrs	60 - 90 HRS by 4 months	left-handed	3
DESK(B)	Approx. One hour sitting changing within the next hours	Approx. 4 hrs sitting changing within the next 6 hours	60 - 90 HRS by 4 months	right Side	4
DESK(C)	Approx. One hour sitting changing within the next hours	Approx. four hour sitting changing within the next 6 hrs	60 HRS/4 months/2 YEAR		3
TABLE/CHAIR Cosco (D)	Approx. One hour sitting changing within the next		60 HRS/4 months/2	left-handed	3

	hours		YEAR		
TABLE WOOD /CHAIR (E)	Approx. One hour sitting changing within the next hours	Approx. 4 hour sitting changing within the next 6hours	60 HRS/4 months/2 YEAR	right Side	3
TABLE/CHAIR (F)	Approx. One hour sitting changing within the next hours	Approx. 4 hour sitting changing within the next 6hours	60 HRS/4 months/2 YEAR	right Side	2

3.3 ANALYSIS ANTROPOMETRIC OF THE POPULATION STUDENT OF IT MEXICALI.

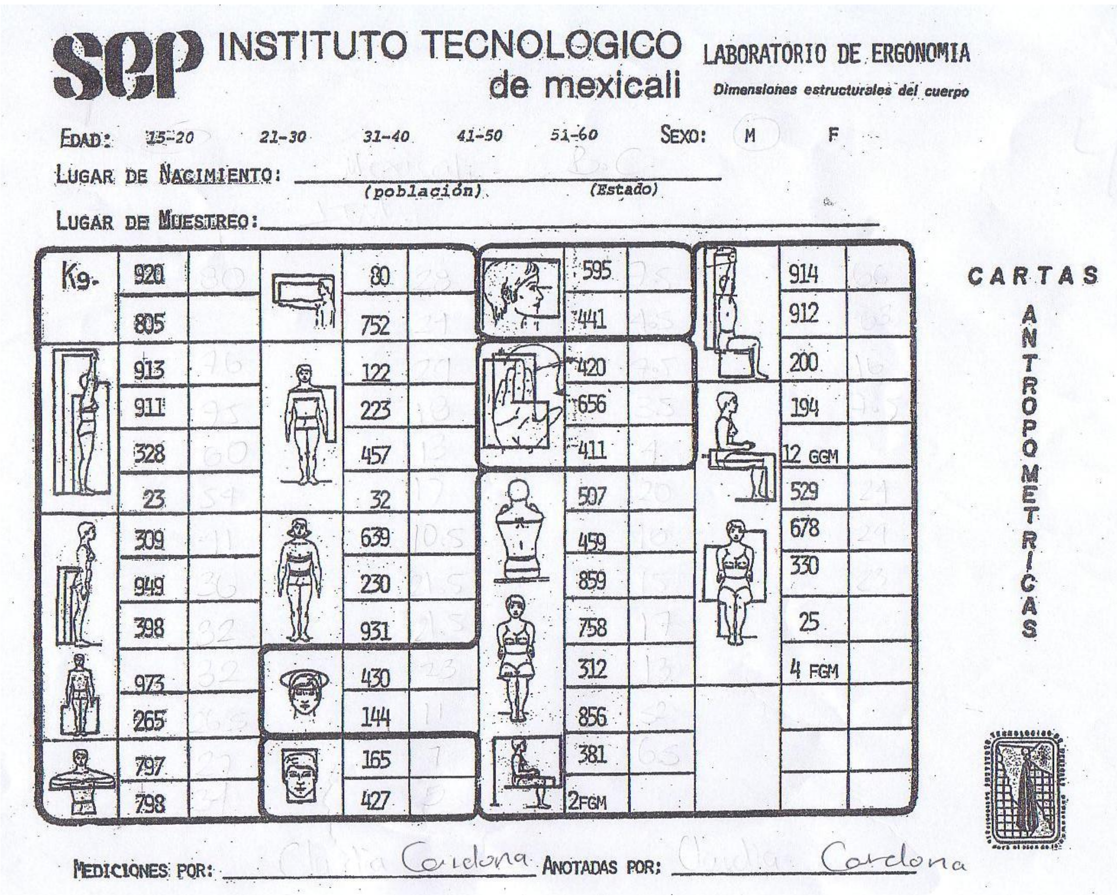
The Antropométrics analysis took place in order to visualize the requirement specific or ideal as regards real measures needs the student according to their physical characteristics, age, weight etc. To ensure the adequacy of the environment of the school user. The main objectives of the Anthropometry are the search for physical adaptation between the human body in activity and the various components of the space surrounding it. Essence of Anthropometry. Took the measures of 100 students which are assessed in statistical form representing 20% of the population of the Industrial Engineering degree or a level of reliability of more than 95% with a minimum error and for the population of 3000 students represent 3.3% of the total number of students...

AS THE PERCENTILE IS CALCULATED:

When you go to analyze a large population, you select a representative sample that should be determined by the following expression:

n = Z2 (/ 2 (2 / e2 where: (= standard deviation.))) Z (/ 2 = percentage that leaves out on either side of the interval. e = admitted Error.) To know the average and standard deviation of each dimension of the population, you can make calculations and make decisions using the following expression and whereas anthropometric data to have a normal distribution. P = X +/-Z (where: P = the percentile in centimeters or measure the interval which includes the percentage of the population.) Z = is the number of times that sigma is separated from the media.

Note: In this way took place the statistics of our population representing more than 95% reliability and an error of less than 5%, so we can say that if we take into account the total number of students of the institute technologic of 3000 only 15 pupils not can sit comfortably in this ideal of Chair according to the table shown above which we can say that 2985 students will be comfortable and comfortable in the classrooms and workshops of our Institute.



Anthropometric charter format used in the taking of measures on the sample of 100 people.

Values or measures which are of people sitting for analysis and decision-making of the ergonomic chair were only taken into account for the study. All samples are emptied in Excel and were treated statistically, finally taking the percentile of 95% which corresponds to the sizes of measures requiring the total population of the institute Technologic de Mexicali where we can be sure that only 5% of the total population at the end of the bell curve may have discomfort in use.

Structural table X. results of the dimensions of the body of students of engineering are taken as sample 100 students of ITM. These measures were taken into account when collating existing in the market or where appropriate measures can decide if sends build specifically under these conditions, this is in the hands of managers, I just submitted the options according to the study is the best child with regard to comfort, safety, ergonomic, etc. Etc., they will decide in a matter of price.

code	DESCRIPTION OF THE MEASURE .	mathematics mean	Deviation Standard	Percentile (95%)
797	WIDTH OF THE ARMS FULLY EXTENDED LATERALLY	76.93	15.78	96.3
798	WIDTH OF ELBOWS WITH THE HANDS TO THE CENTER OF THE CHEST	73.26	17.69	95
80	LENGTH OF THE ARM TO 90 DEGREES WITH RESPECT TO THE WALL	79.92	13.89	93
752	DISTANCE FROM THE WALL TO THE CENTER OF THE CUFF TO 90 DEGREES	64.66	9.82	72
507	WIDTH OF THE BACK WITH ARMS EXTENDED FORWARD	52.84	18.94	91.95
459	WIDTH OF THE HIP	42.79	19.29	78.8
859	WIDTH OF THE THIGHS WITH THE KNEES TOGETHER	46.18	16.09	71
758	HEIGHT OF THE SEAT TO THE HEAD	43.43	17.25	82
312	HEIGHT OF THE SEAT TO ELBOW TO 90 DEGREES	37.74	19.81	70
856	HEIGH THIGH.	105.13	38.10	138
381	LENGTH OF ELBOW TO 90 DEGREES TO THE MIDDLE FINGER	71.83	23.29	98
2FGM	HEIGHT OF THE HEAD TO THE GROUND	116.47	28.51	156.7
914	HEIGHT OF THE SEAT TO THE MIDDLE FINGER WITH ARMS UP	119.85	35.07	165.65
912	HEIGHT TO THE CENTER OF THE FIST, WITH YOUR ARMS UPWARDS	129.65	26.15	176
200	LENGTH OF THE FRONT OF THE KNEE	60.44	22.16	107.65

	TO THE BACK OF THE CHAIR			
194	LENGTH OF THE KNEE TO THE BACK OF THE CHAIR	52.84	20.80	84.1
12GGM	HEIGHT FROM THE FLOOR TO THE TOP OF MUSLO SITTING	59.73	13.77	77.55
529	HEIGHT FROM THE GROUND TO THE KNEE	47.26	20.11	70
678	HEIGHT FROM THE GROUND TO THE PART ABOVE THE KNEE	58.74	15.62	80.3
330	HEIGHT OF THE SEAT TO THE EYES	62.62	12.43	77.4
25	THE SEAT TO SHOULDER HEIGHT	56.63	9.85	76.4
4FGM	HEIGHT FROM THE FLOOR TO THE SEAT	43.26	9.97	61.7

Anthropometric letter format used in

the

3.4.-SURVEY FOR THE EVALUATION OF CONTROLS ERGONOMICOS OF PRACTICAL WORK IN THE SYSTEM MAN / MACHINE. IN THE ITMXCLI.

** Survey conducted with a sample of 200 students who were working with a monitor on a daily basis in the technology in the different buildings, classrooms, laboratories and took the questionnaire of the University of Berkeley.

1. Number del usuries:
2. Telephone: Fecha:
3. Hours a day working at a computer description of work tasks in computer
4. **Is his chair adjustable?si no**

Its Chair supports the lower part of your back? Do you have space between the edge of the front of the seat and the rear part of the seat? ___ ___

5. Can you easily reach their things work without interference from the arms of his chair?
6. His arms and shoulders are relaxed and not forced in a position uncomfortable by the arms of the Chair? ___ ___
7. Rest your feet completely on the floor or foot rests with your knees bent at a 90 degree angle?

If your answer is "NO" to any of the questions above, you may need to change Ergonomics Sitting with his feet placed on the floor (or in a resting feet) will help support your spine. To have your thighs parallel to the seat with your knees bent in a 90 degree angle approximately, and have space right behind his knees, avoid that the Chair will interfere with blood circulation in your legs If the back of your Chair is adjustable, raise or lower it so that the contour of the Chair provide maximum lumbar support (back of the waist). If possible, adjust the inclination of the backrest to support your body in an upright position. A slight angle, either forward or backward, is also acceptable. Adjust the Chair according to whatever is comfortable for you. If your Chair has arms, these should allow you be closer to their things work without blocking him. The arms of the Chair should not force him to raise his shoulders or keep the arms out of the sides.

Recommendation:

- Get new Chair, adjustable height and reclining seat and backrest. Computer users must be able to adjust the chairs with just sitting without using tools. The arms of the seat or Chair, if you have them, must be mobile (remove and put on).
- Exchange within the Department chairs
- Add a cushion of support lumbar if the Chair is not provided adequate support for the waist.
- Add a resting feet if the foot of the user's computer do not rest firm and comfortably on the floor
- Other (Please describe them).

TABLE OF RESULTS IN EACH OF THE ANSWERS WERE PRESENTED THE FOLLOWING PERCENTAGES

1. Ergonomic change	**64% said at least one not**	☐
2. Adjustment of The surfed	**48% said at least one not**	☐
3.AjusteMonitor/screen	**40% said at least one not**	
4. fitting accessories	**24% said at least one not**	
5.Reduccionde shine/reflection	**22% said at least one not**	
6.Practicas of work	**33% said at least one not**	

Conclusion of this study it was determined that as regards an Ergonomic improvement in the design of the seat who met with the two percentages most high is urgent by the user. THIS IS CONTROL ENGINEERING FEATURES.
Note: Does not include the entire text of the survey by only taking what corresponded to the evaluation of the seat, but however in the table was done on the basis of all results for each part of the survey

3.5. Ergonomic guidelines in the Office or area of action or work
The main function of the ergonomics is the adaptation of machines and jobs to the man. For the ergonomic analysis of jobs in officinal y and/or educational spaces or classrooms of teaching, so

we'll call updated working environment of the student and will depart from the study of the following factors that if they correspond to our study:

- Dimensions of the post.
- Working posture.
- Requirements of the environmental comfort

Given that the positions and natural movements they are essential to an effective job, it is important that workplace adapts to body dimensions of the operator, however, before the variety of sizes of individuals is a difficult problem to solve.
For the design of workplaces, it is not enough to think about making them for people of average size (50 percentile), it is more logical and correct to take into account individuals of greater stature to limit dimensions, for example the space to allocate for the legs under the table, and shorter individuals to limit the size of the areas of scope in horizontal plane. (Percentile is 95 - 5).
As well, to establish the essential dimensions of a job of Office, or care or work space in class, we will take into account the following criteria:

- Height of the level of work.
- Space reserved for the legs.
- Optimal scope zones of the working area.
- Height of the level of work

The determination of the height of the level of work is very important for the conception of the jobs, because if it is too high we will have to lift the back with the consequent pain in the homoplastic, if on the contrary it is too low causing the back bending over normal creating pain in the muscles of the back.
It is therefore necessary that the level of work is situated at a height appropriate to the size of the operator or student, either in work sitting or feet is in a laboratory. But for the study is laid. For a sitting job, the optimum height of the level of work will depend on the type of work to be done, if it requires some precision, if you are going to use typewriter, if there are requirements of visual type or requires a sustained effort. If the work requires the use of typewriter and a great freedom of movement is necessary that the level of work is located at the height of the elbows; the level of the level of work given us the height of the machine, therefore the height of the desk should be a little lower than the height of the elbows.
If on the other hand work is Office, reading and writing, the height of the level of work will be placed at the height of the elbows, bearing in mind choose the height for people of larger size because others can adapt the height adjustable chairs.
The heights of the level of work recommended for sitting work shall be those indicated in Figure 1 for different types of work

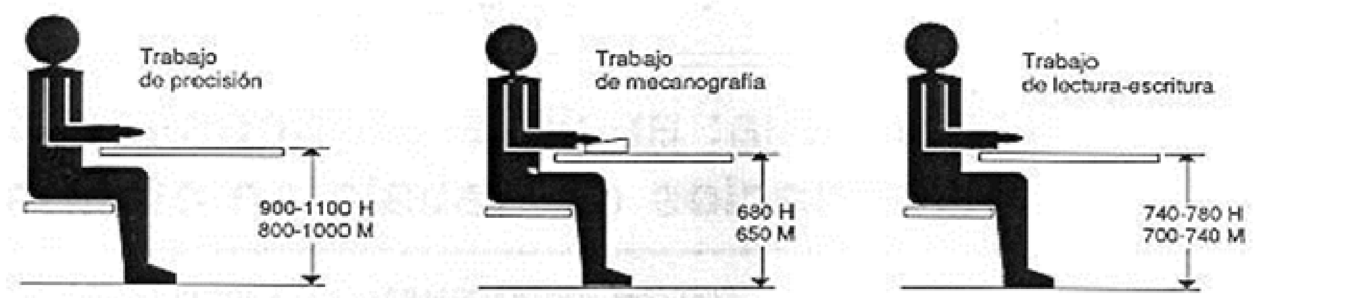


Fig. 1: Height of the level of work for sitting jobs (dimensions in mm) optimal scope zones of the working area

A good provision of elements to manipulate in the workspace will force us not to carry out forced movements of the trunk with the consequent problems of back pain. Both in the vertical plane and the horizontal, we must determine what the optimal distances get proper postural comfort, and are given in figures 3 and 4 for the vertical plane and horizontal, respectively.

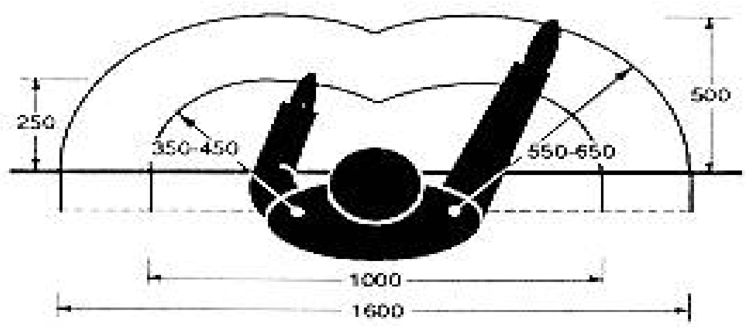


Fig. 3: Horizontal Arch of scope of the arm and workspace on a table (dimensions in mm)

Working not for the mere fact of sitting posture can say that position is comfortable; however, it is true that a foot working position implies a static muscle effort of feet and legs which disappears when we sat down. This has led to the increase in the number of sitting jobs, reaching approximately in Izard's industrial countries, three-quarters of the population active. However, not all are sitting labor advantages. There are drawbacks for the prolonged maintenance of the position, inconveniences resulting in problems that primarily affect the back. To get a correct working posture we will depart from the analysis of criteria related to the basic equipment, which includes:

Spa.
Desk Chair
Chair for Office
They are not covered by this study armrests.
They are not covered in this study

Desk Chair is evident to the relative comfort and the functional utility of chairs and seating are a consequence of its design in relation to the physical structure and mechanics of the human body. The different chairs and seats, and the individual dimensions uses require specific designs; however, there are certain general lines to help choose appropriate designs to work to perform. The ergonomic design of a Chair for Office work has to meet a number of design features and data: the seat will respond to the following characteristics:

- Adjustable height (in sitting position) margin adjustment between 380 and 500 mm.
- Width between 400 - 450 mm.
- Depth between 380 and 420 mm.
- Padding of 20 mm.
- Coated with flexible and breathable fabric.
- Slopping front edge (large radius of inclination).

The choice of support will be based on the existing in the market, high backups and/or low backs. Low support should be adjustable in height and inclination and get the correct support of the lumbar vertebrae. The dimensions will be:

Padding of 20 mm. coated with flexible and breathable fabric. Shopping front edge (large radius of inclination).The choice of support will be based on the existing in the market, high backups and/or low backs. A low back must be adjustable in height and inclination and get the correct support of the lumbar vertebrae

The dimensions serum:

- Anchor 400 - 450 mm.
- Alturas 250 - 300 mm.
- get adjusted 150 - 250 mm

High support should allow the lumbar support and be adjustable in inclination, with the following features:

- tilt back made 15 °.
- Width 300 - 350 mm.
- Height 450 - 500 mm.
- Equal to the seat material.

High backups allow full support of the back and therefore the possibility of relax muscles and reduce fatigue. The groundswell of support for the Chair must ensure a proper stability of the same and therefore will have five arms with wheels that allow freedom of movement. The length of the arms will be at least equal to the (380-450 mm) seat.

- A good desk desks should facilitate the proper development of the task;
- Therefore, when choosing a table for Office work, will have to demand that it meets the following requirements: If the height is fixed, this will be of approximately 700 mm.

- If the height is adjustable, the extent of regulation will be between 680 and 700 mm.
- The minimum area is 1,200 mm wide and 800 mm long.
- The thickness should not exceed 30 mm.
- The surface will be mate material and clear pale, rejecting the bright and dark surfaces.
- It will allow the placement and changes of position of the legs.

Requirements of the environmental comfort, A large group of factors that can influence, and in fact influencing the design of workplaces, are environmental factors. The working environment must maintain a direct relationship with the individual and ensure that environmental factors are within the limits of comfort in order to achieve a degree of well-being and satisfaction. The following have been elected as environmental factors in study:

Lighting.

Noise.

Temperature.

^ ERGONOMICS controls implemented at the Institute TECNOLOGICO in the aspect of environmental comfort, analyze in the analysis of ergonomic risks in each of the buildings of the Institute which were the appropriate lighting, apply control administrative ergonomic, through preventive and corrective maintenance for the detection of change of fixtures and balastras at the time where required for classrooms or laboratories

Noise minimum, control that takes place is to have the students out of the corridors of the buildings through the security guards and the corresponding prefect

The temperature in our city is indispensable and vitally important to have and keep the airs conditioned in perfect conditions as temperatures become to 52 degrees Celsius maximum, and teams usually 45 to 50 degrees, usually ranging from the months of April to October. An ergonomic analysis of depth in this area is therefore obvio.el wear, discomfort, diseases caused by the lack of environmental conditions in the classroom. Laboratories and offices of he technological.

Advance this aspect is taken care of and is controlled by various parameters of assistance for the delivery of classes.

3.6.. BASED ON THE EDUCATIONAL MODEL IN THE TECHNOLOGICAL SYSTEM.

In this part it's stress as part of one of the variables we have one subject to decision of the technological equipment is our scheme of educational models, the Individual and based competition of the teamwork described broadly as follows:

Competition and performance-the concept of competition varies, depending on the angle from which you look or the emphasis given to one or another element, but the most widespread and accepted is "Know-how in a context"".

Competencies are expressed in its most expeditiously in the performance. Maurino and collaborators propose a taxonomy that includes three levels of human performance-based:

- Skills widely practical and scheduled tasks.
- Rules preset in a modified and planned situation. Knowledge (compression) and use of techniques for the resolution of problems and to find solutions to new situations.

Performance based on skills and/or rules can be individual.

4. RESULTS.

4.1. CRITERIA FOR THE DECISION MAKING OF THE BEST OPTION.

ESTABLISHED CRITERIA TO ASSESS DECISION-MAKING OF DECISIONS AS TO THE BEST CHOICE OF THE SEAT OF SCHOOL OR STUDENT, DESK SCHOOL, TABLE OF WORK/CHAIR, ETC

A.-RULA:

NIVEL 1. IS THAT OBTAINED THE LOWEST SCORE IN THE A LEVEL ACTING IN ITS STANCE THAT WAS OF 2.

NIVEL 2. IS THAT OBTAINED THE ACTING LEVEL SCORE OF 3

B.- ANTROPOMETRIA:

NIVEL 1.- IS HAS THE MEASURES MORE CLOSE TO THE REQUIRED PERCENTILE.

NIVEL 2.- IS THE MEASURES APPROPRIATE FOR THE AVERAGE OF THE SAMPLE THAT IS VOLUME.

C.- The risk of ERGONOMICOS: FOR ALL GUI IS.TO THE ACTIVITIES ARE THE SAME

.

D.- OPINION POLL_; PROBE COLLOQUIAL,

NIVEL 1. IT COMPLIES WITH THE HEIGHT OF THE WORKING AREA, THE EXTENT OF THE BUREAU OF WORKING CONDITIONS OF WORK REQUIRED BY THE STUDENT.

NIVEL 2. IT FAIRLY MEETS THE REQUIRED CONDITIONS OF AREA OF WORK.

NIVEL 3. IT MEETS THE REQUIRED CONDITIONS OF AREA OF WORK AS NECESSARY

E-TEACHING-LEARNING METHODOLOGIES:

NIVEL 1 if; whether;

NIVEL 2 If not

TABLE OF CRITERIA ERGONOMICS.

	Rula A	Antropométricos B	Análisis de riesgos C	Practice of the user survey D	Methodology of teaching competencies E
1	1	2	equal	2	1
2	2	2	✓	3	2
3	2	2	✓	3	2
4	1	1	✓	1	1
5	1	1	✓	1	1

5. DISCUSSIONS/CONCLUSIONS.

5.1.1 ANALYSIS COST/BENEFIT OF DIFFERENT CHOICES OF THE MARKET.

Searched several alternatives all based on anthropometric data which I throw the study of the measures of the students of Industrial Engineering sample, and where you can have the feasibility to the context of the accounting system of the technological institutes which was indtrillas@oficentro.com.mx
by legal issues it has to be done in this way, and we find the following features in terms of the cost and its technical option.
In search of options for decision in the choice or present several options the student furniture options were presented the following 5:

1.-the scheme of the first photo of Chair with hexagonal table which resulted from the analysis of the Rula the less risky positions of the evaluated within this is the plastic chair featured in the photo you added,.

2.-The desk that has the feature of sending build under conditions which I am presenting the study Antropométrics

3. The desk that has the option to upload the seat to the conditions of the student to use.

4. The plastic chair which has fitted out for the lumbar support curvature. With its hexagonal table that fills the requirements of working in a team and also work, that attaching the table with each other forming the different options of dynamic group used

5.-The Chair feels very comfortable by your lumbar support and the trapezoidal table meets the requirements required of teaching and learning, as well as presenting the same characteristics of the table no. 4, also showing the optional sketch in the figures below.

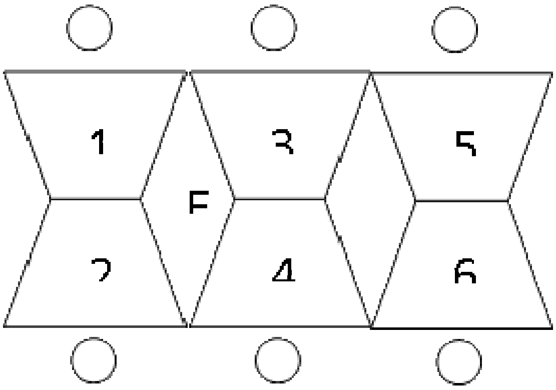
OPCION 1

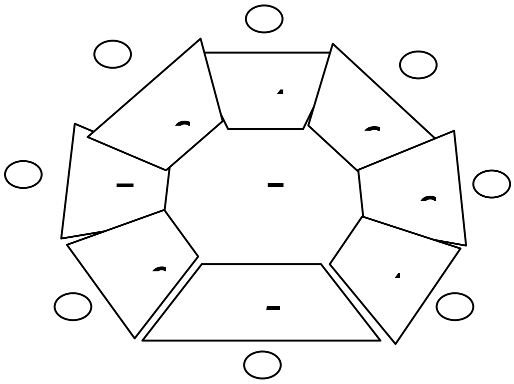
OPCION 3.-

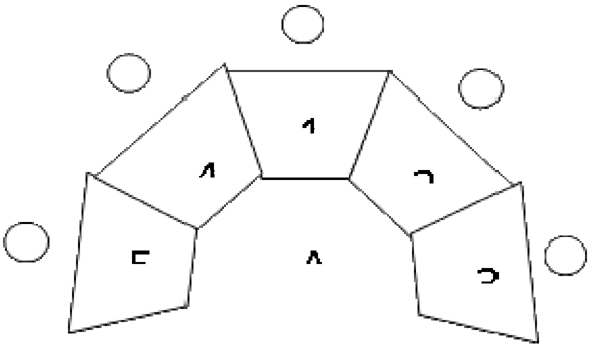
OPCION 2.-

OPCION 4

OPCION 5







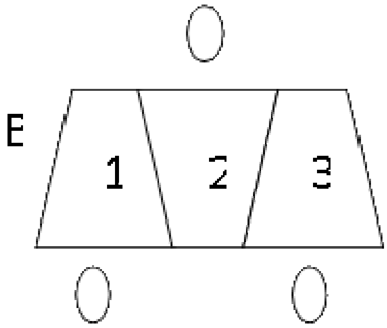


TABLE OF COSTS OF CHAIR/TABLE OF AGREEMENT TO THE PHOTOS SHOWN ABOVE:

Rate suite.	Whole in all	cash on delivery	law warranty	EV.ERGO
1	639.00PESOS	20 DIAS HABILES	5 MESES	3
2	875.00 PESOS	30 DIAS HABILES	UN ANO	4
3	1300.00 PESOS	25 DIAS HABILES	UN ANO	5
4	**1089.00 PESOS**	**15 DIAS HABILES**	**10 ANOS**	**2**
5	**985.32 PESOS**	**15 DIAS HABILES**	**12ANOS**	**1**

Model 4 and 5 is the most viable for its most outstanding qualities in terms of functionality, and because it can engage and disengage introducing flexibility in the dynamic individual and group for the provision of classes and even for internships in the classroom, the cost is Administration's decision. And it is as follows:


OPCION 5


OPCION 4

5.2. The cost of not having this desk or school seat more ergonomic: really seems in the technology that there is no benefit, because it redituaría only the learner but benefit in time which will not be within the Institute when either graduate will be the benefits already that according to a study all the discomfort of not having a proper seat at work or school attention you begin to feel the years of stand before this system human-machine and unfavorable environment.

There are no statistics or reports about incidents of pupils in question of lumbago, cervical, etc., there are institutional insurance, when student enroll have to register in the IMSS by law and the only medical service is offered for inconvenience as headache, influenza etc. Etc. And when there is something else the student goes to the consultation of IMSS. So he could not give or have any statistics to provide us some variables taken into account for the assessment of the project.

5.3.- DECISION-MAKING OF THE PURCHASE OF THE OPTION 5.

The perform this project that since several months had in mind carrying it out and face the adverse circumstances in this environment took the decision to make the purchase equip all the buildings of the technological with the option. to make such projects as soon as possible will be implemented.

The knowledge that we have to take into account all the variables or the greater number of variables that we they arise and/or that we must seek to solve the problems that will confront us as human beings, and especially based on all disciplines or science that you are the responsibility of the well-being, security, care and psychological worldwide maintenance, because every time we are more exposed to ergonomic risks that we are belatedly account already there and it's too late trying to avoid them, and this is reflected in an unfortunate disease.

To avoid reaching this point has no return must focus on our family and social environment first meet him, that if we have no ergonomic chair or what more like comfortable, comfortable, etc., although cost us a little more start thinking about our own welfare and hence to us with the technique, the ergonomics guidelines in our work for more studies and printable them so that benefit most of our working environment, start at home as this is my case for my project.

The biggest concern of us as teachers is and should be our best customer student and we provide not only the guidance of knowledge if not also a bit of our experience to improve their environment while they pass through our classrooms and that tomorrow will be less problems of back pain due to poor posture which had endured for more than five years that not realized because we had as administrative or management the opportunity to make a decision with respect to this and not so peso or value as important that we are as human beings.

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APPLICATION OF ERGONOMIC PRINCIPLES IN TO THE GRAPHIC DESIGN PROJECTS

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Resumen: La asignatura de ergonomía es parte de los programas educativos de diseño de la UACJ, esta es impartida en los niveles principiantes. Se ha detectado que en los proyectos finales de estudiantes de semestres avanzados se aplica muy poco o casi nada los conocimientos ergonómicos. La intención de este trabajo fue de fomentar la aplicación de los principios de ergonomía a proyectos finales de estudiantes de semestres avanzados en la carrera de diseño gráfico de la UACJ, de tal manera que estos se dieran cuenta que los conocimientos aprendidos en semestres anteriores en referencia a factores humanos son de alta prioridad para que sean aplicados en su producción gráfica, tanto en estos trabajos finales como para después ya en el ejercicio de su profesión, que hay que darse cuenta que de esta aplicación puede depender en gran medida el éxito o fracaso de su producción como diseñadores.

Palabras clave: Ergonomía, Factores Humanos, Diseño, Diseño Gráfico,

Abstract: Ergonomics is one of the classes which is part of the curricula of the design educative programs in the UACJ and is being taught on the beginners or basic levels. It has been detected that when the final projects of the students at senior or advanced levels are developed, these projects does not use anything or almost nothing of the ergonomic knowledge learned on early semesters. The intention of this work was to promote the application of the ergonomics principles on the final projects made by the students of the graphic design program of the UACJ., likewise that the students understand the importance to integrate the elements that affect the human factors in their design projects, but not only on the actual projects, but also thinking on those that will be developed when they are professionals. They must recognize that the success or failure of their future design production could depend on the application of ergonomics principles.

Key Words: Ergonomics, Human Factors, Design, Graphic Design

1. INTRODUCTION

The lack of knowledge about ergonomic principles when graphic design projects are being developed can lead to negative effect in the users. When visual education systems are designed, cognitive ergonomic principles should be considered with the main objective to allow the users to correctly assimilate the presented information in a quick and precise manner. Psychology of colors, legibility, and presentation of visual information are critical tools to achieve this assimilation.

Since, ergonomics, it is a holistic concept, this essay is being focused to the application of ergonomics principles to the tasks of graphic design related with presentation of information, for our case, information concerning to the acquisition of good reading habits for children, correct postures at school or work, behavior towards industrial safety, and location of buildings areas. We recognize that a fast assimilation of information, save time, effort and promote motivation in the people that observe any graphic design product (posters, announcements, movies, etc.).

2. PROBLEM DEFINITION

The Design students, whichever the area they belong (industrial, interiors and Graphics) are not truly familiar with the applications of the ergonomic principles when final projects are being developed. Recently, through some professors surveys (Soto Nogueira, 2009) discouraging results were found as follows: a) When students of Industrial Design develop their final projects and make the prototypes (working samples) they did use very little or not at all the knowledge of ergonomic principles acquired in the class of ergonomics, they focused mainly on the aesthetic and cosmetic issues, appearance or they just use their common sense. b) The study on the other hand, showed that the students are conscious and understand well that human factors are relevant elements on their designs, but they accept that are not sure enough how to apply them, they felt that extra information or more skills are required to do that. c) Students mentioned and complained in the survey, that the class of ergonomics was not focused in the design of objects, was more directed to designs of work areas or products related with manufacturing environments.

3. PURPOSE

The primarily objective of this work was the development of a true way of thinking on the students of intermediate level of the graphic design program at the Universidad Autónoma de Ciudad Juárez to apply ergonomics principles into their final year end projects, but most important to them, understand the significance of the positive effects on users when these principles are well applied in their graphic production.

4. DEVELOPMENT

This work was developed during one complete semester in the class of Laboratory of design. Every student in this period was working in new projects with the direction of being practical, innovative and with ergonomics principles applied, concepts than never before were used on their products. The development of projects was made under the scientific methodology trying always to combine both theories of graphic design and ergonomics.

Concepts and definitions were taken into account according with each application, such is the case of: Semiotics, theory of colors, legibility principles, industrial safety, cognitive ergonomics and reading habits.

The Basic definitions of graphic design and ergonomics were as follows:

The school of arts (2010) defines graphic design as “a discipline that pretend satisfy specific needs of visual communication by means of configuration, structuring and systematizing messages with certain meaning referred to its social environment. All this implies that the messages must be understandable in such a way that the persons to whom are directed do not have to decipher the purpose for what they were designed".

The IES (International Ergonomics Society 2010) defines ergonomics as "a scientific discipline related with the understanding of the interaction between persons and other elements of a system. Also, is considered as the profession that applies theory, principles, data and methodologies to design for the optimization of the human welfare and the performance of the system. Thru Ergonomics, tools, machinery, products, work stations and everything that interacts with persons are designed and modified always taking into consideration the human factors and psychology of final product users. With ergonomics designs products users must have products that give them healthy and comfortable interactions.

4.1 Cognitive ergonomics

Cognitive ergonomics it is a concept that also takes part in a very special way in any design project, more if products are graphic production. Cognitive ergonomics is the science that adjusts cognitive skills (perception, learning, memory and capacity to respond) and their limitations to machinery, tools, tasks, labor environment, etc.

In graphic design, become vital its implementation, the cognitive factor avoids catastrophic errors when a machine is operated or when people performs dangerous tasks. An example of this is as follows: In Figure 1 is illustrated a bad design of a measurement device. The graphics used were very simple and were not considered in any sense the human factor, the meter do not show limits, dangerous zones, specification, and on top of these problems the graphic shows fractional settings.

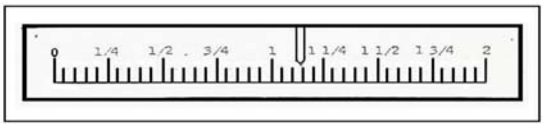

Figure 1: Measurement device (pressure meter)

On the other hand we have on Figure 2, another measurement device which performs the same visual information, but on this we can observe how different the information it is displayed. Visually we can interpret when a value is out of range or if the measurement means a danger, and with the numbers well defined can be avoided misinterpretations when read.

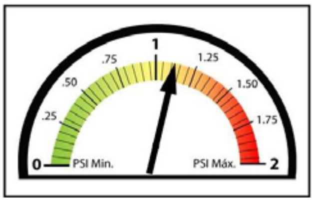

Figure 2: Measurement device (pressure meter)

All graphic production must show the designer intention. Options and applications specifically on cognitive ergonomic principles have multiple choices. In general graphic designers have the opportunity to use ergonomics on any of their specialties such as Industrial and labor environment, Marketing, packing, publicity, social programs, etc.

4.2 Semiotics

Semiotics or Semiology is an auxiliary discipline to graphic design. On its production, graphic design use methodologies of this discipline to study and develop communication based on symbols and signs to provide guidance, orientation, behaviors, motivation to buy things, or travel, etc., all this to be displayed in shopping centers, airports, factories, schools, offices, etc. Also, several graphic productions are used in manuals and booklets that provide information to users about products, processes, machinery or equipments.

Applied ergonomics when signs and symbols are used, means that the correct usage of color, legibility and clarity into the texts are integrated, and become irreplaceable when graphic production is being developed. As a remaining that ergonomics always is looking for the healthy and comfortable interaction for the user. Figure 3 shows different communication posters that included signs and symbols used on factories or business as a safety measurement or as a part of safety procedures. On these posters signs and symbols communicate information, orientation and warning of a danger or the notice of obligatory usage of a safety device.

Figure 3: Semiotics applied to safety information

Other type of graphic production (posters) promotes an action of thinking. On Figure 4 signs and symbols are integrated with a mental interaction of the users by mean of texts and interpretation of these signs and symbols

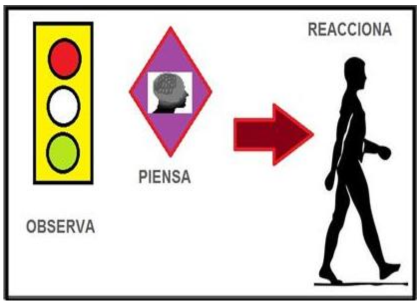

Figure 4: Semiotics applied in publicity to prevent accidents

In reference to graphic production for this study, the projects to be developed by the students, should contain not only what the customers are interested or something very attractive to the view, projects should also comply with the objective of applying ergonomics principles to them.

5. RESULTS

5.1 Directory – Map

An application where Semiology and Ergonomics were mixed, was the making of a locations map (also called "infogram"), corresponding to buildings and areas belonging to the Architecture, Design and Arts Institute of the University of the City of Juárez. This map previously did not exist, and then here was the opportunity to be developed under cognitive ergonomics principles and the marketing side of the graphic design. The result was a very attractive visual map, very useful for users, since a lot of time and effort are being saved when they look for specific areas. Figure 5, shows the map with all elements, roads and entrances clearly specified. Each building or area is identified with a letter which is part of a list of descriptions of each one of the elements located on the bottom part of the map, then the letters on the list are surrounded by a square, and this square is colored in accordance with the colors of the referred area or building.

This combination of visual effects and cognitive arrangement of elements allows the user (visitors) to facilitate the understanding of a place that never has been in there. Four maps were fabricated and installed in the four entrances of the Institute, this visual aid has had very good acceptance from the visitors.

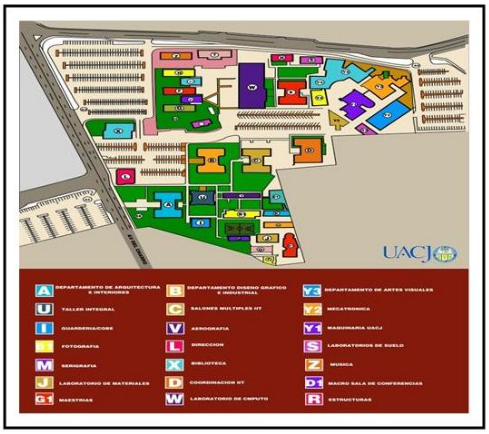

Figure 5: Directory Map
UACJ Institute of Architecture, Design and Art

5.2 Implementation of a reading program on a primary public school

Students of the class in conjunction with the charitable branch of the association of businessmen of the State of Chihuahua, implemented a pilot child development project with the purpose to increase the liking for reading. The school designated as Gabino Barreda was the place where the project took place, under the umbrella of a big program named “Helping child development” and sponsored by the mentioned association.

The project included social activities such as formal talks and diverse surveys with parents, teachers and children with two main purposes: First, for them to become aware of the benefits of the project and secondly for the students to use the information acquired during the talks as the main source of ideas and concepts to design and develop the graphic information, in such a way that this visual product could be attractive enough to be permanently displayed. The result was the poster shown on Figure 6.

Figure 5: Final design of the Poster for the project of reading

The conversations and talks promoted a lot of interest on the children population, but the impact of the visual information on the poster was more powerful, in such a way, that the children by themselves started to design and develop their own posters to invite others to read and obtain benefits when this happens. Later on, the school principal promoted a poster contest with diplomas to the participants and a price for the winner. Likewise, the students modified the covers of several fairy tales using very nice colors and materials textures with the objective that the books were attractive to the children by mean not only by name and content but by mean of the senses (touch and view).

In this project, ergonomics and graphic design are together, colors that do not bother the sense, that be nice to look, very visible and legible texts, background and its color in accordance with the signs, shapes, figures, colors and thematic, letters size and textures, all this are elements that any graphic production should take into consideration.

5.3 Promoting ergonomics through graphic design

In graphic design, publicity campaigns is one of the most relevant areas to work, then, when health campaigns are being developed or when good healthy habits wanted to be promoted, is the time and the best opportunity to apply ergonomic principles. For this case, the students developed a campaign called “keep you ergonomics” that was published on a social network (Facebook) in benefit of the student community. The following figures are just two examples of the work made by the graphic design students as a part this campaign. Figure 3 shows the correct posture when a person is performing a work in a computer.

Figure 3: Graphic design promoting ergonomics (postures)

The second example is illustrated on Figure 4, which shows a series of relaxing exercises, these exercises were recommended to the student community to be performed at the start of any activity of the day or in between activities.

Figure 4: Graphic design promoting ergonomics (relaxation exercises)

The design and development of this campaign made by the students had a basis on the knowledge of ergonomic principles and theory related.

6. CONCLUSIONS

The importance of applying ergonomics into the production of graphic design has no questions or doubts; ergonomics is a real auxiliary discipline that professionals of the graphic design should not to forget.

The usage of ergonomics principles into the graphic production allows the users to have a better understanding of the visual messages and their meaning. Instructions, procedures, programs, etc, can be more understandable and with more sense.

Emphasize the need on the students and professionals of graphic design to introduce the human factors element in to their design projects. The consideration of physical and physiology factors will result in a better interaction between products and users.

Interaction becomes more important when social aspect is the thematic of the projects. Clear examples are those related with health, attitudes changes (environment, life, etc,), old or handicapped people.

Application of ergonomics in to the graphic design consists in finding the exact, understandable, and legible information, as well the proper usage of harmonious colors, optimum visual paths and reading patterns.

To the professionals and students of graphic design follow the recommendation of a specialist (Costa, 2011), "Designing for the eyes is designing for the brain".

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RISK ANALYSIS OF CUMULATIVE TRAUMA DISORDERS OF UPPER LIMB MUSCULOSKELETAL FOR MUNICIPAL EMPLOYEES OF A CITY FLEA.

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RESUMEN
En la industria el daño músculo-esquelético de las extremidades superiores representan uno de los accidentes de trabajo más comunes. Las actividades de trabajo que normalmente requieren movimientos repetitivos son las extremidades superiores, bajo ciertas condiciones ofrecen un riesgo potencial. El objetivo de este trabajo es analizar la relación que existe entre la aparición de la DTAME en miembro superior y la fatiga con la disminución de la productividad en un rastro municipal, para lo cual incluía los 31 trabajadores involucrados en el sacrificio de ganado bovino. La metodología consistió en la aplicación del método OCRA para la codificación y así poder evaluar los factores de riesgo al que están expuestos los trabajadores en el desempeño de diferentes tareas y operaciones que se realizan en la línea de ganado vacuno. El estudio se llevó a cabo es un estudio descriptivo, transversal y de campo. La aplicación del método OCRA demostró que dentro de la cadena de suministro hay 2 actividades que presenten un riesgo muy alto de DTAME para los trabajadores, a saber: Fase "I" el funcionamiento del proceso llamado "Desollado" y la segunda operación llamada "H", "Extracción de la cabeza". El primero con una puntuación de 23 y el segundo con una puntuación de 14 sobre una escala de 0 a 23. En el primer caso requiere una acción inmediata para reducir los factores de riesgo, mientras que el segundo sugiere una intervención planificada en el corto plazo. El análisis de los resultados confirma la hipótesis de que la incidencia de problemas musculoesqueléticos y la acumulación de fatiga, en las operaciones de alto riesgo, obviamente impacta en la productividad del proceso en la línea de sacrificio de ganado bovino.

Palabras clave. - Movimientos repetitivos músculo-esqueléticos, OCRA

Abstract

In industry the damage of upper extremity musculoskeletal represent one of the most common workplace injuries. Work activities that usually require repetitive movements and exercises of the upper extremities, under certain conditions offer a potential risk. The objective of this work is to analyze the relationship present the occurrence of the upper limb DTAME and fatigue with decreased productivity in a municipal slaughterhouse, for which included the 31 workers involved in the slaughter cattle trail. The methodology involved the application of OCRA method for encoding and evaluate the risk factors to which workers are exposed while performing different tasks and operations performed in the line of cattle. The study was conducted is a descriptive, transversal and field. The application of OCRA method showed that within the supply chain there

are 2 activities that pose very high risk of DTAME for workers, namely: Phase "I" operation of the process called "skinning" and the second operation called "H" "Removing the head. "The first with a score of 23 and the second with a score of 14 on a scale of 0 to 23. For the former requires immediate action to reduce risk factors, while the second suggests a planned intervention in the short term. The analysis of the results confirms the hypothesis that the incidence of musculoskeletal problems and the accumulation of fatigue, in operations with high risk, obviously impacts the productivity of the process in the slaughter line of cattle.
Keywords. – Musculoskeletal, Repetitive movements, OCRA

INTRODUCTION

In industry the damage of upper extremity musculoskeletal represent one of the most common workplace injuries. Work activities that usually require repetitive movements and exercises of the upper extremities, under certain conditions offer a potential risk. In recent years, industrial activities face significant changes related accidents and illnesses. Found, the upper extremities first place of employment in accordance with the statistics set out in the memories of the IMSS in your information on accidents and occupational diseases national 2008-2010. The anatomic region most affected is that which is understood as "wrist and hand." In the municipal slaughterhouse note that the jobs in each stage of the production process, there are tasks in which they are presented: manual handling of loads, awkward postures and repetitive movements (Villegas, 2009).

With regard to repetitive movements, it is understood by them to "a group of continuous movements, maintained for a job that involves the same set osteo in the same muscle causing muscle fatigue, overload, pain and ultimately damage" ("Health Surveillance Protocols Specific: Repeated movements. "Ministry of Health. 2000).

The most accepted definition of repeatability is to Silverstein, indicating that the work is considered repeated when the duration of essential duty cycle is less than 30 seconds (Silverstein et al, 1986). The rework of the upper limb is defined as the continuous realization of similar duty cycles, each work cycle looks like this in the time sequence in the pattern of forces and spatial characteristics of the movement.

The injuries associated with repetitive work, as well as repeatability are a number of factors that interact with the repetition and duration of work cycles, increasing the risk of injury and fatigue. So much so that the force and repetition interact so that the rise both increase the risk multiplicatively.

Both the experimental and epidemiologic indicate that awkward postures increase the risk of injury, also the high speeds of movement and duration of exposure of minutes per day and the exposure time in years to realize it.

OBJECTIVE

Analyze the relationship presented DTAME the occurrence of upper limb fatigue and the declining productivity in a municipal slaughterhouse.

METHODOLOGY

For this study included the 31 workers involved in the slaughter cattle trail. The methodology involved the application of this method evaluates OCRA method in the first instance, the inherent risk of a position, ie the risk that involves the use of the post regardless of the particular characteristics of the worker. The method obtains, from the analysis of a number of factors, a numerical value called Check List OCRA Index. Depending on the score for the Index OCRA checklist method classifies the risk as Optimum, Acceptable, Very Light, Light, Medium or High. Finally, depending on the level of risk, the method suggests a number of basic actions, except in cases of Optimo or Acceptable risk where it is considered that no actions are needed on the job to code and evaluate the risk factors to which workers are exposed while performing different tasks and operations performed in the line of cattle. The study was conducted is a descriptive, transversal and field.

The 31 workers who form the study population underwent labor history, thorough, including formal and literature as reported by National Aeronautics and Space Working Load Index NASA-TLX Administration (National Aeronautics and Space Administration -Task Load Index for its acronym in English) (Hart and Staveland, 1988) and inventory Fatigue Swedish labor SOFI (Swedish Occupational Fatigue Inventory) (Ahsberg, 1997) which had an amendment in 2007 (Sebastian, 2008) SOFI -SM (SOFI Modified Spanish version)

OCRA method was used to assess repetitive movements performed by the employee. The questionnaires SOFI-SM and NASA-TXL to confirm fatigue as a result of the presence of excessive loads on the activities of workers in some stages of the production chain.

The productivity was determined by the index of productivity, which is the quotient of observed productivity (considered in hours) between the standard productivity, all multiplied by 100.

Productivity was considered as hours to determine at what point in the day, workers, reflecting decreased it. Found that in the last two 8-hour of the day, values were lower productivity.

RESULTS

Included 31 of 53 workers with an average age of 31 (with a range of 20 to 48), of which 100% were male.

Table 1. - Results of the evaluation of the OCRA method

Stage	OCRA	Stage	OCRA	Stage	OCRA
A Recepción del ganado en pie en los corrales	0	**B** Inspección Sanitaria de los animales	0	**C** Encierro de los animales	0
D Aturdimiento	3	**E** Desangrado	5	**F** Retiro de Patas traseras	8

G Retiro de Patas delanteras	9	**H** Degüello	14	**I** Desollado	23
J Corte Ventral	9	**K** Evisceración	11	**L** Corte en Canal	11
M Vigilancia del estado de la carne	0	**N** Etiquetado y sellado	4	**O** Transporte sanitario de los canales	10

The application of OCRA method showed that within the supply chain there are 2 activities that pose very high risk of DTAME for workers, namely: Phase "I" operation of the process called "skinning" and the second operation called "H" "slaughter. "The first with a score of 23 and the second with a score of 14 on a scale of 0 to 23. For the first immediate intervention is required to reduce risk factors, while the second suggests a short-term planned intervention.

As fatigue is confirmed its presence by the SOFI-SM questionnaire from which is obtained by a rapid analysis (18 items) a score of 60 in "Skinned" indicating an inadequate level of risk and priority occupational and 43 in "slaughter" with the previous indication. Questionnaire regarding NASA-TXL reveals the presence of fatigue weighted scoring 68 for the "skinning" and 45 in the "Degüello" on a scale of 0 to 100. So that a correlation is acceptable.

CONCLUSIONS

The analysis of the results confirms the hypothesis that the incidence of musculoskeletal problems and the accumulation of fatigue, in operations with high risk, obviously impacts the productivity of the process in the slaughter line of cattle. The existence of biomechanical tasks that affect the presentation of repetitive motion injuries such as upper limb: movements repeated extensions and wrist curls, especially if performed against resistance. Can be considered triggers, workload and task cycle.

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Ergonomic Study to Identify Opportunities for Improvement in the Management of Heavy Loads in Hardware

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RESUMEN

En este artículo se presentan resultados de una investigación llevada a cabo en un negocio de ferretería. Para su realización fueron evaluados 32 videos grabaciones de la tarea de cargar y descargar bultos de cemento, por medio de los métodos ergonómicos: OWAS y REBA, así como, los levantamientos de diferentes profundidades de estibas con Tablas Liberty Mutual y Ecuación de NIOSH. Los resultados obtenidos hacen referencia a que la manipulación manual de bultos de cemento, con un peso de 50 kilos implica alto riesgos de sufrir lesiones musculo- esqueléticas para el personal que los manipula.

ABSTRAC

This paper presents results of research carried out in a hardware shop. The methodology involves the analysis of 32 video recordings that were evaluated for tasks of loading and unloading sacks of cement, using OWAS and REBA methods. Also, surveys made for different manual materials handling tasks were conducted for several anthropometric dimensions and variables. Liberty Mutual Tables and NIOSH Equation were also developed. Results show that for the studied manual handling tasks with loads of 50 kilos of weight represent a high risk for musculoskeletal injuries for the employees at this hardware shop.

KEY WORDS: Musculoskeletal Disorders, Evaluation of risks of Work in Hardware, Handling of Loads.

1. INTRODUCTION

In most of work places it is necessary to handle heavy materials loads from one place to another and this fact is the cause of many accidents and musculoskeletal disorders, inadequate working places, defective products and injured employees. Reviewing historical data presented by the

Mexican Social Security Institute (IMSS) in Chihuahua, Mexico, 2008; companies engaged in the purchase and sale of building materials and hardware products represent a 1.6% of total disability and illness. The kind of work studied in this research involves diverse hardware tasks mostly performed manually due to the variety of products to be sold.

2. OBJETIVE

Identify ergonomics deficiencies and determine the level ergonomic risk in manual handling by ergonomic methods.

3. DELIMITATION

A hardware store is a commercial establishment dedicated to the sale of items to locksmithing, carpentry, construction and household needs. Handling loads usually involves repetitive movements. The work to be evaluated is the dealer of merchandise at home. The specific activity of interest is to load and unload sacks of cement delivery truck and the address of the client concerned.

4. METHODOLOGY AND RESULTS

In this section the methods used and the results obtained are presented for each phase of this study. This research was conducted in three phases:

4.1 Phase 1: is the compilation of methodologies:

OWAS: This method was used to identify the most critical postures during the manual handling of sacks of cement of 50 kilos of weight including their frequency and duration.

REBA: To assess the most stressful postures identified by the OWAS method.

LIBERTY MUTUAL TABLES: Determine the percentage of population 50 percentile that is capable of handling cement bags of 50 kilos without suffering injury.

NIOSH Equation: Evaluation of lifting sacks of cement at different height of pallets.

4.2 Phase 2: field research: Field research: In this part, the information about working conditions, characteristics and symptoms in health personnel handling heavy loads manually in a hardware store are presented. Below, is a histogram of the most common symptoms of discomfort among the staff, data of 14 respondents was collected in 6 hardware stores. According Figure 1, 15% of respondents said they suffer from back pain and cramps in his shoulders or arms, 7% have weakness in hands or arms, 7% discolored hands of some fingers, 9% numbness in the fingers or hands, heavy hands 4%. Also, 13% of respondents said they have suffered any of these symptoms for the past seven days .The 4% said that the symptoms are present part-time, 17% refers to symptoms that occur during the rest.

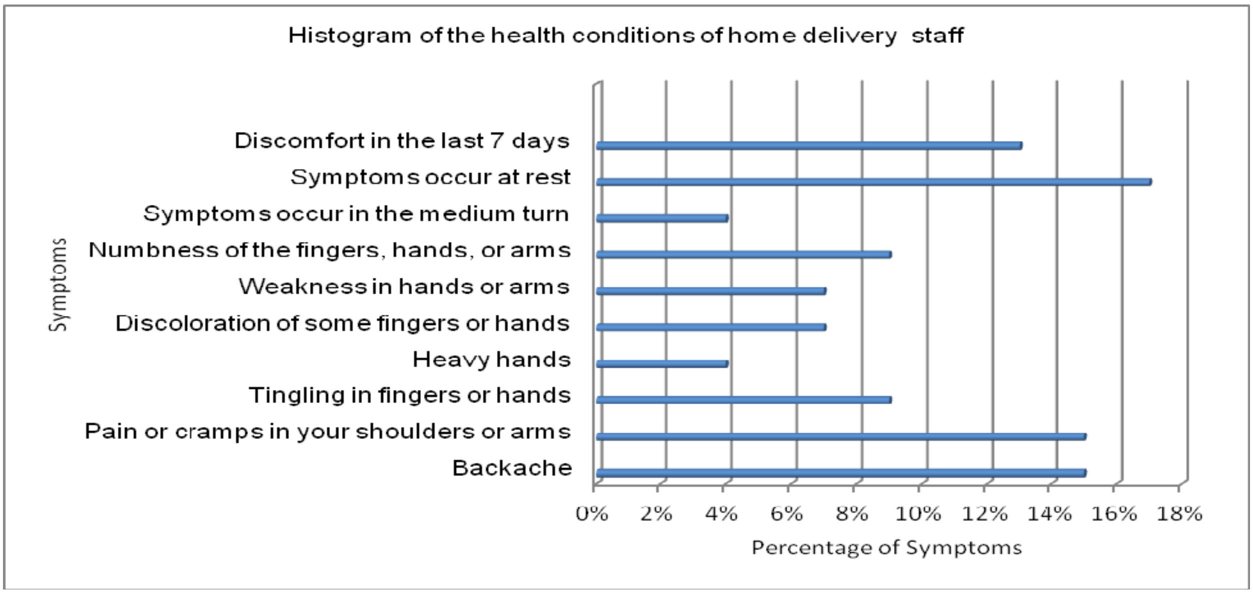


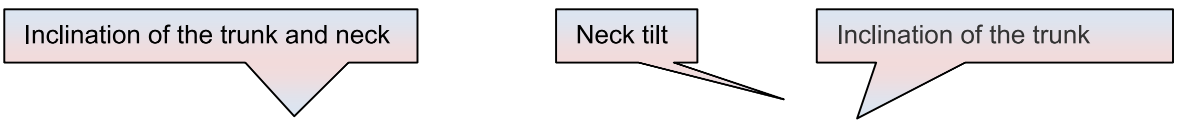
Figure 1 Health condition of personnel working in hardware stores

4.3 Phase 3: is for the use of ergonomic methods: OWAS, REBA, Liberty Mutual Tables and NIOSH Equation.

4.3.1 *EVALUATION OVAKO WORKING ANALYSIS SYSTEM METHOD (OWAS)*

The OWAS method postures were settle in four groups to the corresponding to numbered categories: 1 (no need to implement changes), 2 (planning for future changes), 3 (implement corrective measures as soon as possible) and 4 (implement corrective measures immediately).Were obtained a total of 27 different postures. It is noteworthy that no data were lost because the assessment was carried out from the freezing of the video image. The postures were observed every 2 seconds because the movements are very fast. Assessments were made when the worker is in front of the pallet and load of cement reached, until the worker left the sack of cement on the truck .Also, when the worker is in front the truck and takes the sack of cement to place it in the client's home.

The posture most often was 2133, with 28 recurrences of 125 and corresponds to: back bent, arms below shoulder level, stand with one leg straight and with a force exceeding 20 kilos. Posture located in the category 3. The following position is 4273, with 23 frequencies, which represents: back bent and rotated with the arm above shoulder level, walking, weighing in excess of 20 kilos. This posture is in category 4. The following figures shows these postures that represent the most frequently found with the method OWAS.



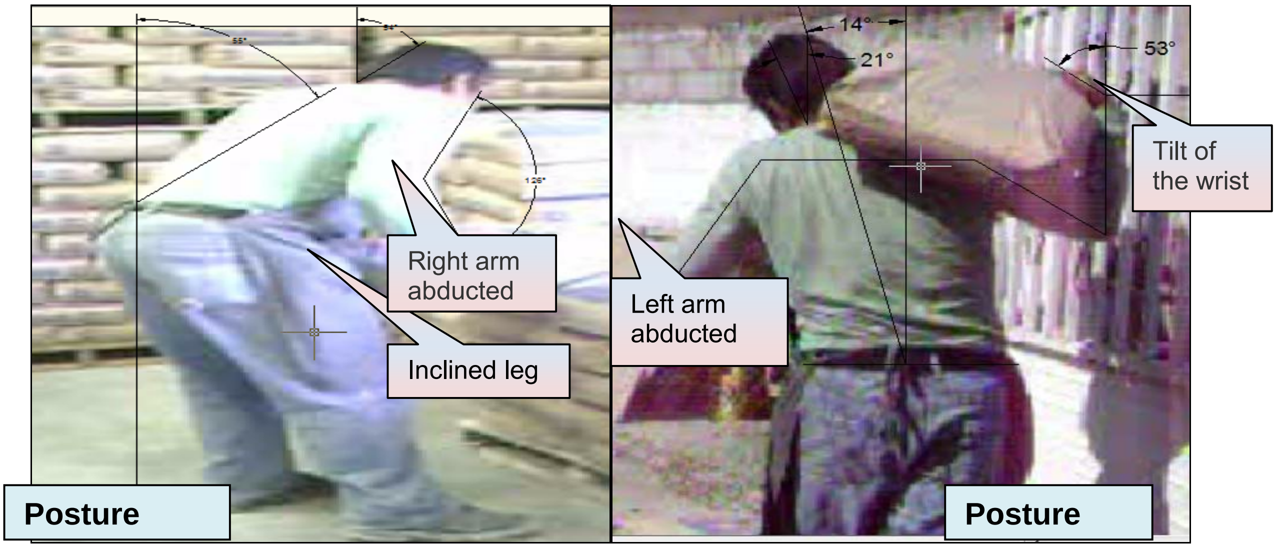


Figure 2 Postures more often OWAS

In addition, the joined frequencies occurring for back, arms and legs postures in the tasks of loading and unloading sacks of cement were analyzed. The result of the evaluation of the back: The upright back has a 6% frequency while the leaning forward back or backward to 42%; rotated back posture or tilted to the side is 15% for the back bent and rotated or tilted forward and the sides have 37% of total postures back. Figure 3 shows the results of this analysis.

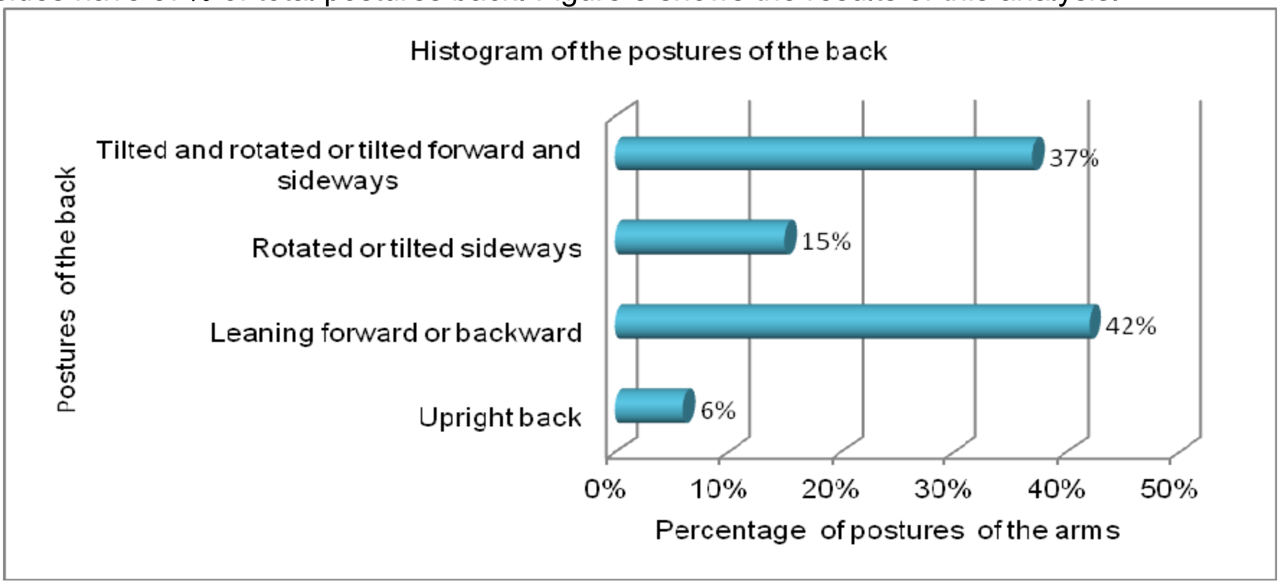


Figure 3 Postures of the back

Figure 4 corresponds to the results of the arms. The posture of the arms below shoulder level has 66% of frequency, while the posture of the arm above the shoulder level is 24% and for both arms above the level of the shoulders 10% frequency.

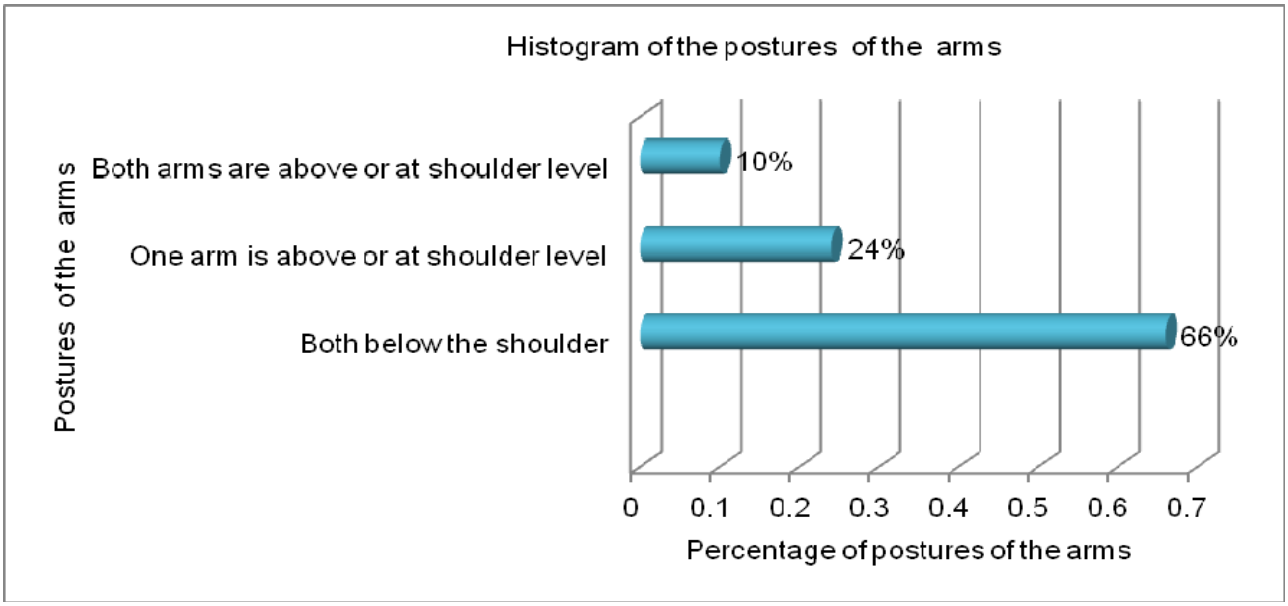


Figure 4 Postures of the arms

Figure 5 shows the postures of the legs; it is observed that most often posture is: standing with weight on one leg straight 48%, walking with 31%, standing with both legs straight 13% of standing crouched with both knees bent 8%.

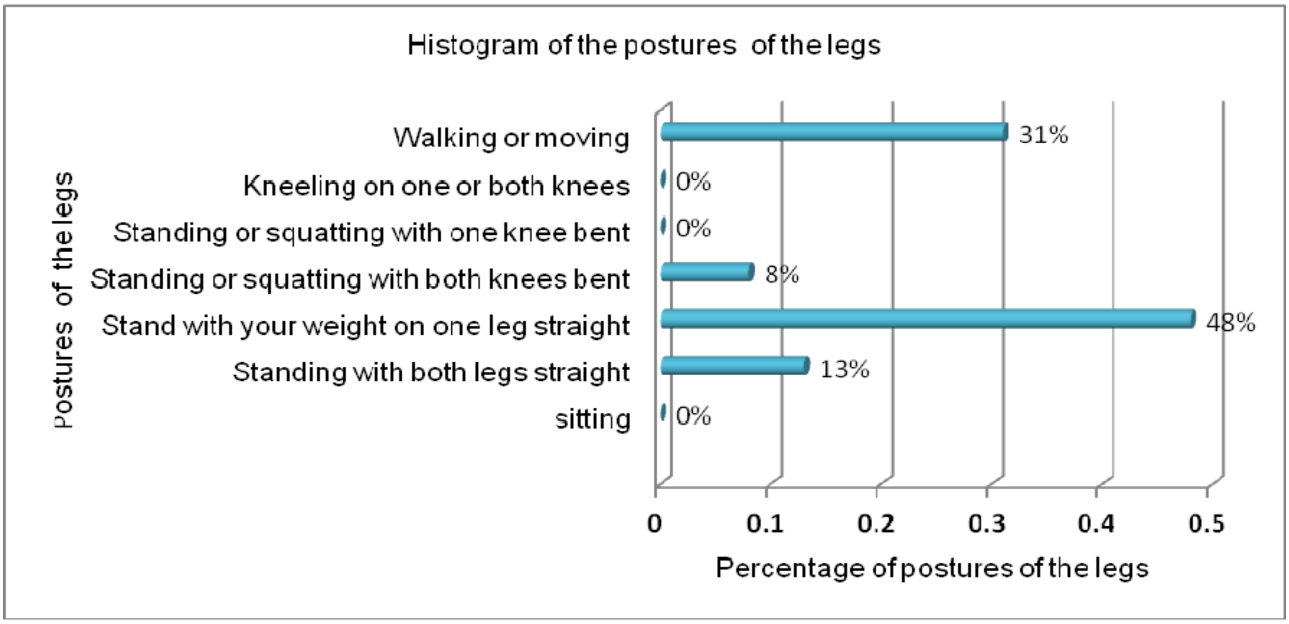


Figure 5 Postures of the legs

Finally, they settled postures in four groups corresponding to categories 1, 2, 3 and 4. And we obtained the percentages of each position category. We obtained a total of 27 different postures. The results for each category are: category 1 corresponds to 17 postures; the percentage is 13%.For category 2 postures are 11 and represent 11%, the category 3 represents 46% of the total frequency of 46 postures, and category 4 is 30% with 37 postures.

The postures found most often refer to the possibility of causing extremely harmful effects on the musculoskeletal system of personnel working manipulating and moving sacks of cement. Figure 6 shows the frequency of action category.

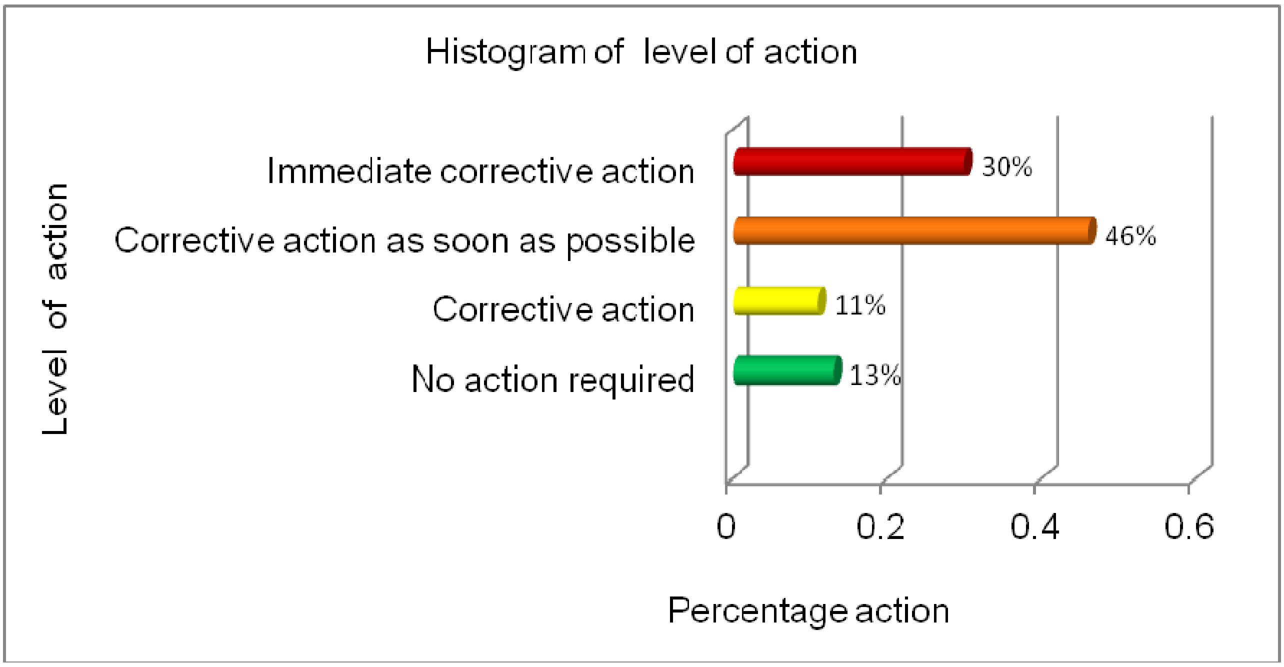


Figure 6 Frequency categories

4.3.2 EVALUATION RAPID ENTIRE BODY ASSESSMENT METHOD (REBA)

Evaluation with the REBA method (Nogareda, Centro Nacional de Condiciones de Trabajo) was performed taking into account the angles formed by the worker's body, as well as, frequency and force of these postures. This involves the activity score, a coupling score and load and/ force applied during the task for the left and right side of the worker's body. This method divides the body into two groups A and B. Group A, evaluates the trunk, neck and legs of the worker. The group B evaluates the arm, forearm and the wrist. Commercial software for the evaluation of REBA method was used in this research.

Figure 7 corresponds to the evaluation right side, in the group A of the posture 2133, found with the OWAS method.For the evaluation the input data is the following: for the trunk posture with and inclination between 0° and 60 °; with no adjustments for lateral tilt or twist. The neck flexion is about 20 ° with any adjustments for twisting or lateral tilt. There is a unilateral supported leg flexion between 30 ° and 60 °.The punctuation for the group A is 6 adding 2 for the force, we get an 8.

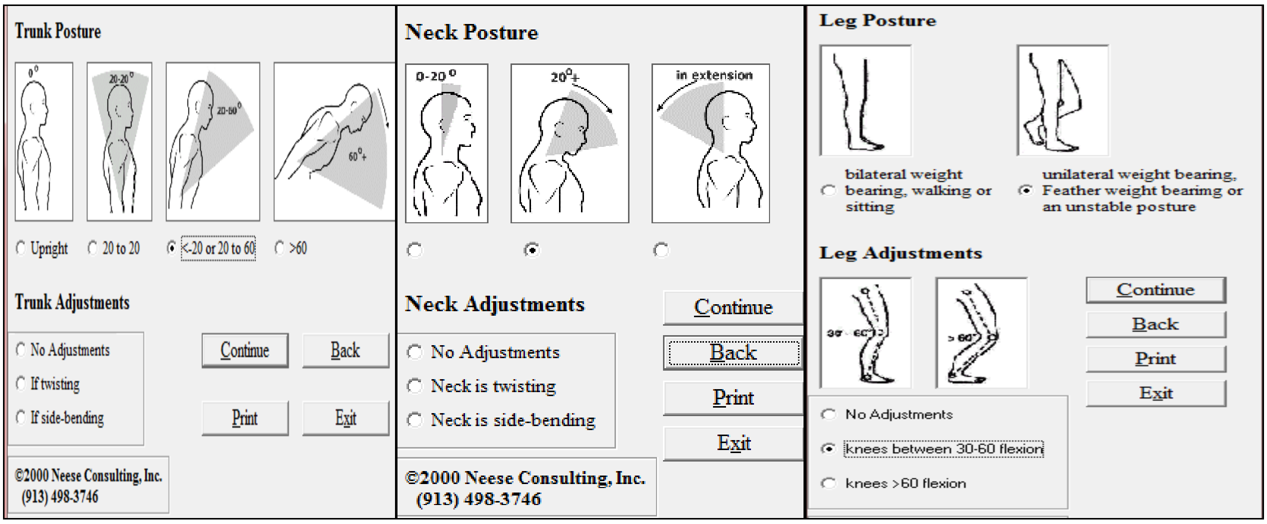


Figure 7 Evaluation of the group A

The following evaluation shown in Figure 8 corresponds to the group B. Was selected arm posture that marks between 45 ° and 90 °, in addition, select the option to arm abducted next select forearm posture between 60 ° and 100 °, selected wrist mark the position over 15 ° of flexion. For the frequency option selected positions unstable and weighing more than 10 kilos; with a bad grip. Finally select the side that we are evaluating right here, you get the punctuation according REBA 11, which represents a high risk of injury and should take immediate action.

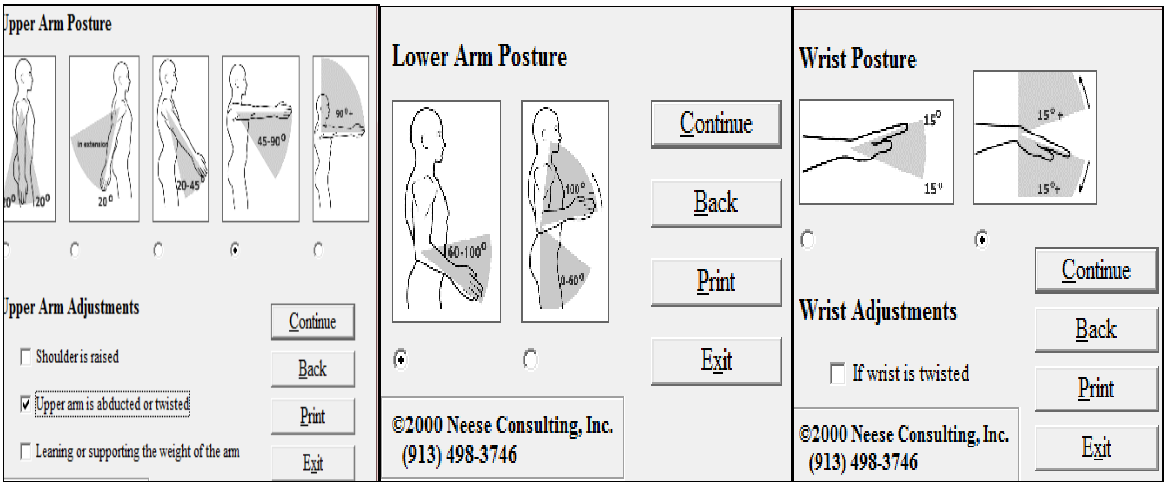


Figure 8 Evaluation of the group B

The figure 9 shows the results of evaluations of the posture 2133, with the use of REBA tables: in figure 9 that shows that the posture of the arms is the one that causes more stress, as well as the trunk, grip and legs. REBA as the punctuation is higher in those postures.

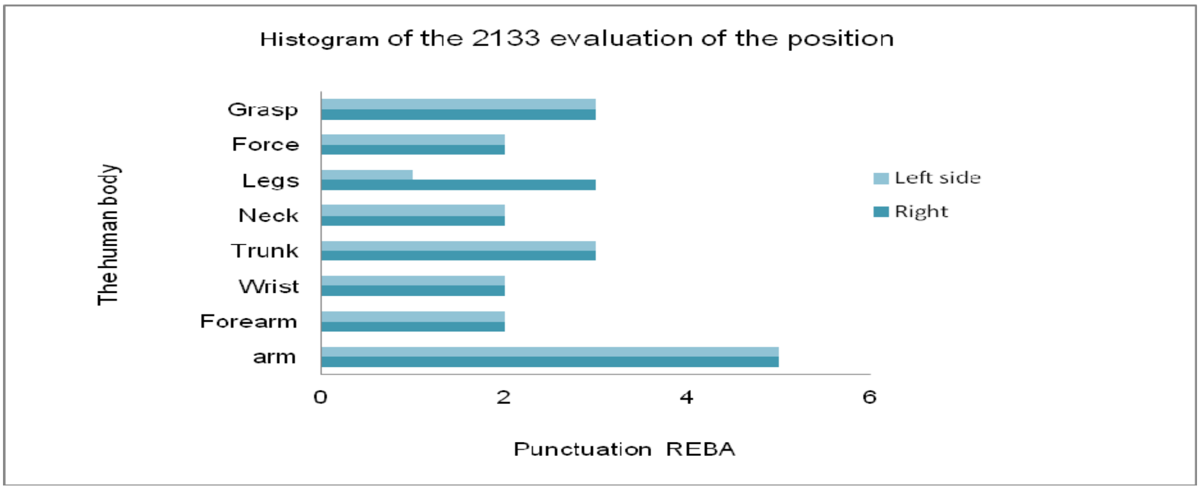


Figure 9 Results of the evaluation of posture 2133

The figure 10 corresponds to the evaluation of the posture 4273, the results of the tables REBA shows that the posture is more stressful to the arm, followed by the trunk, neck, legs and grip.

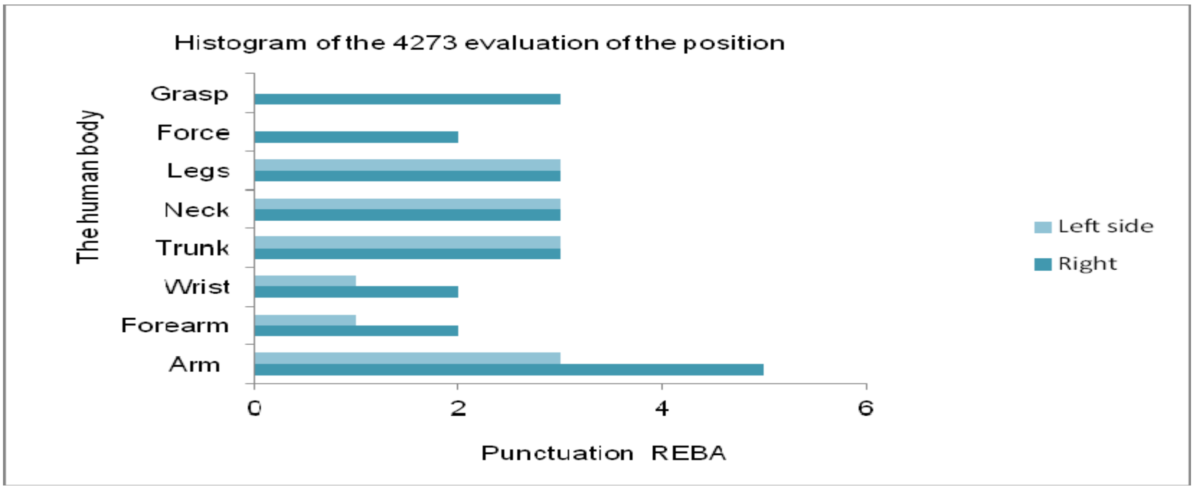


Figure 10 Results of the evaluation of posture 4273

4.3.3 EVALUATION LIBERTY MUTUAL TABLES

According to the study of Ceriello and Snook, (1993) a task is acceptable when it is capable of realizing at least 90% of the workforce. If they can make between 90% and 75% work should be improved, although certain trained workers would be asked to carry out the task without significant risk to health. The tasks can be performed by less than 75% of workers are considered at risk and should be redesigned.

The Evaluation with Tables Liberty Mutual was carried out taking into account the height of the piles: lower, middle and top, as well as the height of the truck dealer, those averages are for lifting from floor to knuckle and from knuckle to shoulder. Evaluations were made by both approaches as the heights corresponding to the weight and time duration of the task. The following table corresponds to the lower stowage evaluation. The yellow highlight shows the location on the frequency table (5 minutes), bundle width (34 cm), vertical height (23 cm) and weight (54), being the most approximate to the actual data; this is how we get the percentage of 25%.

Table 1 Maximum acceptable weight (kg) lifting from floor to knuckle, man. (Source: Prado, 2001)

Width	Distance	Percentage	Lift each							
			Seconds			Minutes				Hours
			5	9	14	1	2	5	30	8
34	76	90	8	10	11	15	17	19	19	23
		75	12	14	17	22	25	28	28	33
		50	16	19	22	30	34	37	38	44
		25	20	24	28	37	42	47	47	55
		10	24	29	33	44	50	54	56	65
	51	90	9	10	12	16	18	20	20	24
		75	12	15	18	23	26	28	29	34
		50	17	20	24	31	35	38	39	46
		25	21	25	30	39	44	48	49	57
		10	25	30	35	46	52	57	58	48
	25	90	10	12	14	18	20	22	23	27
		75	15	18	21	26	30	32	33	38
		50	20	24	28	35	40	43	44	52
		25	26	30	35	44	50	54	55	65
		10	29	35	41	52	59	64	66	76

Actual data are: height 23 cm, width 38 cm and bulk of a lifting every 8 minutes with weight of 50 kilos. What percent share?

- For 54 kilos = 25% to 50 kilo = X, (1.250 / 54) = 23,148%

-For 5 minutes = 23,148% to 8 = x, (185,184 / 5) = 37.0368%

-For package-width of 34 = 37.0368, 38 = X, (1,407.39 / 34) = 41.39%

-For height: 25 = 41 394%, 23 = x, (952.06 / 25) = 38,082%

The results of the lifting from floor height to the worker knuckles taking into account the lower stowage (23cm), resulted in 38% of the industrial population is able to lift a load of cement of 50 kilos every eight minutes, during a working day of 8 hours.

The results of assessments for the delivery truck height and stowage height are explained in this part. The evaluations correspond to the height from the knuckles to the shoulder according Liberty Mutual Tables. For the evaluation of the height of the truck with a vertical height of 109 cm and worker's shoulder height of 146 cm, the subtraction (146-109 = 37 cm) was used to obtain a vertical lifting distance is 37 cm. The result of this evaluation is that 27% of the industrial population is capable of lifting a load of 50 kilos every 8 minutes for an 8-hour workday. For evaluation of the medium height (76cm) and the highest stack (130 cm), similar approximations were made for every lifting. Results of this analysis are shown in Figure 11. According to Liberty

Mutual recommendations none of the lifting tasks are safe since less than 75% of population is able to perform these tasks, and changes must be made immediately.

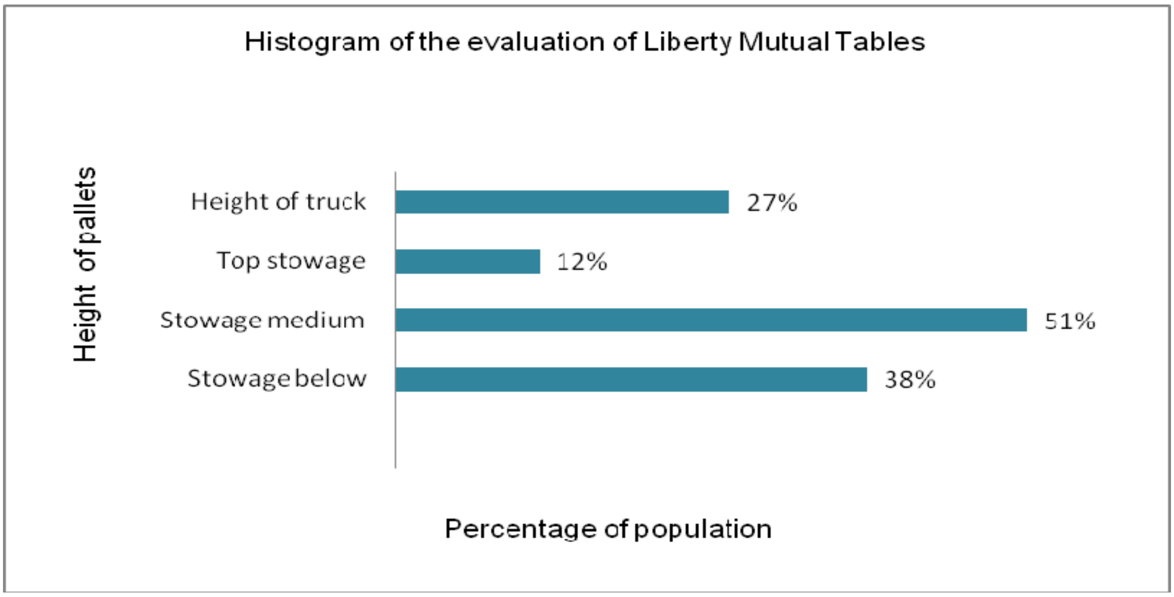


Figure 11 Evaluation of Liberty Mutual tables

4.3.4 EVALUATION NIOSH EQUATION

This evaluation takes into consideration the work of loading sacks of cement, considering the task of manually load of different heights. To use the methodology of the NIOSH Equation was used software. Was taken into account the heights of the pallet, lower, middle and high (23, 76 and 130 cm), with the knowledge that it is a simple task. The figure 12 shows the lifting of the load of cement and rotation of the worker to perform the task of lifting the load of cement and take it to the shoulder of the worker.

Figure 12. Posture during the lifting task

The figure 13 shows the data of the variables in the NIOSH Equation (horizontal distance factor (HM), height factor (VM), vertical displacement factor (DM), asymmetry factor (AM), frequency factor (FM), grip factor (CM)) corresponding to the medium stowage, to obtain recommended weight (RWL). For the origin was obtained 9.91 kilos, to 6.18 kilos destination. Weights less than the load of cement.

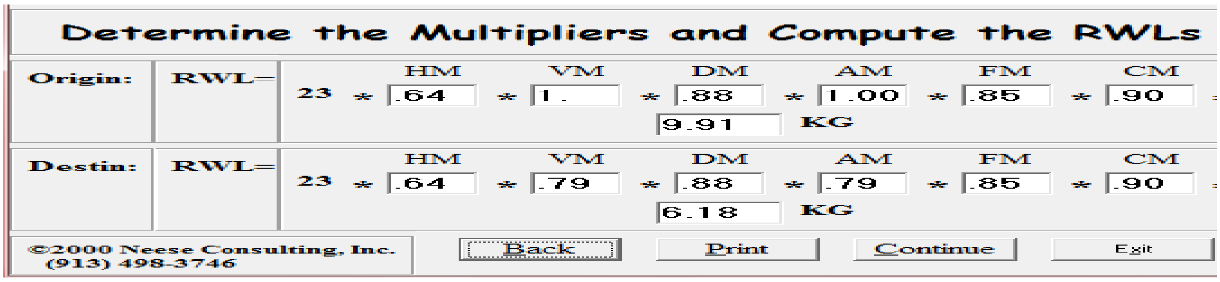


Figure 13 NIOSH Equation

The figure 14 shows the results obtained using the software. It is noted that according to the source NIOSH Equation recommended weight for lower stowage at the origin is 9 kilos and the destination is 6 kilos. To top stowage the results are 10 kilos at the origin and destination 6.In addition, to surveying the height of the truck, we have the result of 9.5 kilos in the origin and destination 7.Lower weights at 50 kilos actual weight of the sack of cement.

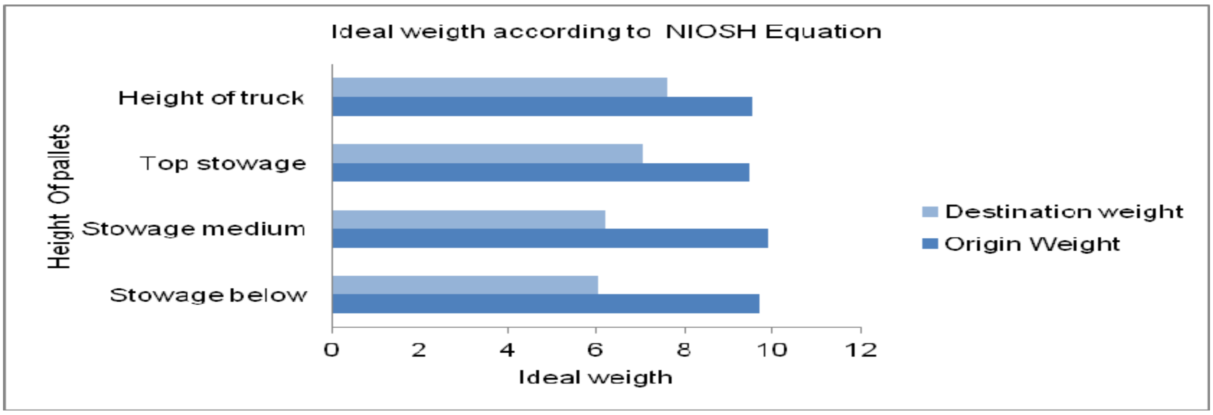


Figure 14 NIOSH recommended weight

Figure 15 shows the urgency factor according to NIOSH Equation. It is observed that both the depths of pallets, to the height of the truck, the urgency factor in the origin is 5 and the destination is 7 and 8.Factors that indicate very high need for radical changes in the task. Since the lifting of sacks of cement to the deep study involves great risk of musculoskeletal injury to the worker who performs.

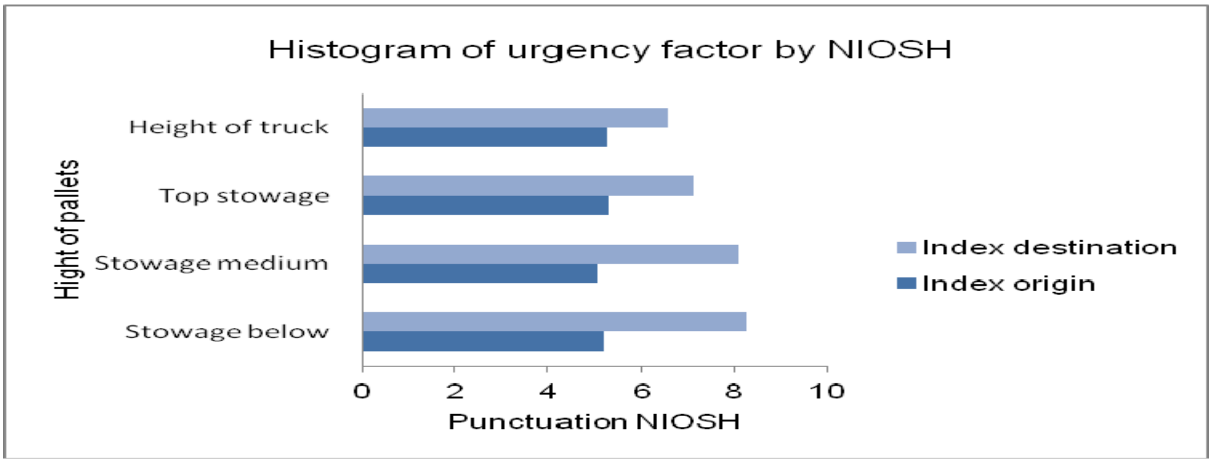


Figure 15 NIOSH urgency factor

5. CONCLUSION

The objectives of this study were met since the field research helped identify ergonomics risks by mean the applied questionnaire to the staff working in hardware stores. Respondents refer mainly to backache, shoulders ache and arms discomfort also to feel hand finger numbness and the sensation of heavy hands.

The level of risk found using a battery of methods like: OWAS, REBA, Liberty Mutual Tables and NIOSH Equation methods, refer to a high risk of musculoskeletal injury for the staff. It can be concluded that the results give us the foundation needed to affirm the need to sensitize the personnel involved, as well as to the business owners in the same line, about the great risk to which workers are exposed to make the handling of heavy loads. More severe implications and consequences can be found if these working conditions continue. In fact, to make this activity more comfortable and less risk to the staff .In addition, providing assistance mechanics to workers by handling the sacks of cement at different heights of stowage and can move more easily.

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DEVELOPMENT OF A MANUAL OF OCCUPATIONAL HEALTH AND PREVENTING RISKS AND ITS IMPLEMENTATION IN A WORKSHOP SERVICES OF AUTOMOTIVE DISTRIBUTOR

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RESUMEN
En cualquier proceso de producción de bienes materiales o prestación de servicios, las personas se exponen a diferentes factores físicos, químicos, biológicos y psicosociales, los cuales en determinadas circunstancias se convierten en riesgos laborales, El trabajar con cierta cantidad de horas continuas en un día puede provocar fatiga o cansancio, más aún en la actualidad donde la globalización lleva a las empresas a ser más competitivas; y en la búsqueda de ser más productivas se han inclinado en herramientas con mayor tecnológica, estas en conjunto generan innumerables riesgos que a cierto periodo de tiempo pueden afectar la salud de los trabajadores.

PALABRAS CLAVES: LESIONES, FATIGA, TALLER DE SERVICIOS.

SUMMARY
In any process of production of material goods or services, people are exposed to different physical, chemical, biological and psychosocial, which under certain circumstances become occupational hazards Working with a number of continuous hours in a day can cause fatigue or tiredness, especially today where globalization leads companies to become more competitive, and in the quest to be more productive have been tended to more technological tools, these together generate many risks to a certain period of time can affect the health of workers.

KEY WORDS: INJURIES, FATIGUE, WORKSHOP SERVICE.

1. INTRODUCTION

Work is a source of psychological and social well-being for humans. However, also causes adverse effects. One and perhaps the most common is fatigue, which is a common effect in all the activities required of an effort. The effects that occur in the workplace include decreased work capacity in the individual, and consequently greater number of failures, mistakes and shortcomings. This in turn causes a decrease in attention span and delay in the individual to perform his tasks. Symptoms include tiredness and muscle aches.

In the workplace, problems of fatigue should be addressed to the study of all conditions of work, the performance of any task involves the effort of all our capabilities, if the amount of effort required exceeds the ability of an individual response, can lead to fatigue. This translates into a series of physical and mental dysfunctions, accompanied by a feeling of fatigue and decreased performance.

People express fatigue in different ways, using terms such as tired, weak, exhausted, tired, heavy or slow. In general, fatigue can be defined as a disorder characterized by distress and reduced functioning associated with decreased energy. The specific manifestations may be physical, mental or emotional.

Edwards (1981), defines fatigue as *"the impossibility of generating a force required or expected, or not produced by a previous excersice. This would be obviated the level of force and frequency thereof, and the type of muscle contraction and scope thereof1* ".

Legido (1986) *calls it physical or muscular fatigue, and together with other types of fatigue (mental, sensory, local, general, etc..) Is generally conceived by "fatigue1.*

Vollestad and Sejersted (1988) define it as *"reduced ability to generate a force 1."*

Barbany (1990) sees it as *"a significant protective functional state, transient and reversible expression of a homeostatic response in nature, through which unavoidably imposes the need to cease or at least reduce the magnitude of effort or the power of the work being making1 ".*

The fatigue of manual work appears in jobs dominated by efforts and characterized by mechanical, automatic, repetitive, routine process where a reduction of worker autonomy and there is a impoverishment of tasks that creates a sensory stimulation below cognitive.

Physical fatigue is often the case in those activities which make static exercises (which are those where there is no muscle movement) or dynamic (which are those where muscle movement) and where it is used more than 30% of maximal voluntary contraction during about 3 minutes or more, long enough to accumulate lactic acid that is causing the pain and muscle fatigue. (Kroemer K, Grandjean E 2000).

In service garages are dynamic exercises where is use more voluntary contraction (repetitive) for 3 minutes or more, this situation poses risks to which workers are exposed derivatives of the safety (falls, blows, cutting, trapping, etc..) that can cause injuries of varying severity as breaks, sprains, wounds, etc.. and physical stress from work (overexertion, poor posture, etc..) that can cause musculoskeletal disorders and physical fatigue.

Ergonomicals	**Work load**	**Physical / Mental Fatigue**	**Muscle and Joint pain, sleep disturbances, etc.**

Ergonomics is a science that studies the characteristics, needs, abilities and skills of human beings, analyzing those aspects that affect the relationship between humans and their environment, and is directly related to acts which man performed in any activity undertaken. Aims to adapt the job to the worker, taking charge of designing machines, tools and how they are performing the work, to maintain the minimum pressure that holds the body work.

Work analysis is designed to detect and take preventive or corrective action activities or operations which may affect workers health seeking continuous improvement in order to become competitive enterprises with competitive staff.

We can distinguish two types of fatigue, according to W. T. Singleton in his Principles of Ergonomics:

1. Physiology: associated with input muscular energy and elimination of toxins. Factors that occur in general way we can name the failure of the diet (the higher activity, greater need for feed), lack of oxygen (places with poor ventilation, etc.). and locally the contraction of muscles and tendons (repetitive motion), insufficient blood flow (too long in one position).
2. Psychic: manifested by feelings of weakness, changes in moral and other symptoms of the person. This type of fatigue comes mainly due to lack of motivation of individuals, and leads to boredom and introversion, is also very important the lack of communication or information.

2. OBJECTIVES

The overall objective of this research is to determine the risks involved in a workshop of automotive services of a distributor of the City of Los Mochis, Sinaloa, through documentary research and observations in the different tables and workstations to persons engaged in this trade. The particular aim is to implement risk prevention manual and propose a redesign of the working groups to avoid possible injury (DTA `S) in the near future.

3. METHODOLOGY

Currently there are several methods to assess physical fatigue, muscular or mental. In this work the fatigue be evaluated subjectively by 4-point scale of Luke, Corlett & Bishop to understand and evaluate the degree of discomfort in different parts of the body and ergonomic evaluation was performed with the methods RULA and OWAS. The study of movements applied to carefully analyze the body movements used in carrying out their activities. (Table and workstation).

4. RESULT

According to the results obtained with the 4-point scale of Luke fatigue usually presents with a highest rate since the third day to begin their workday weary, from 5 to 6 workday they conclude very tired. Body parts that are most trouble are: upper back, lower back, legs, knees, ankles and feet. Another factor is the time it is working, as most have more than 5 years working, doing physical effort type tasks. In addition many of the workers at the end of their working day go home and do extra activities such as performing work for the home, study and personal activities. Being this is another factor that influences the fatigue of workers and in the presence of muscle soreness.

Worker 1						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
At start of work	1	1	1	1	1	1
End of work	1	1	1	2	1	1

According to the 4-points of Luke scale, there is no fatigue in the worker, although there is discomfort in certain parts of his body

Parts of the body having discomfort	Head, lower back and ankles

Worker 2						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Start of work	1	1	2	2	2	2
End of work	2	2	3	3	3	3

According to the 4-points of Luke scale, there is fatigue in the worker.
Note: At end of his working day on the third day fatigue is present, and there is discomfort in certain parts of this body

Parts of the body having discomfort	Head, neck, upper back, middle back, lower back, knees, legs and feet

Worker 3						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Start of work	1	1	1	1	1	1
End of work	2	2	2	2	2	2

According to the 4-points of Luke scale there is no fatigue in the worker although there is discomfort in certain parts of his body.

Parts of the body having discomfort	Upper back, lower arms middle back, wrist and hands, knees, legs, ankles and feet.

Worker 4						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Start of work	1	1	1	1	1	2
End of work	2	2	2	2	2	2

According to the 4-points of Luke scale there is no fatigue in the worker, although there is discomfort in certain parts of his body

Parts of the body having discomfort	Lower back, knees, legs and ankles

Worker 5						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Start of work	1	1	1	1	1	1
End of work	2	2	2	2	2	2

According to the 4-points of Luke scale there is no fatigue in the worker, and there is no discomfort in his body

Worker 6						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Start of work	1	1	2	2	2	2
End of work	2	2	2	2	3	3

According to the 4-points of Luke scale there is no fatigue in the worker,
Note: At end of his working day of the fifth day is present very tired, and there is discomfort in certain parts of his body

Parts of the body having discomfort	Upper back, lower arms, wrists and hands, knees, legs and feet.

Worker 7						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Start of work	1	1	1	2	2	2
End of work	2	2	2	2	3	2

According to the 4-points of Luke scale there is no fatigue in the worker.
Note: At end of his working day of the fifth day is present very tired, and exists discomfort in one part of his body.

Parts of the body having discomfort	Upper back,

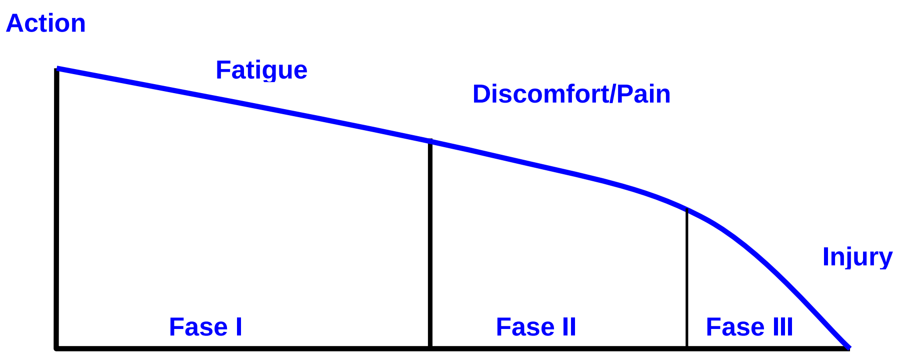
Worker 8						
Workdays	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Start of work	2	2	2	2	2	2
End of work	3	3	3	3	3	4

According to the 4-points of Luke scale there is fatigue in the worker.

Note: At end of his working day of the sixth day is present extreme tiredness, and exists discomfort in certain parts of his body.

Parts of the body having discomfort	Neck, shoulder, upper back, upper arms, lower arms, middle back, lower back, wrists and hands, thighs, legs, ankles and feet.

SIMBOLOGy		
Final Punctuation		Concept of punctuation
1 or 2	There is no fatigue	1 or 2 = Acceptable
3 or 4	There is fatigue	3 or 4 = investigate further to take action to reduce the stress - trouble.



Graph of fatigue, discomfort, pain and injury

Increased fatigue is based on physical symptoms, mental fatigue seems unaffected by the working day; physical fatigue is the most increased, is consistent with the work they do, because it requires more effort by the activities performed in the service garage. There is a direct relationship between fatigue and hours worked.

There is relation between fatigue and age of the workers. They present ages between 30 to 52 years, so from the point of view of labor they are mature adults and middle age workers. There is a relationship between fatigue and the time they have in the workplace. These factors contribute to the onset of fatigue in this study.

In the workplace, fatigue issues must be addressed from the study of all the work conditions, the same requirements on the person and the resources of the response to such demands on the conditions. The prevention of fatigue must start from the design of working conditions and the definition of jobs. Prevention measures by the company have to be adapted to the specific characteristics of workers, of the activity of the differents jobs that are made and the process.

In connection with this, is proposed the following ideas:

- ✓ Design the work and job to be adapted to the worker and their specialties (ergonomic design).

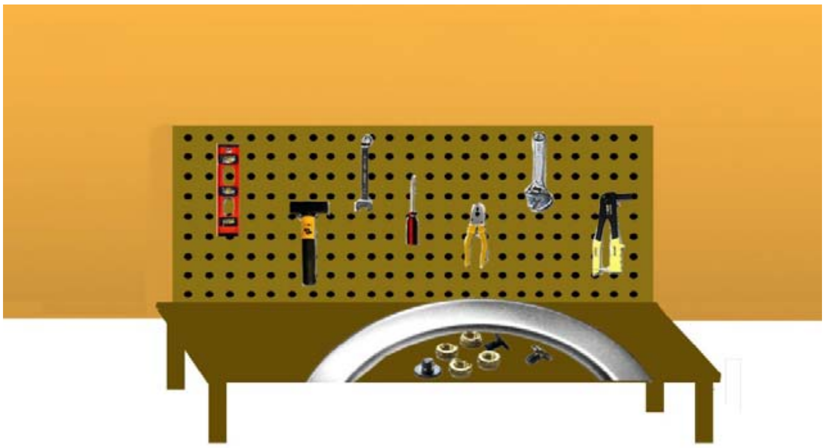
- ✓ Apply safety measures and health protection of workers.
- ✓ Create rotation schemes and flexible schedules.
- ✓ Promoting social support and leadership styles that promote empowerment and participation of workers.

According to the method OWAS results and starting in the service workshop of this automobile distributor company the workers perform similar operations and its working tables are equal, it is necessary to redesign them, as they are not ergonomic and is a cause for the presence of DTA `s in the future with the analysis of photographs was encoded the positions, showing the following results:

1	1	2	1

BACK 1 = Right 2 = Tilted foward or backward 3 = Rotated or tilted to both sides 4 = Tilted and rotated forward and both sides	LEGS 1 = Sit 2 = Standing with legs straights 3 = Standing with the weight over one leg 4 = Standing or squatting with both knees bent 5= Standing or squatting with one flexed knee 6 = Kneeling on one or both knees 7 = walking or moving	BRAZOS 1= Both arms are below the shoulder 2= One arm is above or at shoulder level 3 = Both arms are above or at shoulder level	Use of force load 1 = Weight or force needed is less than 10 kg 2 = Weight or force needed exceed 10 kg is less than 20 kg 3 = Wieght or force needed

Proposed redesign of working table:



NOTE: You need to place mats for rest, For in the working day they are standing.

With the RULA method resulted in the need to improve the mobile stations, as there is a gap in their workplace that causes extra effort by the worker to perform their activities.

GROUP A: ARM is flexed more than 90° Also the arm is separated as well.

GROUP A: FOREAMR is flexed above 100˚

GRUPO A: WRIST is flexed from 0° to 15° with a mid-range pronation.

GROUP B:NECK: there is a bend between 10° and 20° score of 2, there is also lateral tilt (+1).

GROUP B: LEGS: the Yorker is standing with the wiegh distributed symmetrically and space to change positions. (puntuation1)

GROUP A: ARMS flexed more than 90° más de 90˚, also having high shoulder.

GROUP A: FOREARMS above the 100˚.

GROUP A: WRIST
Is flexed from 0 to 15˚, with a mid-range pronation.

GROUP B: NECK: There is a bend between entre 11˚ and 20˚ puntuation of 2, there also a laterl tilt (+1).

GROUP B: TRUNK: there is a flexion between 0 and 20˚, also the trunk is rotated.

GROUP B: LEGS: The weight is not symmetrically distributed

(GROUP A): ARM: is flexed between 21 and 45˚, also the arm is rotated.

(GROUP A): FOREARM: is flexed between 60 and 100˚

(GROUP A): WRIST: is flexed between 0 and 15˚, with a mid-range pronation.

(GROUP B): NECK: has a bend between 11 and 20˚, resides being rotated and lateralized.

(GROUP B): TRUNK: flexed between 21 and 60˚, resides being rotated an lateralized.

(GROUP B): LEGS: the weight is not simmetrically distribuited because the slope of the floor.

5. - DISCUSSION / CONCLUSIONS:

The degree of fatigue is influenced by the number of hours of work, physical and mental stress, monotony, environmental conditions and emotional causes of workers.

From the point of view of safety and industrial hygiene, fatigue is an element that can temporarily alter the psycho-physical state of the worker, being a reflection of the effects of a lengthy task, with their respective consequences on the individual. Having a negative influence on production, as the labor force and performance decreases can cause accidents and injuries that result in wasted time, materials, and decreased production costs.

Therefore it is possible to determine that there is a malfunction in the system known Man-Machine-Environment, being the cause of fatigue the following relationships:

Man-Environment: Poor environmental conditions, poor communication and incomplete, negative sociological factors, organizational factors.
Man-Machine: incorrect assignment of activities, poor communication, excessive workload, lack of security.

To combat fatigue, it takes training and planning to try to eliminate it, for this is needed:

- To ensure optimal environmental surroundings.
- Simplify tasks with simple movements, equitable distribution of workload between hands and feet and ease of implementation.
- Continued efforts below the tolerances limits.
- Ensure breaks or rest periods appropriate.

Preventing workplace fatigue to reduce injury (DTA `S) can be achieved by starting with an ergonomic study of the work position: postures, movements, turns, shifts, etc.. Avoid excessively sedentary work, monotonous and repetitive and introduce motivators on labor relations, leisure time or rest and music.

It has been concluded that the prevention of fatigue is preventing accidents because fatigue causes a decrease in functional abilities (attention, memory, ability to react to stimuli), increasing the number of failures and mistakes, and therefore, accidents occur. However, a work must have a safe design (tables and work stations) without risk, allowing workers to perform their activities with sufficient space to perform its operations, proper placement of their tools to optimize their management so that even though the consequences may have due the fatigue, do not become accidents.

Any concrete action to prevent fatigue and improve job satisfaction should merit the attention of the organization, its directors, managers and workers, through activities such as the planning, prevention, and application of ergonomics as a structural part of the companies. Hence the importance for the prevention of negative effects, the appropriate design conditions, spaces and tools, adaptation of work to the individual as well as meet and hear one's own body.

In any area where the human element is involved is necessary to identify what the characteristics of working conditions are that may increase the fatigue from which it can be implement preventive measures to reduce them. These measures need not be specific, but adapt it to eliminate or minimize risks.

Repetitive work can cause direct damage to tendons, when subjected to constant contractions and increase the likelihood of fatigue of the tissues, reducing the chances of recovery. If the overload of work affects nerves, symptoms may be accompanied by loss of tactile sensitivity and numbness of the limbs. In case of prolonged exposure to repetitive work, people can develop musculoskeletal disorders with irreversible disability.

Working conditions that may influence the onset of fatigue are:

- Poor design of the job and the work equipment.
- Work overload.
- Unfavorable environmental conditions: lighting, noise, temperature, vibrations.
- High work rate and repetitive.
- Lack of autonomy in planning and organizing work.
- Working poor posture: static and dynamic loads.
- Hours: distribution of working hours, shifts, flexibility.

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HUMAN ERROR ANALYSIS FOR AN ANTHROPOMETER ASSEMBLY USING SHERPA

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Resumen: Este trabajo presenta el análisis de error humano para el ensamble de un antropómetro por medio de los métodos de Análisis Jerárquico de Tareas (HTA por sus siglas en inglés) y SHERPA. HTA proporciona una forma de identificar, organizar y representar las tareas y sub-tareas seleccionadas que son incluidas en una actividad compleja, mientras que SHERPA es una técnica que analiza las tareas e identifica soluciones estructuradas para los errores. En este caso, se observó que los usuarios cometen una serie de errores mientras ensamblan el antropómetro y éstos pueden dañar el artefacto, retrasar y afectar la correcta adquisición de datos. Los objetivos de este estudio son analizar la tarea del ensamble del antropómetro, obtener datos e información acerca de las dificultades durante el ensamble, estudiar las posibilidades de error humano y proporcionar una serie de recomendaciones para reducir el error humano. La metodología incluye una encuesta que fue aplicada a 10 estudiantes de la Universidad Autónoma de Ciudad Juárez, que fueran usuarios del antropómetro, el cual es un dispositivo ampliamente utilizado en el área de Ingeniería Industrial para desarrollar una serie de medidas del cuerpo humano. HTA fue desarrollado con el propósito de organizar y representar las tareas que pertenecen a este ensamble y asegurarse que ninguna de estas tareas sea omitida. La etapa de Identificación del Error Humano (HEI), se realizó en base a la tabla de taxonomía del error de SHERPA, en la que se consideraron los errores potenciales para cada tarea según su clasificación, la probabilidad de cometer el error fue estimada mediante la encuesta. De acuerdo al análisis de la información compilada se proponen una serie de recomendaciones y posibles soluciones para cada error identificado con el objetivo de reducirlos. En este caso de estudio se comprueba que la técnica SHERPA no es exclusiva para el campo de la aviación, sino que se puede aplicar en diferentes contextos, se observó además que es una técnica práctica y sencilla de utilizar.

Palabras clave: *HTA, SHERPA, error humano.*

Abstract: This work presents the analysis of human error for the assembly of an anthropometer by means of the Hierarchical Task Analysis (HTA) and the SHERPA methods. HTA provides a way to identify, organize and represent the selected tasks and sub-tasks that are included in a complex activity, while SHERPA is a prediction technique that analyses tasks and identifies structured solutions to errors. In this case, it was noted that users incurred in several errors while assembling the anthropometer and they can damage the artifact, delay and affect the correct data acquisition. The objectives of this study are analyzing the task of the anthropometer assembly, obtaining data and information about difficulties during the assembly, studying the possibilities of human error, and providing a set of recommendations to reduce human error. The methodology includes a survey that was applied to 10 students of Universidad Autonoma de Ciudad Juarez, that were users of the anthropometer, which is a widely used device in the field of Industrial Engineering to perform several human body measurements. HTA was developed with the purpose of organizing and representing the tasks that belong to this assembly, and ensuring that none of those tasks are omitted. Human Error Identification (HEI) was elaborated based on the table of SHERPA error taxonomy, where potential errors were considered for each task according with classification, the probability of committing errors was estimated through the survey. According to the analysis of collected information, a set of recommendations and possible solutions were proposed for found errors in order to reduce them. In this case study it is found that the SHERPA technique is not exclusive to the field of aviation, but can be applied in different contexts; it is further noted that the technique is practical and simple to use.

Keywords: *HTA, SHERPA, human error.*

1. INTRODUCTION

Human error has been subject of much debate over the past two decades. People have a tendency to blame themselves, their employees or their colleagues for "human error" (Stanton y Baber, 1996). Human error is a significant contributor to produce a failure in systems (Baber y Stanton, 1994). It arises as a consequence of the interaction between user and product, the model of such interaction permits the likelihood to commit certain errors (Stanton, Salmon, Walker, Baber, and Jenkins, 2005a).

When accidents occur, due to "human errors", companies often react through the implementation of a number of measures, such as dismissing or disciplining the concerning employee, including additional checks in work activity, increasing staff training, initiating retraining programs or investing on technology to automate the process (Stanton y Baber, 1996).

The main reason of this work is because it was noted that users commit several errors while they are assembling the anthropometer, the main problem is that these errors can delay and affect the correct data acquisition or sometimes damage the artifact, depending of the committed error. The objectives of this study are analyzing the task of anthropometer assembly, obtaining data and information about difficulties during the assembly, studying the possibilities of human error, and providing a set of recommendations in order to reduce human error and prevent any kind of damage occasioned for human error.

This work used a convenience sample of 10 subjects, who used the anthropometer at least once, in laboratory conditions. The device (anthropometer) has 3 measurement scales, base support for scales, and stick-holder which indicates the measurement.

2. OBJECTIVES

2.1 General Objective

Analyze the task of anthropometer assembly through the Hierarchical Task Analysis (HTA) with the purpose of organizing and representing the cognitive and physical tasks that belong to this assembly, and ensuring that none of those tasks are omitted. Identify different types of errors that users can commit, through SHERPA technique.

2.2 Particular Objectives

Obtain data and information about difficulties in the anthropometer assembly.
Analyze the task by means of HTA.
Analyze the task to study the possibilities of human error through SHERPA method.
Provide a set of recommendations about design, based on results obtained.

3. LITERATURE REVIEW

There is a variety of literature about methodologies for the human error study as: Task Analysis for Error Identification (TAFEI), Systematic Human Error Reduction and Prediction Approach (SHERPA), Human Error Template (HET), Technique for the Retrospective and Predictive Analysis of Cognitive Error (TRACEr), Human Error HAZOP, Technique for Human Error Assessment (THEA), Human Error Identification in Systems Tool (HEIST), The Human Error and Recovery Assessment Framework (HERA), System for Predictive Error Analysis and Reduction (SPEAR), Human Error Assessment and Reduction Technique (HEART), The Cognitive Reliability and Error Analysis Method (CREAM), among others (Stanton et al., 2005a).

However, for purpose of this study, SHERPA technique was used due to the easiness it provides when being used and reliability of data. This work arises because in static anthropometry, there is an artifact that is used to measure different human body segments, it is called anthropometer, which is generally portable and requires an assembly prior to use, this assembly consumes time, which considerably increases when during the assembly a human error is committed. Hence, the need to achieve this study, for detecting potential errors that people make when they perform the assembly.

SHERPA technique (Systematic human error reduction and prediction approach), is a method for human error analysis, developed for Embrey (1986), it's a prediction technique that also analyses tasks and identifies structured solutions to errors (Stanton, Hedge, Brookhuis, Salas, and Hendrick, 2005b). This human error analysis consists of a computed question/answer of routine that identifies the most common errors for each step during the task analysis (Kirwan, 1992).

The process starts with the analysis of work activities, using the Hierarchical Task Analysis (HTA), which provides a convenient way to identify, organize and represent the selected tasks and sub-tasks that are included in a complex activity.

The beginning for an HTA, consists in describing the main goal of an activity. Then, the analyst describes the main goal both wide and narrow detail, but understanding a group of sub-goals (Annett, 2003). This re-description process is followed by the development of a group of tasks hierarchically organized, which are described from lower levels of this hierarchy with enough detail for the analysis. It is important to note, that the main purpose of HTA is to provide an analysis for understanding the relationship between different task's elements and ensuring that none of those tasks are omitted (Sandom and Harvey, 2004). HTA not only analyses actions, also analyses goals and operations, and ways to achieve the aims (Stanton et al., 2005b).

The use of HTA is imminent, due to the wide scope of fields and applications where it can be focused and it should serve as benchmark for all other ergonomics methods. The key features of the approach are that it was not only developed on theoretical foundations, but also on solving real-world problems, its main characteristic is that hierarchy sub-goals is flexible enough for any kind of analysis, therefore it may be the beginning of ours (Stanton,2006).

SHERPA uses a HTA in conjunction with error taxonomy to identify credible errors associated with sequence of human activity. SHERPA technique operates indicating which error modes are credible for each task step upon this analysis of the work activity (Harris et al., 2003). Despite being developed originally for use in industrial process, the SHERPA behavior and error taxonomy is generic and can be applied in any domain involving human activity (Stanton et al., 2005a).

Some authors, as Stanton et al. (2002), have developed studies with SHERPA methodology for analyzing a flight deck during automatic landing, with the aim of providing some evidence for the reliability and validity of the method in aviation domain. They found that results are promising to SHERPA, and even novices showed ease of learning to apply the technique.

On the other hand, Harris et al. (2005), evaluated the suitability of the SHERPA technique in an aerospace context. It was found that many of the potential errors that were identified were types of errors that most pilots were aware of, and they accepted to committing them during everyday operations. This paper demonstrates that SHERPA can already be applied as a flight deck design evaluation tool, although during the initial phase, the HTA may be time consuming. Another research developed by Stanton (2002) was an analysis for a vending machine, through different techniques for analyzing human error. The findings showed reliability for SHERPA and TAFEI, it was also found that SHERPA is better because of its great number of error detections, with the only inconvenient of producing more false alarms.

4. METODOLOGY

4.1 Material

To develop the analysis it was use an anthropometer, which is shown in Figure 1, surveys and photographic camera.

4.2 Method

Methodology contains three phases, the first one for data collection, the second phase for HTA development, and the last one phase to make the analysis by means of SHERPA.

Figure 1. Anthropometer parts.

4.2.1 Data Collection

This phase consisted in applying the survey to 10 subjects. It was a convenience sample where every subject was student of Industrial Engineering career from Universidad Autonoma de Ciudad Juarez, who used the anthropometer at least once. First of all, the reason of the work was explained to them, then they answer a survey, related to anthropometer assembly, with the aim to know what kind of errors have committed during the assembly.

4.2.2 HTA Development

Anthropometer assembly was done step by step for HTA development, at the same time each one of the required activities for the assembly was registered, without omitting some of them, until thoroughly understood the anthropometer assembly as shown in Figure 2.

Figure 2. Assembled anthropometer

4.2.3 SHERPA Analysis

After HTA development, an Excel® table was created, in which every activity involved in the anthropometer assembly was classified in action, retrieval, checking, selection, and information communication.

Then, the phase of Human Error Identification started, based on the table of error taxonomy from SHERPA, shown in Table 1, where possible errors for each one of the tasks were considered, according to the classification of each one of them, that information was collected in the same Excel® table.

Table 1. Error Taxonomy from SHERPA

Action error		Checking error	
A1	Operation too long/short	C1	Check omitted
A2	Operation mistimed	C2	Check incomplete
A3	Operation in wrong direction	C3	Right check on wrong object
A4	Operation too little/much	C4	Wrong check on right object
A5	Misaligned	C5	Check mistimed
A6	Right direction on wrong object	C6	Wrong check on wrong object
A7	Wrong operation on right object	Selection error	
A8	Operation omitted	S1	Selection omitted
A9	Operation incomplete	S2	Wrong selection made
A10	Wrong operation on wrong object		
Retrieval error		Information communication error	
R1	Information not obtained	I1	Information not communicated
R2	Wrong information obtained	I2	Wrong information communicated
R3	Information retrieval incomplete	I3	Information communication incomplete

Then, the consequences associated to each previously identified error, and the chance of recovery were described. Once the previous step was done, the probability of committing errors was estimated through the survey, where the users indicated the more common errors, a value was assigned for the error probability of occurrence of the error, either low, medium or high, according to frequency of occurrence. After that, based on the type of consequences produced for these errors, it was analyzed if these were considered critical or not, to finally plant possible solutions and strategies, with the aim to reduce error.

5. RESULTS

The results of this study are presented in this section. First the results from the Hierarchical Task Analysis will be deployed in diagram and tabular style, and finally the SHERPA method development. In Figure 3, is shown the resulting HTA diagram, where the hierarchical order of the activities to be performed to do the anthropometer assembly, can be observe through a flow chart.

The main task was established, called “Assembly an anthropometer” from which a series of subtasks are derived from, and each one is broken down into several steps to accomplish the main task; they contain a plan to indicate the order to follow in each step.

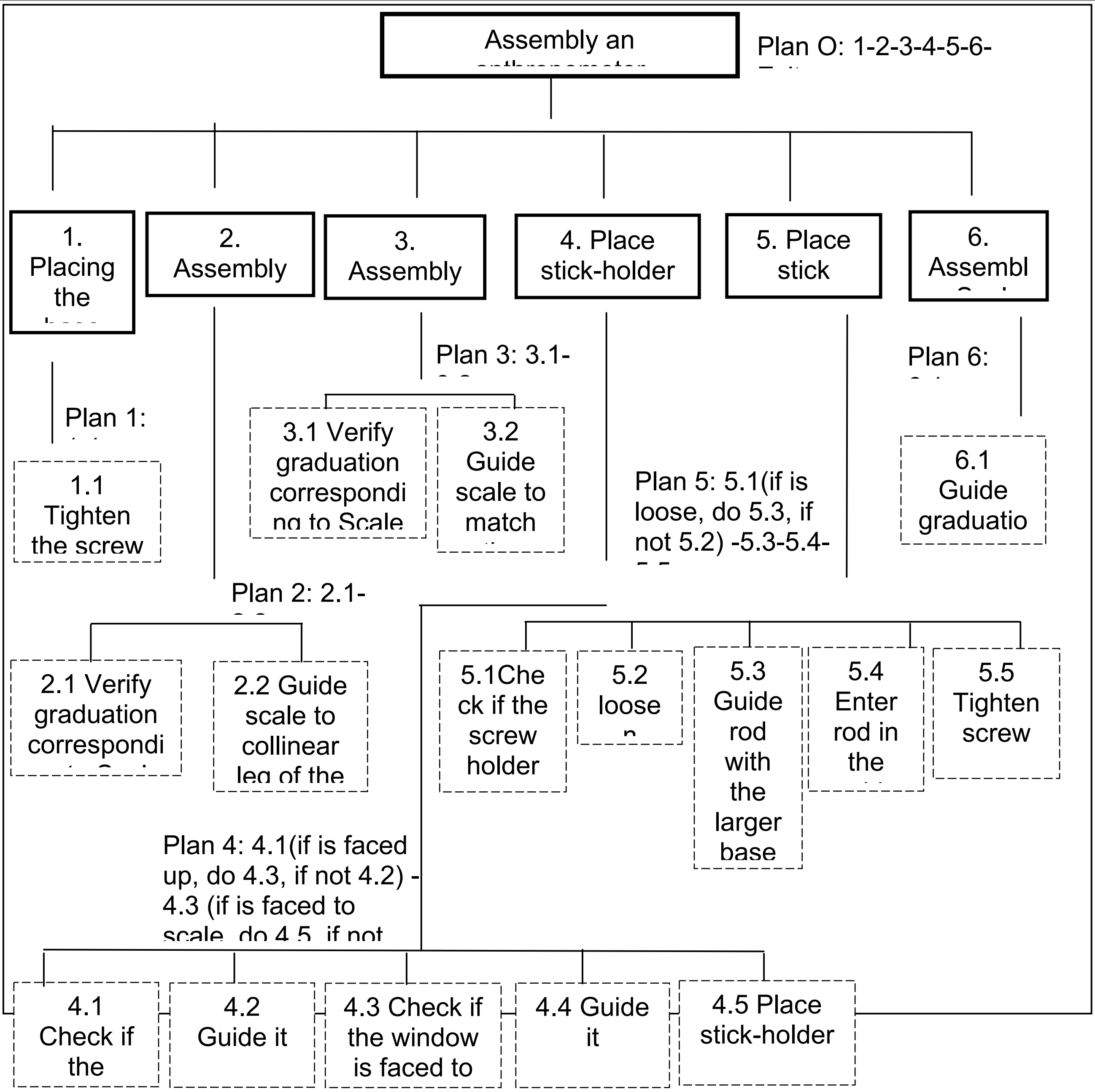

Figure 3.HTA diagram of the anthropometer assembly

In Figure 4, can be appreciated the HTA tabular obtained to assembly the anthropometer, where each of the sub-tasks and respective plans is shown, with the order in which each of these should be performed, this is represented by rows.

0. Properly assembly of an anthropometer
   Plan 0: Do correctly 1-2-3-4-5-6-Exit
   1. Placing the base
      Plan 1: Do 1.1
      1.1 Tighten the screw head
   2. Assembly Scale 1
      Plan 2: Do 2.1 and then 2.2
      2.1 Verify that it is the graduation corresponding to the Scale 1 graduation number 0 to 70.
      2.2 Guide the scale to one of the collinear legs of the base.
   3. Assembly Scale 2
      Plan 3: Do 3.1 and then 3.2
      3.1 Verify that it is the graduation corresponding to the Scale 1 graduation number 70 to 140.
      3.2 Guide the scale to match the Scale 1.
   4. Place stick-holder
      Plan 4: Do 4.1, and then 4.1 and finally 4.3
      4.1 Check if the screw is facing up, if NO guide it, if YES do the step 4.2
      4.2 Check if the window faces the graduation of the scale, if NO guide it, if YES do the step 4.3
      4.3 Place stick-holder
   5. Place stick
      Plan 5: Do 5.1, then 5.2, then 5.3 and finally 5.4
      5.1 Check if the screw rod holder is loose, if NO loosen, if YES continue to step 5.2
      5.2 Guide rod with the larger base down
      5.3 Enter rod in guide, starting in the measurement area until it comes out the other end
      5.4 Tighten screw
   6. Assembly Scale 3
      Plan 6: Do 6.1

Figure 4. HTA tabular of the anthropometer assembly.

Then, Table 2 was obtained, it contains the SHERPA method development, which includes the rankings of the sub-tasks included in the HTA, with its own error, property, consequence of each one of them, as well as the chance of recovery. This table also includes the likelihood of committing these errors, based on applied surveys. A column for criticality is also displayed, in case that these are considered critical; they are identified with an exclamation mark.

The sub-tasks classified as the most critical were “tighten the screw head” and “verify graduation corresponding to scale”, because in the first one, this error can produce the equipment fall and therefore damage it. While an error in the second mentioned sub-task, give a wrong measurement.

Possible solutions to reducing the frequency of errors discussed above are included in the last column of the SHERPA table.

Table 2. SHERPA for the anthropometer assembly

Step of the task	Type of Error	Description of Error	Consequence	Recovery	P	C	Suggestions
1.1	A8	Forget tighten screw	Base without stability	2.1	H	!	Implement instructions with photos.
2.1	C4	Select another scale	Incorrect scale ordination	2.2	H	!	Scales with number and distinctive color.
2.2	A3	Incorrect orientation of the scale	Graduation not observed	3.1	M		New exterior trapezoidal form for the scale, as well as different internal assembly for each scale.
3.1	C4	Select another scale	Incorrect scale ordination	3.2	H	!	Scales with number and distinctive color
3.2	A3	Incorrect scale ordination	Graduation not observed	4.1	M		New rectangular shape for the scale, and different internal assembly for each scale.
4.1	C1	Not check screw orientation	Problems by placing rod	4.2	L		Implementing instructions with photos
4.2	C1	Not check window orientation	Problems to observe the graduation	4.3	L		Trapezoidal exterior form of the scale.
4.3	A3	Put in the wrong direction stick-holder	Problems to observe the graduation	5.1	L		Trapezoidal exterior form of the scale.
5.1	C1	Skip verification of screw	Problems by placing the rod	5.2	L		Trapezoidal exterior form of the scale.
5.2	A3	Place the rod in the wrong direction	Take erroneous measurement	5.3	L		Placed on the top rail of the rod.
5.3	A9	Not insert the rod	Will not reach the measuring rod	5.4	L		Set mark to indicate the top of rod.

		completely				
5.4	A8	Not tighten screw	The rod can leave	6.1	L	Implementing instructions with photos
6.1	A3	wrong orientation	Not observed graduation	Immediate	L	Scales with number and distinctive color.

6. CONCLUSION

The objectives for this case study; analyzing the task of anthropometer assembly, obtaining data and information about difficulties during the assembly, studying the possibilities of human error, and providing a set of recommendations in order to reduce human error, were achieved through the application of Hierarchical Task Analysis and SHERPA technique. Different errors that people can commit during the anthropometer assembly were identified. Main problems and difficulties that users face also were detected through the applied survey while they interact with this interface. The most frequent errors and the likelihood of committing them were identified by means of the applied survey.

An HTA was obtained for the anthropometer assembly and allowed the classification of each one of the potential errors, as well as the likelihood of occurrence. Also, the sub-tasks classified as the most critical were "tighten the screw head" and "verify graduation corresponding to scale".

Finally, a set of recommendations and possible viable solutions were proposed for each identified error, with the aim to reduce them. The proposed recommendations were: the implementation of an instructive with pictures, another one is a redesign of the scale where its external shape is trapezoidal as well as a different internal assembly for each scale, these scales in a different color each one of them and numbered.

In the other hand, it is recommended to place a rail on the top of the rod having the function of guide, and set a mark to indicate the top of the rod.

In this case study it is found that the SHERPA technique is not exclusive to the field of aviation, but can be applied in different contexts; it further noted that the technique is practical and simple to use.

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ERGONOMIC EVALUATION BY RULA METHOD OF STYLIST USING AN STRAIGHTENING IRON AT LOS MOCHIS, SINALOA.

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INTRODUCCION. . El trabajo se vuelve día a día algo indispensable y necesario para nuestras vidas, es por eso que debemos estudiar la manera o la forma en la que cada persona realiza su trabajo. La herramienta de mano utilizada para el planchado o alaciado de cabello, es empleada por los trabajadores de las diferentes estéticas siendo esta de cerámica, placas de titanium y cubierta exteriores de aislantes, teniendo un peso aproximado estándar 1.300 kg. Y un brazo de sujeción con acabados anti ergonómicos. OBJETIVO. Evaluar por medio del método RULA la herramienta que se utiliza y un rediseño propuesto para reducir y/o eliminar los posibles DTA´s y Fatiga, en una estética en la ciudad de Los Mochis, Sinaloa. DELIMITACION. Está delimitada a la evaluación en una estilista de la estética Lili, la cual en una investigación de posible fatiga y desorden de trauma acumulado se encontró que está desarrollando fatiga y dta´s. METODOLOGIA. Se observa a la trabajadora por varias jornadas de trabajo para ver las posturas que se manejan durante sus turnos. Se observa la herramienta de mano utilizada para la realización del trabajo en este caso el planchado de cabello, se aplica el método RULA alaciando con la herramienta que utiliza y después con un la herramienta rediseñada. RESULTADOS. Con la herramienta sin rediseño de 4 investigación futura y con el rediseño propuesto de 2 aceptable. CONCLUSIONES. Es importante enfocarse a las necesidades de cada persona para desempeñar cualquier puesto, y así poder evitar la fatiga, y los DTA´S por el mal uso de herramientas, las malas posturas adoptadas, y los trabajos repetitivos ya que esto es parte de la seguridad.

INTRODUCTION. The work becomes indispensable every day and necessary for our lives, that is why we must study the manner or form in which each person does their job. The hand tool used for pressing or straightening of hair, is used by workers in this being different aesthetics ceramics, titanium plates and insulating outer cover having a standard weighing approximately 1,300 kg. And a supporting arm with ergonomic anti finishes. OBJECTIVE. Evaluate through RULA tool is used and a proposed redesign to reduce and / or remove any CTD's and Fatigue in aesthetics in the city of Los Mochis, Sinaloa. DELIMITATION. It is bounded to the evaluation of the aesthetic stylist Lili, which in an investigation of possible fatigue and CTD´s was found that fatigue is developing and dta's. METHODOLOGY. The worker is observed by several days of work to see the positions that are handled during their shifts. Note the hand tool used to perform the work in this case the hair ironing, applies RULA with the tool you use and then with a redesigned tool. RESULTS. With the redesign of 4 tool without further research and the proposed redesign of 2 acceptable. CONCLUSIONS. It is important to focus on the needs of each person to perform any job, so you can avoid fatigue and CTD's by the misuse of tools, poor posture adopted and repetitive jobs as this is part safety.

Keywords: RULA, ERGONOMIC EVALUATION, STRAIGHTENING IRON.

In Lili Cosmetic company, where they work mostly female staff, it was observed that a large number of users requesting the services of straightening, Chinese, ironing which require a straightening iron to fulfill their requests and an effort of the employees performing the work. He thought of how to support women workers in these places to make it easier to work through ergonomic redesign the tool, such as a hair straightening iron. The hand tool used for pressing or straightening of hair, is used by workers in this being different aesthetics ceramics, titanium plates and insulating outer cover having a standard weighing approximately 1,300 kg. And a supporting arm with antiergonomic finishes, this eventually causes exhaustion, fatigue, muscle aches, taking into account that this tool is used by most workers in this area.
Based on research by Dagnino C., Leyva A. and L. Ramirez L. (2011), which found that physical fatigue was developed and DTA's possible there is concern redesign work hand tool (straightening), initially taking the performance area of aesthetic being is the focus of research .

OBJECTIVE. Evaluate through RULA tool is used and a proposed redesign to reduce and / or remove any CDT's and Fatigue in aesthetics in the city of Los Mochis, Sinaloa.

METHODOLOGY. After analyzing the research area, there are several points such as that all the time were the same positions of the workers and the activities were repetitive. Is also detected which was very slow the process of ironing this hair can be a bit faster. First you look at the workers for several days of work to see the positions that are handled during their shifts, how they felt after work and time to do well. Note the hand tool used to perform the work in this case the hair ironing, and concludes that in designing or redesigning that same hand tool can reduce fatigue and CDT´s caused to workers. Based on this method is applied to solve research RULA the stylist who encountered major problems of fatigue and possible CDT's performing activities such as: RULA method is applied before the redesign.
Video is taken the worker at the time of their activity and to compare the study was conducted after the improvement of physical performance that is obtained and performance is also mentioned in the productive for the company, as it allows reducing the fatigue and poor posture when performing such work.
This is the way it works with the hand tool designed for ironing hair before RULA evaluation and implementation of new design, as shown in Figure 1 and Figure 2, the original hand tool.

Figure 1 Use of tool

Figure 2 Original Hand Tool
Made of ceramic and titanium plates

Anthropometric study was performed with a brand anthropometer Clarita, in an investigation of a hand tool for making donuts. Valdez L and Ramirez L. (2011) took measurements of the width of the palm, lard palm, grip, hand over, in this investigation are added measures from floor to waist, floor-to-shoulder, elbow to middle finger hand, elbow to wrist, arm outstretched measured to staff working in the aesthetic as they all have the same opportunity to make this work, being pure women, morning and evening shifts.

According to the measurements are taken the results obtained lead to the completion of the redesign. First survey shows that marked that 69% of workers, ie, most of them were from the city of Los Mochis, and according to the results show that most parents were also born in the city of Los Mochis. With 49% the popes born in that city, and the breast by 47%.

It is also noted that taking into account the 2 shifts were morning and evening, there is a higher percentage of men and women 79% only 21%. After obtaining the anthropometric measurements taken at each of the 75 workers interviewed, they choose only those necessary for the completion of the redesign.

And taking and the idea of redesigning the hand tool, based on the observations and evaluations applied for assistance from the RULA method is continued to the decision of the redesign.

Used only 3 steps to making this, which are the width of the palm, grip and arm's length. Percentiles are determined according to each measure, to take this a step to develop a standard and ergonomic redesign. It lists the 75 measurements obtained in descending order, ie from largest to smallest (width of the palm, grip and arm extended). Table shows the measures, together with the equivalent percentiles to each value, taking only the 3 measures chosen for the development of the redesign.

• The width of the hand: To determine the percentage used in this measure, the data are arranged in descending order, and choose to take 95% percentile as the average measure for the development of the redesign, in this case are shown in Table (Table.1) that 95% the person falls between 4 and 5 the person selected number with red, having both the same extent, so as to choose in this case would be 10 cm.

This resulted in agreement to the following.

If 100% percentile is equivalent to the 75 workers interviewed, we applied a rule of 3 for the percentage of each worker according to the values of the table (Table 1)

100% ¿? = 98.66%
75 T. 74 T.

And so on is done with each of the steps to get the percentage that amount.

This shows that any of the 75 workers who use this tool in hand, will have no problems when applying for work redesign. We see a range of 10.5 cm (high) to 7 cm (low).

Table 1 Measurements of the width of the hand and percentiles

	PERCENTILES	**ANCHO DE LA MANO**
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

.

Grip: We fit the data in descending order, and choose to take the 5% percentile, because if you take the 95% data is higher for people with more grip, workers with a less grip they would have great difficulty when using the tool. That's why we take the 5% percentile; it performs the same token, used to the width of the hand, to obtain the percentiles of each value. This is seen in Table (Table 2) to the extent that occupies 5% percentile is a grip 35. Which is marked with a blue background.

Table 2 Measures of grip and percentiles

	PERCENTILES	**AGARRE**
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

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The extended arm: We fit the data in descending order, and choose to take the 5% percentile, because if you take 95% ie people with longer arms, workers with shorter arms were to have great difficulty when using the tool according to the position, as they would have to stoop or stretch too much, what would cause bad posture. That's why we take the 5% percentile; it performs the same token, used to the width of the hand, to obtain the percentiles of each value. This is seen in Table (Table 3) to the extent that occupies 5% percentile is a measure of 70 cm. Which is marked with green background.

Table 3 Measures of the outstretched arm and percentiles

	PERCENTILES	**BRAZO EXTENDIDO**
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

.

Is evaluated again with the RULA method after application of the redesign on the workstation, and to observe the results obtained with the implementation of this redesign. Basing with the purpose of this research.

First shows the evaluation applied before the redesign, giving a score of 4 (4 further investigation), this means that it is necessary to make a further investigation as soon as possible. (Figure 3 assessment applied before the redesign). As shown here the bids were at first, and the way people worked, considering also that the chair in which they performed their work is not allowed to take the best position as it was not the appropriate to their needs in terms of height measurements of the chair, to do the job, that they had caused to bend the neck too, and they had to stretch or bend too much at the time of ironing hair.

Figure 3 presents the evaluation made by the RULA redesign

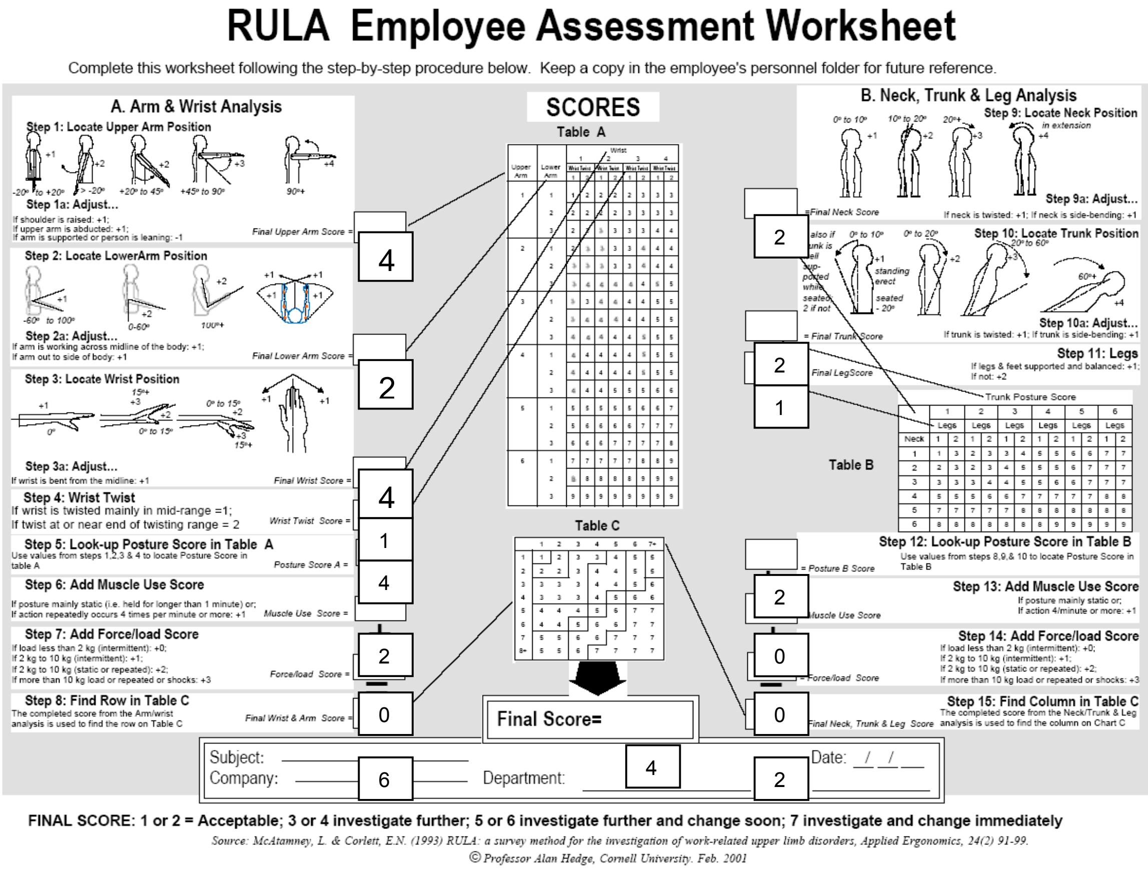

Figure 3 Assessment applied before the redesign.

Giving a score of 4 (4 research in the future), this means that it is necessary to make a further investigation as soon as possible. (Figure 3) evaluation applied before the redesign). As shown here the bids were at first, and the way people work, taking into account also the chair in which they performed their work is not allowed to take the best position as it was not the appropriate to their needs in terms of height measurements of the chair, to do the job, that they had caused to bend the neck too, and they had to stretch or bend too much at the time of ironing hair.

While in the evaluation (Figure 4) with application of the redesign of the hand tool, providing a level of 2 which is an acceptable level (1 or 2 Acceptable). As shown the positions have changed dramatically, achieving the level of acceptance based on RULA. In group A, which is the top, it shows that the arm is bent, that the position of the forearm is straight, the wrist and does not flex down and therefore gives a score that was lower than previously. In group B, where you take account of the trunk neck and legs, also observed the change of position, as the neck and trunk lean if not both, due to the adjustment of the worktable and position taken by the worker taking the hand tool redesigned.

Figure 5. Use of new tool. Made of ceramic and titanium plates

Figure 6 redesigned hand Tool.

This is the way in which the work must be redesigned with the hand tool for the finishing of hair during the evaluation RULA (Figure 5) and the new design as shown in Figure 6.

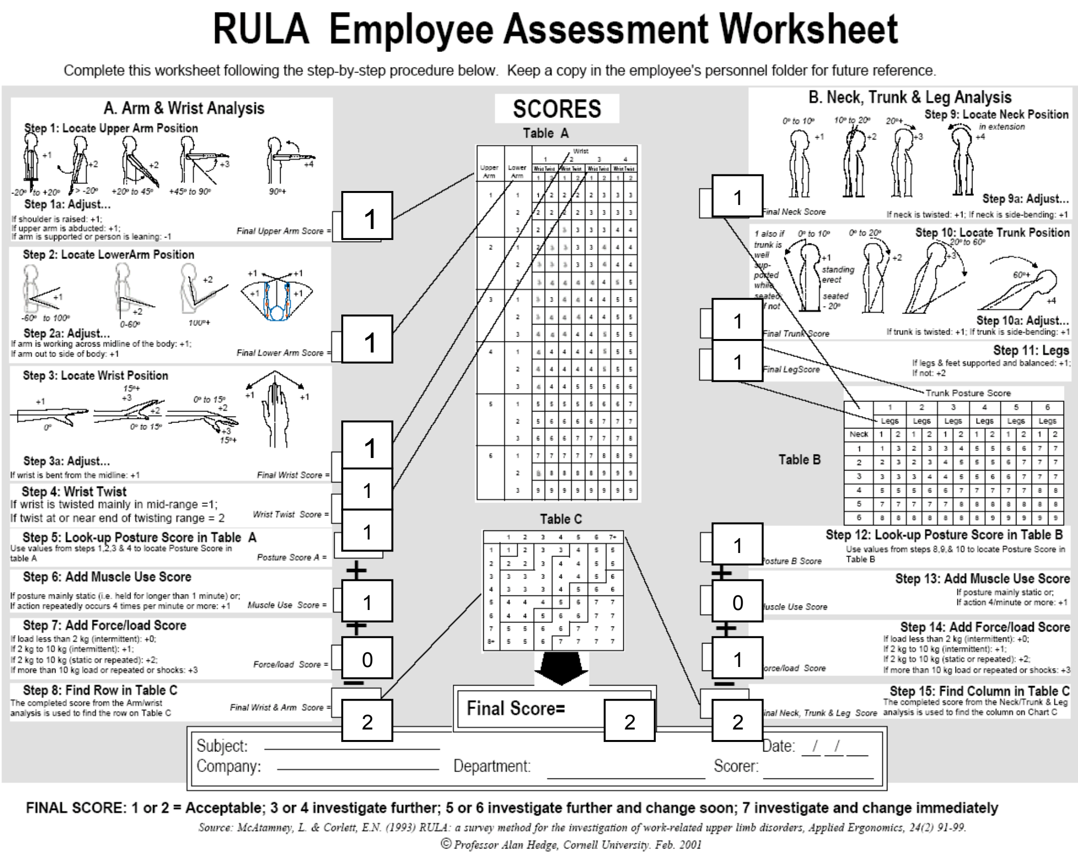

Figure 4. Assessment applied after the redesign.

Discussion/Conclusions

Today most companies care about their staff, since the human factor will always be the main part for the proper functioning or growing a business. These are concerned with providing protective equipment necessary for their activities and this certainly take care of industrial safety and the tools needed to conduct business in any job.

It is important to focus on the needs of each person to perform any job, so you can avoid fatigue, and CDT'´s which can be garnered by the misuse of tools, poor posture adopted and repetitive jobs as this is part safety.

Based on research conducted through surveys of a population of 75 employees of a bakery, and the use of tools such as the method RULA, photos and videos, it was the redesign of this tool in hand, which helped to a significant improvement in the worker at the time of use.

It is noted that a level 4 where research was needed quickly decreases to a level 2 being this an acceptable level, as the positions changed completely when using the new tool, and this helps workers become fatigued both the performance of repetitive work..

The application of RULA proved very productive, since it provided the basis for the implementation of the redesign, taking into account that this method has significant advantages since it does not use any special equipment to perform the evaluation, and can be applied in any place. Apart from being a method of quick and easy application that provides clear results.

As mentioned above, to fund this research and test the effectiveness of the redesign RULA method is applied for the assessment of risks they were exposed, within which we can mention poor posture, repetitive movements, or other forces applied.

Ergonomic studies are not limited to man-workplace problem, but go beyond, applying its criteria and schemes to any human activity, both in production and in daily life.

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DETERMINATION OF FREQUENCY OF COMPLAINT OF FATIGUE AND ANALYSIS OF SUBJECTIVE SYMPTOMS OF FATIGUE PRESENTED IN FOOTWEAR CLEANERS IN DOWNTOWN LOS MOCHIS, SINALOA

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Resumen. INTRODUCCIÓN. Los aseadores de calzado, conocidos también como “lustrabotas”, son personajes característicos de México y América Latina, dado que han ocupado las calles más concurridas de sus ciudades para el aseo y mantenimiento personalizado de zapatos y botas, principalmente. **OBJETIVO.** Determinar la Frecuencia de Quejas de Fatiga (FQF) y analizar los síntomas subjetivos de fatiga presentados en los aseadores de calzado de la Zona Centro de Los Mochis, Sinaloa. Esta investigación considera a los FQF’s generales y semanales de una muestra de 34 sujetos. **DELIMITACIÓN.** Aseadores de calzado de la Zona Centro de la ciudad de Los Mochis, Sinaloa, ubicados en los alrededores del Mercado Independencia. **METODOLOGÍA.** Este trabajo se basa en la encuesta arrojada por los estudios realizados por H. Yoshitake (1978), los cuales tenían la finalidad de indicar los tres patrones característicos de síntomas subjetivos de fatiga: somnolencia y monotonía, dificultad de concentración y proyección de daño físico. **RESULTADOS.** La aplicación del cuestionario de Yoshitake (ver Fig. 11 y 12), dividido en tres categorías, resultó en un FQF de 4.39 % para somnolencia y monotonía, 1.90 % para dificultad de concentración y 4.08 % para proyección de daño físico a la hora de entrada . A la hora de salida, el FQF de somnolencia y monotonía se incrementó a un 7.07 %, 2.96 % en dificultad de concentración y 6.94 % en proyección de daño físico (ver Tabla 1). **CONCLUSIONES.** En general, el FQF se presentó en niveles que no superaban el 10 %, considerando individualmente a la monotonía, concentración y daño físico, correspondiendo el mayor valor a la primer clasificación. Asimismo, todos los FQF presentaron un incremento a la hora de salida.

Adicionalmente, la mayor parte de los síntomas corresponde a la somnolencia y monotonía y a la proyección de daño físico, quedando en último lugar la dificultad de concentración. Es importante realizar ejercicios que ayuden a combatir la tensión y problemas derivados del trabajo sedentario con pocos descansos.

Abstract. INTRODUCTION. Footwear cleaners, also known as "lustrabotas", are traditional characters of Mexico and Latin America, as they have occupied the busiest streets of their cities for cleaning and maintenance of boots and shoes. **OBJECTIVE.** To determine the frequency of complaints of fatigue and analyze the subjective symptoms of fatigue presented in footwear cleaners from Downtown Los Mochis, Sinaloa, with a sample of 34 subjects. **DELIMITATIONS.** Footwear cleaners in Downtown Los Mochis, Sinaloa, located near “Independencia” flea market. **METHODOLOGY.** This work is based on the survey presented by H. Yoshitake studies (1978), which were intended to show the three characteristic patterns of subjective symptoms of fatigue, drowsiness and dullness, difficulty of concentration and projection of physical impairment. **RESULTS.** The Yoshitake questionnaire application (see Figure 11 and 12), divided into three categories, resulted in a frequency of 4.39 % for drowsiness and dullness, 1.90 % for difficulty of concentration and 4.08 % for the projection of physical impairment at arrival time. At departure time, the drowsiness and dullness frequency increased to 7.07 %, difficulty of concentration obtained a 2.96 % frequency and there was a 6.94 % for physical impairment (see Table 1). **CONCLUSIONS.** In general, the frequencies obtained did not exceeded 10 %, considering separately the dullness, concentration and physical impairment. All frequencies showed an increase at departure time. Additionally, most of the symptoms correspond to drowsiness and dullness, and projection of physical impairment, leaving difficulty of concentration at third place. It is important to exercise in order to minimize stress and problems of sedentary work with few breaks.

Keywords: Yoshitake Questionnaire, Frequency of Complaints of Fatigue, Footwear cleaners.

1. INTRODUCTION

Within the history of mankind, work has been an important source of subsistence and personal growth. Work activities have consequences for the general population and for individuals. The economically active population performs functions within the social structure, such as provisioning of services and overall progress for people, as well as motivation for the community. On the other hand, there are physical and psychological consequences on workers, related to the type of activities that are carried out, which affect their welfare and quality of life. According to Gran Coleccion de la Salud: *La Salud y la Mente I* (2004), *work* regularly is an essential part of life, it is a source of income, self-esteem, status, social relationships, and provides a sense of achievement and integration. It also establishes that service provision is considered by some psychologists as more stressful, since it requires an interaction with customers, which is often exhausting.

A wide variety of services are offered, according to population’s needs and traditions. Moreover, activities vary according to formal and informal self-employment, etc. Informal economy is a source of income for an important sector of the population.

According to the *Instituto Nacional de Geografia y Estadistica* (2011), known by its acronym INEGI, the employment rate in the informal sector corresponds to 29.20 % of the employed population in the last quarter of 2011, this means that about a third of people working in the country occupies with activities related to the informal sector.

According to INEGI reports, *La Razon de Mexico* (2011) published an article which states that "...the number of people who works in the informal sector reaches 13.4 million inhabitants..." The informal economy includes different types of activities; one of these is footwear cleaning.
Footwear cleaners, also known as "lustrabotas", are traditional characters of Mexico and Latin America, as they have occupied the busiest streets of their cities for cleaning and maintenance of boots and shoes. This activity, commonly includes long job shifts, therefore workers are more likely to feel exhausted and face difficulties due to lack of concentration, monotony at work or physical damage, among others.

Regarding of fatigue, Gran Coleccion de la Salud: *La Salud y la Mente I* (2004) establishes the following:

Overwork and stress often lead to fatigue. It is characterized by a sense of laziness, lethargy and lack of motivation. Although a person could sleep several hours, he/she may feel tired during the day due to poor quality of sleep. Fatigue is sometimes a direct result of emotions such as boredom and depression rather than lack of sleep. In addition, the author shows the relationship that is commonly created between fatigue and sleep disorders or back pain.

2. OBJECTIVE

To determine the frequency of complaints of fatigue and analyze the subjective symptoms of fatigue presented in footwear cleaners from Downtown Los Mochis, Sinaloa. This research calculates general and weekly frequencies with a sample of 34 subjects.

3. METHODOLOGY

This work is based on the survey presented by H. Yoshitake studies (1978), which were intended to show the three characteristic patterns of subjective symptoms of fatigue, drowsiness and dullness, difficulty of concentration and projection of physical impairment. It also makes use of the methodology used by Dagnino, Leyva & Ramirez (2011) and Estrada, Leyva & Ramirez (2009), for the determination of physical fatigue.

3.1 Method.

1. Define the project's objective and extent, the population to which it is addressed, and the tools required to accomplish its main goal.

2. Determine the sample of subjects to be interviewed, in order to present the project and the benefits of this research.

3. Apply a questionnaire in order to collect general data, which will serve as background information to know the sample's main characteristics.

4. Apply the Yoshitake questionnaire (1978) to the selected sample, everyday during three weeks in order to know the symptoms experienced by the participants.
5. Record the results in Microsoft Excel, for further analysis and determination of the frequency of complaints of fatigue, see equation 1.

Frequency of Complaints of Fatigue (%) =
(Number of replies "Yes" / Number of questions) * 100 (1)

6. Present the conclusions and recommendations.

4. RESULTS

The objective was established as determining the frequency of complaints of fatigue and analyze the subjective symptoms of fatigue from the Yoshitake questionnaire applied to 34 footwear cleaners, this is due to the fact that those were the participants available for research development.

The application of the general questionnaire (see Figure 1) produced the following results: the sample consists exclusively of men, who work 7 days a week, except for one subject, additionaly, only one subject studies besides working. In order to know the participants age, see Fig 2.

The 76.47 % of those surveyed say they feel tired during work (see Figure 3), although 79.41% do not feel they have been ill from overwork (see Figure 4). Most of the sample (41.18 %) believes that the main consequence from work is fatigue, while the 32.35 % says it is accompanied with mental fatigue (see Figure 5).

Regarding the job shift, the 55.88 % works 10 to 12 hours (see Figure 6). The 73.53 % of individuals eat before work (see Figure 7), and half of them uses the city bus for transportation, while bicycle and walking are at second and third places, respectively (see Figure 8).

The 35.29 % of subjects takes 20 minutes to travel from home to workplace and 20.59 % takes 10 minutes (see Figure 9). The 47.06 % of all subjects is not involved in other physical activity before or after work, while 23.53 % walks as a hobby, this being the most practiced activity outside work (see Figure 10).

The application of the questionnaire Yoshitake (see Figure 11 and 12), was divided into three categories, and it resulted in a frequency of 4.39 % for drowsiness and dullness, 1.90 % for difficulty of concentration and 4.08 % for projection of physical impairment at arrival time (see Table 1).

At departure time, drowsiness and dullness frequency increased to 7.07 %, 2.96 % corresponded to difficulty of concentration and 6.94% frequency was directed towards projection of physical impairment (see Table 1). For a weekly analysis of the frequencies presented, see Table 2.

During the analysis of all symptoms presented by footwear cleaners, 42.31% and 41.67% of all symptoms are related to drowsiness and dullness at arrival and departure time, respectively, while 18.35% (arrival time) and 17.45% (departure time) of symptoms is related to the difficulty of concentration. The projection of physical impairment covered the 39.33% of all symptoms, at arrival time, and 40.87% at departure time (see Table 3 and Figures 13 and 14).

For a detailed weekly analysis of the quantity of symptoms, and the percentages for each group, see Tables 4-6 and Figure 15-20.

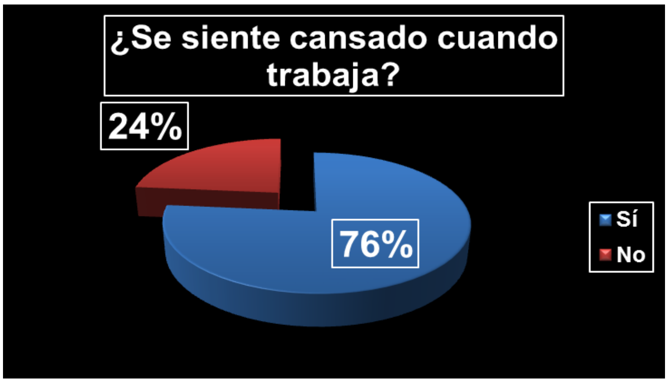


Figure 2. Age

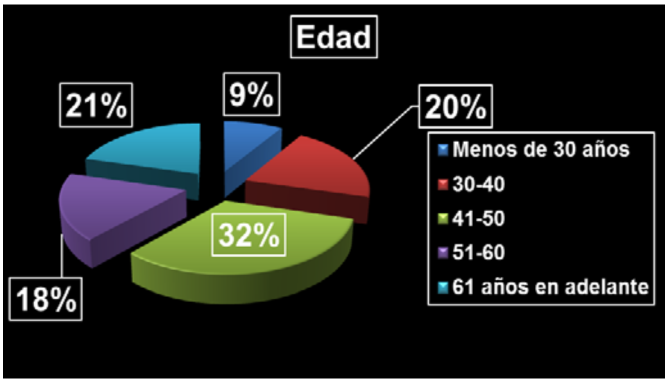


Figure 3. Do you feel tired at work? *Yes (76 %), No (24 %)*

Figure 4. Have you been ill from overworking? *Yes (21 %), No (79 %)*

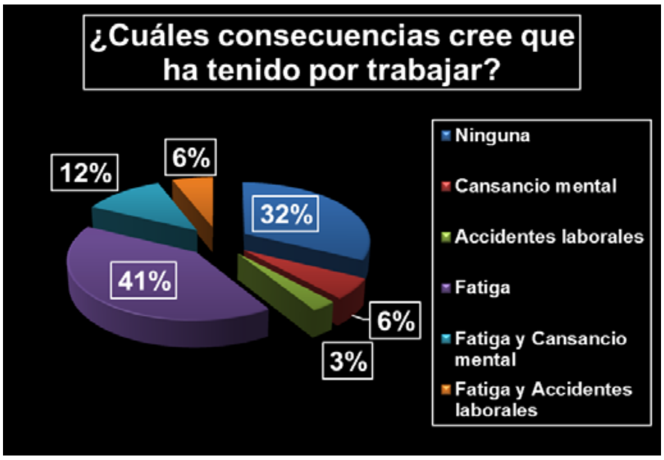


Figure 5. Which consequences have you experienced from overworking? *Fatigue (41 %) None (32 %), Fatigue and mental tiredness (12 %)*

Cuestionario general

Con	1. Nombre del sujeto	2. Género	3. Días de trabajo a la semana	4. Estudia además de trabajar	5. Se siente cansado cuando trabaja	6. Edad	7. Se ha enfermado por trabajar	8. Consecuencias del trabajo	9. Horas de trabajo al día	10. Horario	11. Come antes de trabajar	12. Medio de transporte	13. Tiempo que tarda en llegar	14. Realiza otra actividad
1	Jesús Ramón Mitre Noriega	Masculino	7	No	Sí	44	No	Ninguna	12	7 am - 7 pm	No	Automóvil	10 min	Caminar
2	Diego Mitre	Masculino	7	Sí	Sí	17	No	Fatiga y Cansancio Mental	12	7 am - 7 pm	Sí	Automóvil, Motocicleta y Camión Urbano	15 min	Correr
3	Miguel Galván	Masculino	7	No	Sí	42	No	Fatiga	11	7 am - 6 pm	No	Motocicleta	15 min	Entrenador de fútbol
4	Mario Adolfo Fierro Ruelas	Masculino	7	No	Sí	38	Sí	Fatiga y Cansancio Mental	9.5	7:30 am - 5 pm	Sí	Camión Urbano	20 min	No
5	Enrique Zamora Ramírez	Masculino	7	No	Sí	42	No	Fatiga	10.5	7 am - 5:30 pm	No	Automóvil	20 min	No
6	Irving Enrique Zamora López	Masculino	7	No	No	19	No	Ninguna	5.5	7:30 am - 1 pm	Sí	Camión Urbano	15 min	Karate
7	Jesús Cañedo Nolasco	Masculino	7	No	No	40	No	Fatiga	12	7 am - 7 pm	Sí	Camión Urbano	30 min	No
8	Gilberto Hijar Montiel	Masculino	7	No	Sí	74	Sí	Fatiga y Cansancio Mental	10	7 am - 5 pm	Sí	Bicicleta	10 min	No
9	Mauro Díaz	Masculino	7	No	Sí	30	No	Fatiga	12	8 am - 8 pm	No	Bicicleta	8 min	No
10	Jesús Castañeda Hernández	Masculino	7	No	Sí	43	No	Fatiga	10	8 am - 6 pm	Sí	Bicicleta	20 min	No
11	Marcos Ceceña	Masculino	7	No	Sí	45	No	Fatiga	9	8 am - 5 pm	Sí	Motocicleta	15 min	Fútbol
12	Pedro Ramón Ceseña Vega	Masculino	7	No	Sí	33	Sí	Cansancio Mental	11	8 am - 7 pm	Sí	Bicicleta	20 min	No
13	Óscar Rodríguez	Masculino	7	No	Sí	66	Sí	Fatiga	13	7 am - 8 pm	Sí	Motocicleta y Caminar	30 min	Caminar
14	Miguel Ángel Delgado Leyva	Masculino	7	No	Sí	56	No	Fatiga	14	6 am - 8 pm	Sí	Automóvil	10 min	No
15	Francisco Ceceña Soto	Masculino	7	No	Sí	50	No	Ninguna	12	7 am - 7 pm	Sí	Caminar	20 min	Caminar
16	Jaime Morales	Masculino	7	No	Sí	41	Sí	Fatiga	7	7 am - 2 pm	Sí	Caminar	10 min	Caminar
17	Iván Fernando Armenta Palafox	Masculino	7	No	No	19	No	Ninguna	6	8 am - 2 pm	No	Camión Urbano	10 min	Fútbol
18	Daniel Rodríguez Moreno	Masculino	7	No	Sí	46	Sí	Cansancio Mental	11	7 am - 6 pm	Sí	Camión Urbano	25 min	Ejercicio
19	Felipe Jesús Ramírez Muñoz	Masculino	7	No	No	42	No	Ninguna	6	7 am - 1 pm	Sí	Camión Urbano	20 min	No
20	José Aarón Meza	Masculino	7	No	Sí	36	No	Fatiga y Accidentes Laborales	11	8 am - 7 pm	No	Camión Urbano	30 min	Caminar
21	José Eligio Romero Cota	Masculino	7	No	Sí	62	No	Accidentes Laborales	9	8 am - 5 pm	Sí	Camión Urbano	20 min	No
22	Julio Herrera Ceceña	Masculino	7	No	No	59	No	Ninguna	10	7 am - 5 pm	Sí	Camión Urbano	40 min	No
23	Ramón Robles Cervantes	Masculino	7	No	No	70	No	Ninguna	10	7 am - 5 pm	Sí	Camión Urbano	5 min	No
24	Jesús Mario Cota	Masculino	7	No	Sí	61	No	Ninguna	8	9 am - 5 pm	Sí	Bicicleta	20 min	No
25	Javier Valencia Llanez	Masculino	7	No	Sí	52	No	Fatiga	10	7 am - 5 pm	Sí	Camión Urbano	30 min	Ejercicio
26	José Ildefonso Gonzáles	Masculino	7	No	Sí	38	No	Ninguna	6	8 am - 2 pm	Sí	Caminar	10 min	Caminar
27	Roberto López Romero	Masculino	6	No	No	54	No	Fatiga	10	8 am - 6 pm	No	Bicicleta	15 min	Fumigador y Albañilería
28	Efren Cota Sepúlveda	Masculino	7	No	Sí	36	No	Fatiga y Accidentes Laborales	13	7 am - 8 pm	Sí	Bicicleta	20 min	Bicicleta y Fútbol
29	Felipe Pérez Zavala	Masculino	7	No	Sí	43	Sí	Fatiga	9	10 am - 7 pm	Sí	Camión Urbano	30 min	No
30	Arturo Perea Medina	Masculino	7	No	No	65	No	Ninguna	10	6:30 am - 6:30 pm	Sí	Camión Urbano	60 min	Caminar
31	Manuel Osorio Flores	Masculino	7	No	Sí	65	No	Fatiga	10	7 am - 5 pm	No	Camión Urbano	20 min	No
32	Benito Figueroa Castro	Masculino	7	No	Sí	59	No	Fatiga	11	7 am - 6 pm	No	Camión Urbano	10 min	Caminar
33	Alfredo Rivera Acosta	Masculino	7	No	Sí	59	No	Ninguna	9	8 am - 5 pm	Sí	Camión Urbano	20 min	Correr
34	Crescencio Castro Soto	Masculino	7	No	Sí	70	No	Fatiga y Cansancio Mental	6	8 am - 2 pm	Sí	Camión Urbano	20 min	No
	TOTAL	34												

Figure 1. Results Matrix (General Survey)

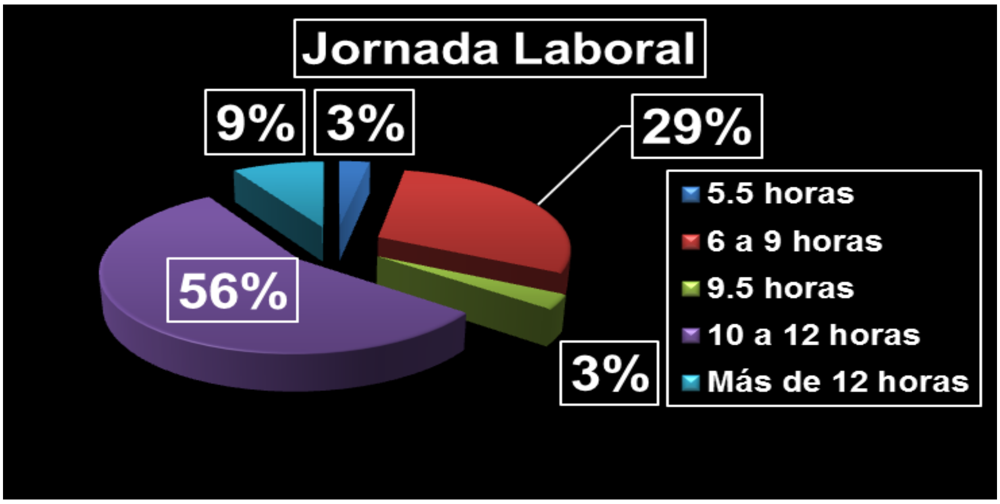
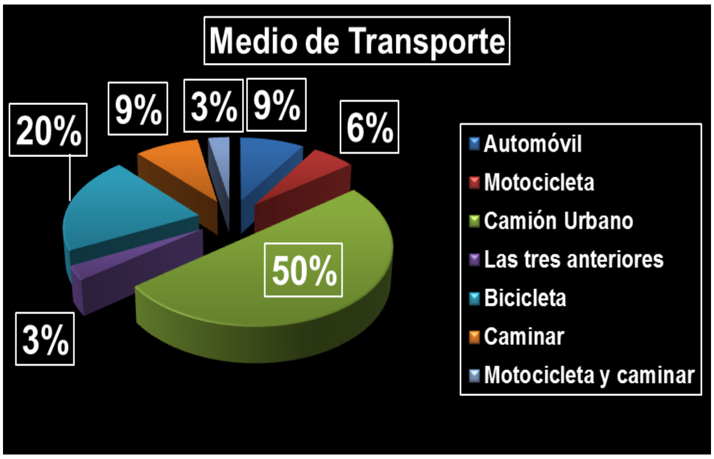


Figure 6. Job shifts



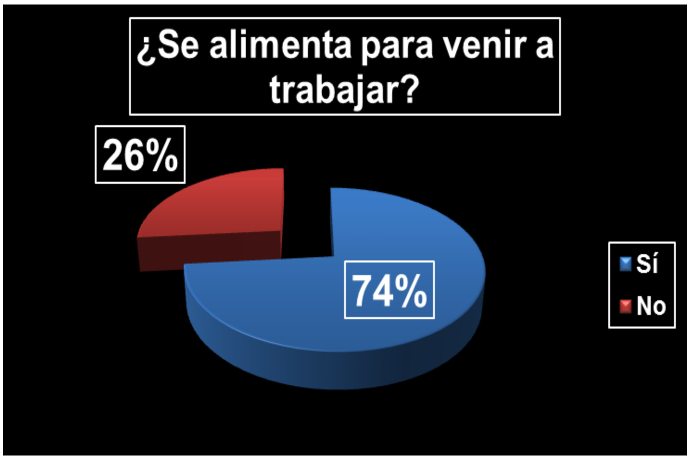


Figure 7. Do you eat before work? *Yes (74 %)*

Figure 8. Means of Transport *City bus (50 %)*

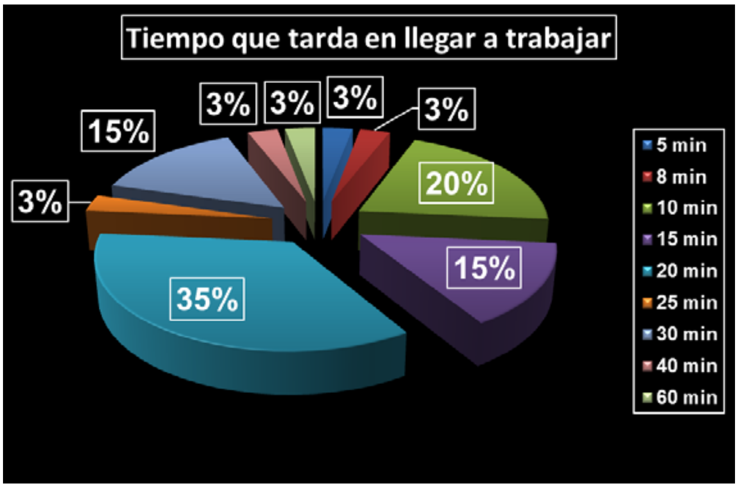


Figure 9. Time needed to get to work
20 min (35 %), 10 min (20 %), 15 min, 30 min (15 %)

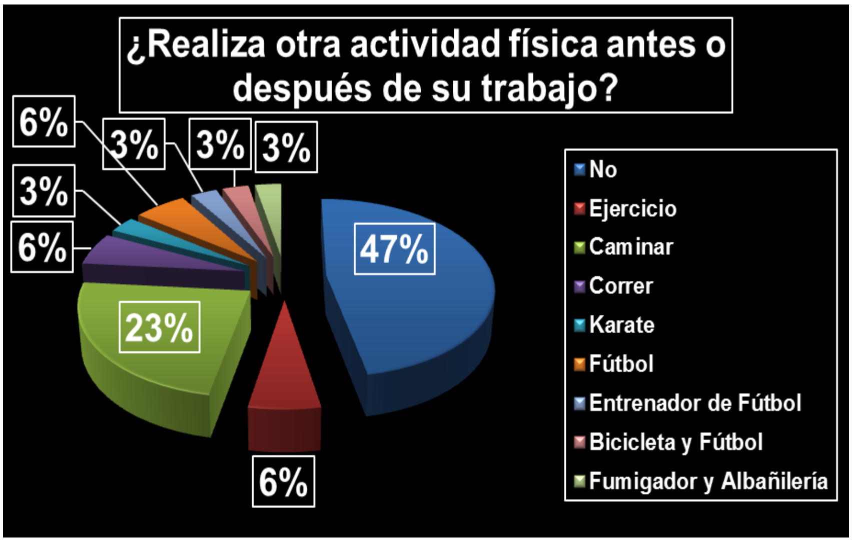


Figure 10. Extra activities *None (47 %), Walking (23 %), Exercise, Running, Soccer (6 %)*

Cuestionario Yoshitake (Hora de entrada)										
		1era semana			2da semana			3ra semana		
No. Control	Nombre del sujeto	Monotonía	Concentración	Daño físico	Monotonía	Concentración	Daño físico	Monotonía	Concentración	Daño físico
1	Jesús Ramón Mitre Noriega	18	1	12	4	1	3	7	3	5
2	Diego Mitre	10	8	7	5	0	0	8	2	11
3	Miguel Galván	16	4	16	10	7	4	7	3	9
4	Mario Adolfo Fierro Ruelas	2	7	14	15	2	9	2	5	3
5	Enrique Zamora Ramírez	18	7	11	8	1	3	4	0	7
6	Irving Enrique Zamora López	11	15	10	15	8	9	8	4	7
7	Jesús Cañedo Nolasco	7	10	16	13	4	5	10	2	9
8	Gilberto Hijar Montiel	22	7	9	19	7	11	10	5	10
9	Mauro Díaz	6	1	6	0	0	0	5	0	1
10	Jesús Castañeda Hernández	21	8	25	12	9	14	14	8	14
11	Marcos Ceceña	10	0	10	14	6	9	9	4	10
12	Pedro Ramón Ceseña Vega	23	3	29	32	0	19	7	3	5
13	Óscar Rodríguez	17	8	6	13	3	6	10	6	10
14	Miguel Ángel Delgado Leyva	10	9	11	3	7	19	4	5	14
15	Francisco Ceceña Soto	0	0	5	3	1	6	7	1	4
16	Jaime Morales	14	4	13	10	1	9	5	3	9
17	Iván Fernando Armenta Palafox	18	25	12	14	12	6	12	10	13
18	Daniel Rodríguez Moreno	11	3	10	13	2	8	6	4	7
19	Felipe Jesús Ramírez Muñoz	15	5	13	17	0	7	6	4	8
20	José Aarón Meza	10	5	12	7	1	6	10	2	9
21	José Eligio Romero Cota	4	2	12	7	3	10	6	1	9
22	Julio Herrera Ceceña	6	6	4	11	0	8	11	1	9
23	Ramón Robles Cervantes	6	1	5	6	5	6	13	2	9
24	Jesús Mario Cota	2	3	4	0	1	3	7	3	8
25	Javier Valencia Llanez	6	3	4	6	2	7	4	4	6
26	José Ildefonso Gonzáles	6	7	5	8	1	9	8	10	6
27	Roberto López Romero	5	4	10	3	3	4	2	1	1
28	Efren Cota Sepúlveda	2	2	1	3	3	8	6	0	5
29	Felipe Pérez Zavala	16	6	25	7	10	16	12	9	21
30	Arturo Perea Medina	8	3	3	8	7	6	8	6	6
31	Manuel Osorio Flores	13	0	5	23	2	12	9	0	5
32	Benito Figueroa Castro	10	2	9	6	2	11	7	1	9
33	Alfredo Rivera Acosta	4	2	2	3	3	5	3	0	2
34	Crescencio Castro Soto	16	8	7	5	0	4	3	1	4
	TOTAL	363	179	343	323	114	262	250	113	265

Figure 11. Yoshitake Questionnaire Results Matrix (Arrival time)

		Cuestionario Yoshitake (Hora de salida)								
		1era semana			2da semana			3ra semana		
No. Control	Nombre del sujeto	Monotonía	Concentración	Daño físico	Monotonía	Concentración	Daño físico	Monotonía	Concentración	Daño físico
1	Jesús Ramón Mitre Noriega	33	5	19	16	2	19	19	9	12
2	Diego Mitre	22	8	18	25	4	22	14	8	14
3	Miguel Galván	16	8	19	13	9	12	10	4	12
4	Mario Adolfo Fierro Ruelas	6	5	18	12	7	13	10	3	10
5	Enrique Zamora Ramírez	17	4	17	11	5	13	4	9	15
6	Irving Enrique Zamora López	7	16	12	4	7	7	9	8	11
7	Jesús Cañedo Nolasco	17	6	15	5	9	4	11	1	7
8	Gilberto Hijar Montiel	37	12	21	21	6	21	28	10	21
9	Mauro Díaz	17	8	17	25	7	20	10	4	14
10	Jesús Castañeda Hernández	19	3	14	32	14	28	14	7	13
11	Marcos Ceceña	14	0	8	20	4	14	13	6	11
12	Pedro Ramón Ceseña Vega	32	4	36	22	5	22	20	6	20
13	Óscar Rodríguez	14	10	17	14	5	8	17	9	11
14	Miguel Ángel Delgado Leyva	6	2	9	11	7	19	12	5	14
15	Francisco Ceceña Soto	3	1	5	5	1	5	10	3	4
16	Jaime Morales	26	5	9	5	1	6	10	1	11
17	Iván Fernando Armenta Palafox	25	28	18	16	16	4	13	5	20
18	Daniel Rodríguez Moreno	6	3	7	8	1	5	6	6	5
19	Felipe Jesús Ramírez Muñoz	4	12	6	12	8	12	11	4	13
20	José Aarón Meza	10	5	11	12	0	16	16	1	25
21	José Eligio Romero Cota	8	4	22	14	9	18	8	1	14
22	Julio Herrera Ceceña	6	6	5	20	4	17	13	2	17
23	Ramón Robles Cervantes	22	4	17	17	9	16	9	6	7
24	Jesús Mario Cota	6	8	13	9	5	10	14	8	5
25	Javier Valencia Llanez	11	2	7	13	6	13	10	7	12
26	José Ildefonso Gonzáles	10	8	9	12	4	15	10	9	7
27	Roberto López Romero	10	7	16	4	7	9	6	7	11
28	Efren Cota Sepúlveda	15	5	12	11	2	14	14	6	14
29	Felipe Pérez Zavala	44	11	39	30	18	39	28	13	43
30	Arturo Perea Medina	15	9	11	14	6	15	19	8	16
31	Manuel Osorio Flores	32	6	11	22	4	20	20	2	16
32	Benito Figueroa Castro	17	3	24	8	4	17	13	4	14
33	Alfredo Rivera Acosta	5	3	13	11	6	9	10	5	5
34	Crescencio Castro Soto	26	12	24	23	6	20	23	4	15
	TOTAL	558	233	519	497	208	502	454	191	459

Figure 12. Yoshitake Questionnaire Results Matrix (Departure time)

Total number of questions	21330

Table 1. Frequency of Complaint of Fatigue (Arrival and Departure time)

ARRIVAL TIME			
TOTAL OF SYMPTOMS		**Percentaje**	
Dullness	936	4.39	**Accumulated**
Concentration	406	1.90	**Frequency**
Physical	870	4.08	10.37
No complaints	19118	89.63	89.63
Total	21330	100	100
DEPARTURE TIME			
TOTAL OF SYMPTOMS		**Percentaje**	
Dullness	1509	7.07	**Accumulated**
Concentration	632	2.96	**Frequency**
Physical	1480	6.94	16.97
No complaints	17709	83.02	83.02
Total	21330	100	100

Total number of questions by symptoms group	7110

Table 2. Frequency of Complaint of Fatigue – Weekly analysis (Arrival and Departure time)

ARRIVAL TIME			
WEEKLY ANALYSIS			
	Week 1	**Week 2**	**Week 3**
Dullness	5.11	2.78	2.21
Concentration	1.90	2.32	2.47
Physical	1.42	1.91	1.45
No complaints	91.58	92.99	93.87

DEPARTURE TIME			
WEEKLY ANALYSIS			
	Week 1	**Week 2**	**Week 3**
Dullness	7.85	6.99	6.39
Concentration	3.28	2.93	2.69
Physical	7.30	7.06	6.46
No complaints	81.58	83.02	84.47

Table 3. Symptoms Analysis (Arrival and Departure time)

ARRIVAL TIME		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentaje**
Drowsiness and dullness	936	42.31
Difficulty of concentration	406	18.35
Physical impairment	870	39.33
TOTAL	2212	100
DEPARTURE TIME		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentaje**
Drowsiness and dullness	1509	41.67
Difficulty of concentration	632	17.45
Physical impairment	1480	40.87
TOTAL	3621	100

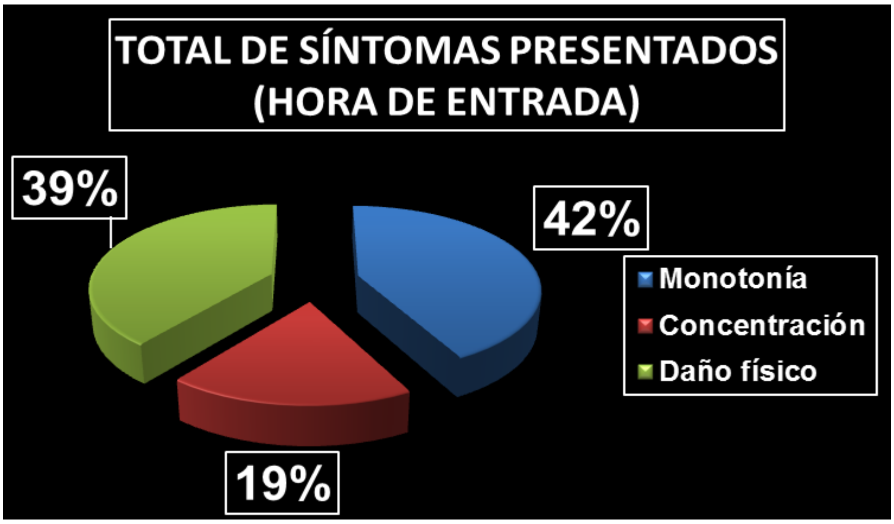


Figure 13. Symptoms experienced (Arrival time) *Dullness, 42 %*

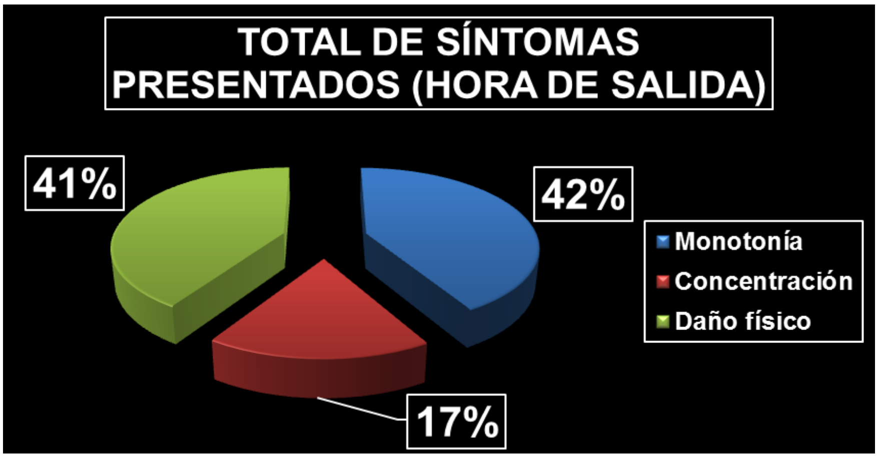


Figure 14. Symptoms experienced (Departure time) *Dullness, 42 %*

Table 4. Symptoms experienced – Week 1 (Arrival and Departure time)

ARRIVAL TIME (Week 1)		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentaje**
Drowsiness and dullness	363	41.02
Difficulty of concentration	179	20.23
Physical impairment	343	38.76
TOTAL	885	100
DEPARTURE TIME (Week 1)		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentaje**
Drowsiness and dullness	558	42.60
Difficulty of concentration	233	17.79
Physical impairment	519	39.62
TOTAL	1310	100

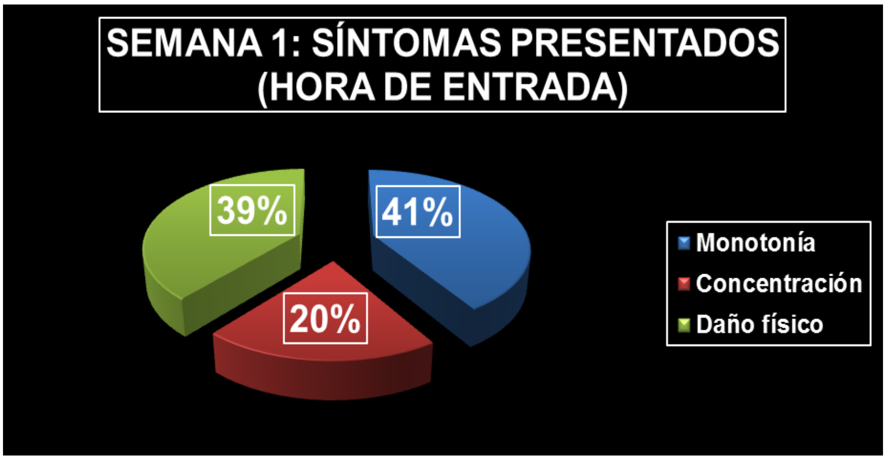


Figure 15. Symptoms experienced – Week 1 (Arrival time) *Dullness, 41 %*

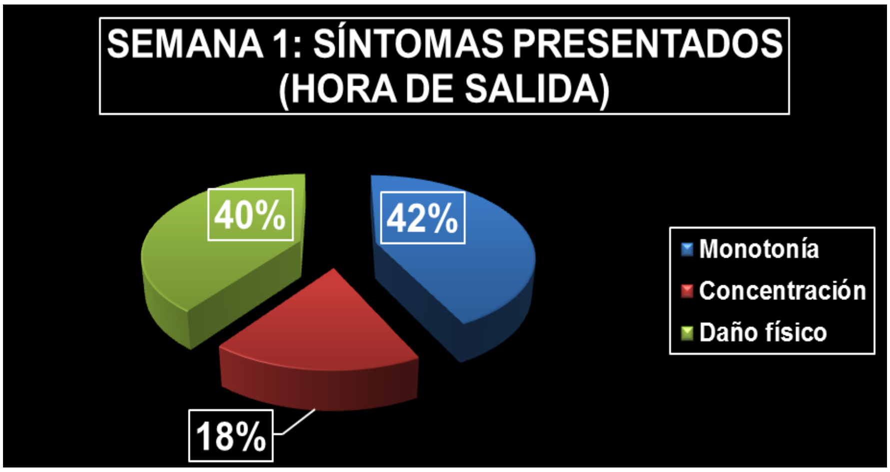


Figure 16. Symptoms experienced – Week 1 (Departure time) *Dullness, 42 %*

Table 5. Symptoms experienced – Week 2 (Arrival and Departure time)

ARRIVAL TIME (Week 2)		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentage**
Drowsiness and dullness	323	46.21
Difficulty of concentration	114	16.31
Physical impairment	262	37.48
TOTAL	699	100
DEPARTURE TIME (Week 2)		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentage**
Drowsiness and dullness	497	41.18
Difficulty of concentration	208	17.23
Physical impairment	502	41.59
TOTAL	1207	100

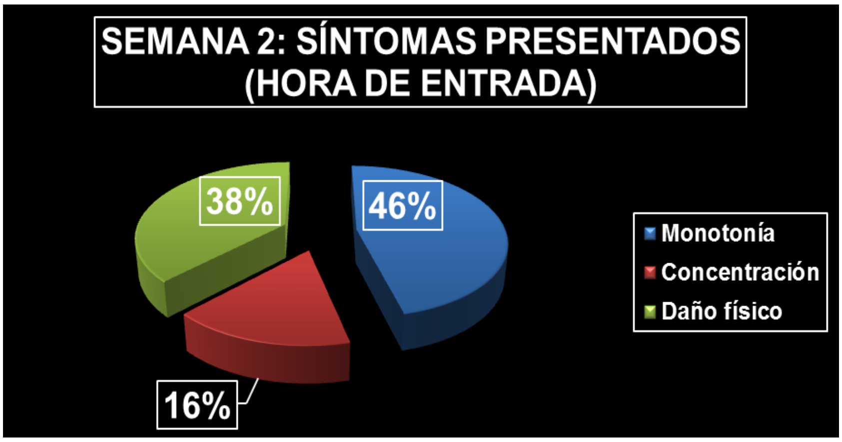


Figure 17. Symptoms experienced – Week 2 (Arrival time) *Dullness, 46 %*

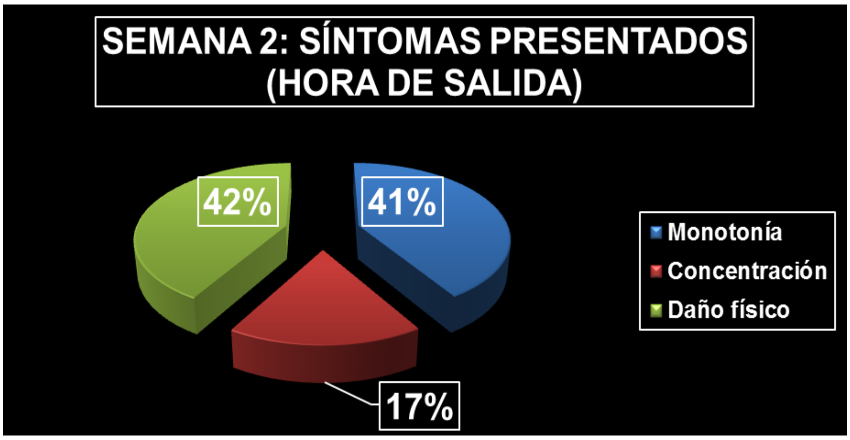


Figure 18. Symptoms experienced – Week 2 (Departure time) *Physical impairment, 42 %*

Table 6. Symptoms experienced – Week 3 (Arrival and Departure time)

ARRIVAL TIME (Week 3)		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentage**
Drowsiness and dullness	250	39.81
Difficulty of concentration	113	17.99
Physical impairment	265	42.20
TOTAL	628	100
DEPARTURE TIME (Week 3)		
SYMPTOMS EXPERIENCED	**Quantity**	**Percentage**
Drowsiness and dullness	454	41.12
Difficulty of concentration	191	17.30
Physical impairment	459	41.58
TOTAL	1104	100

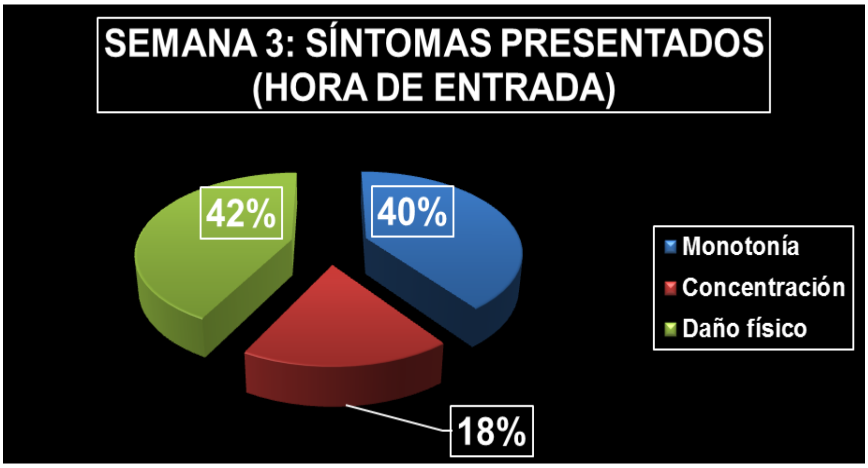


Figure 19. Symptoms experienced – Week 3 (Arrival time) *Physical impairment, 42 %*

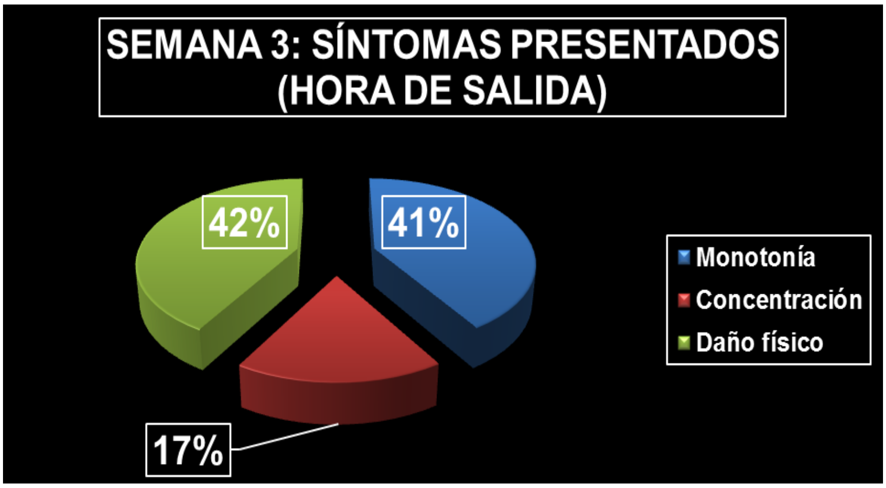


Figure 20. Symptoms experienced – Week 3 (Departure time) *Physical impairment, 42 %*

5. CONCLUSIONS

In general, the frequencies obtained did not exceeded 10 %, considering separately the dullness, concentration and physical impairment. All frequencies showed an increase at departure time. Additionally, most of the symptoms correspond to drowsiness and dullness, and projection of physical impairment, leaving difficulty of concentration at third place. It is important to exercise in order to minimize stress and problems of sedentary work with few breaks.

Jobs that are tedious and repetitive are stressing and also have a negative effect on workers personal life, as they cause fatigue and irritability.

Gran Colección de la Salud (2004). *La Salud y La Mente I.*

According to the literature mentioned, it is highly recommended to follow a healthy diet, exercise regularly, seek hobbies outside of work and use mental relaxation techniques. It also provides some guidelines to reduce the risk of exhaustion:

1. Establish an appropriate plan and time management and set realistic daily goals.
2. Learn some relaxation techniques and practice them regularly.
3. Take regular rest periods (breaks).
4. Follow a balanced diet and do not skip meals.
5. Develop a hobby that allows enjoying nature or playing sports.

6. REFERENCES

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ERGODIS/IBV
Analysis of jobs for people with disabilities

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Work disability

INTRODUCTION

In Chihuahua City live 64,817 people (until 2010) who have disabilities with limited activity, aged between 20 and 59 years old, of which 52.5% are male and 47.5% women, same that very few are those who have been provide the opportunity to work, and this is attributed to lack of awareness and research.

	HOMBRES	MUJERES
Caminar o moverse	13,865	12,419
Ver	9,757	10,662
Escuchar	1,946	1,576
Hablar o comunicarse	2,172	1,635
Atender el cuidado personal	1,093	903
Poner atención o aprender	965	769
Mental	4,246	2,809

SOURCE: INEGI 2010

The ERGODIS method was validated by the Institute of Biomechanics of Valencia, through field studies conducted on 473 workers with physical, sensory and/or mental disabilities in their current jobs (the result of the studies where performed by the same Institute) as well was analyzed for a total of 265 professionals involved in the area of disability and risk prevention in Spain.

OBJECTIVE

To adapt products, tasks, tool, spaces and the wider environment, needs and abilities of people with disabilities in order to improve efficiency, safety and welfare for users in the workplace.

DELIMITATION

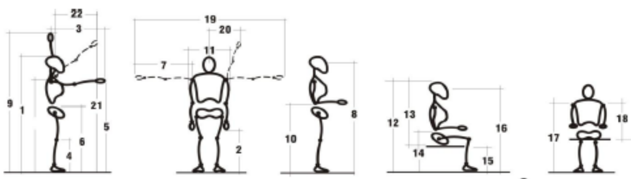
This software was provided to the STPS Nationwide by the Institute of Biomechanics of Valencia (Spain), however, few organizations accepted it because the lack of training and for many, the complexity of applying, as example, here in Chihuahua city, were awarded to four organizations which were: Promotoría Social Personas con Discapacidad, A.C., DIF, CEIAC and the same STPS Nationwide.

By march 2011 it had the opportunity to not only training to these organizations, but was open to the public al large, which had considerable assistance, whre sadly, this software was living aside for the reasons discussed above. It was not until early January of 2012 when it really started to implement this software with the permission of Promotoría Social Personas con Discapacidad, A.C., because faced with two dilemmas, the first was to find companies where people with disabilities employed and allow to apply the method, and second, that in these businesses, people with disabilities were distrustful of the process of applying the method, for this reason, research is focused mostly on "Promotoría Social Personas con Discpacidad, A.C." and "Autozone".

METHODOLOGY

To apply this method, it consider the use of an anthropometric table, both for standing and wheelchair users, in which, besides raising the measures include the collection of information for the environment in the work area where the person works with graphic measurements in terms of noice, light and temperature by placing the person in the area that is working (based on Mexican Official Standards), to complement this approach and deliver complete results still further.

DATOS ANTROPOMETRICOS PARA PERSONAS CON DISCAPACIDAD DE PIE



#	CODIGO	POSTURA	CMS.
1	A	Altura	160
2	ADMP	Altura dedo medio a piso	63
3	ABF	Alcance brazos al frente	70
4	ARP	Altura rodilla al piso	48
5	ABP	Altura brazo a piso	137
6	ACA	Altura cadera al piso	87
7	ABL	Alcance brazo lateral	66
8	AOP	Altura ojos a pies	151
9	AM	Alcance máximo	206
10	ACP	Altura codo al piso	103
11	AMC	Ancho maximo cuerpo	56
12	ASP	Altura sentado al piso	124
13	ABSC	Altura base silla cabeza	84
14	ACPS	Altura codo al piso sentado	65
15	APO	Altura popítlea	40
16	AOPS	Altura ojos al piso sentado	117
17	AHPS	Altura hombro a piso sentado	96
18	AHA	Altura hombros al asiento	56
19	AHM	Alcance horizontal maximo	168
20	DCBL	Distancia cabeza a brazo 45 lat	27
21	AB4P	Altura brazo 45 a piso	163
22	CBP	Cabeza a brazo 45 posterior	60

Tipo de discapacidad

Nombre

Pedro González Castillo

Empresa

Promotoria Social Personas con Discapacidad, A.C.

CODECA

Fecha 01/02/12

SEXO Femenino [ ] Masculino [X] **DOSSIER** 003

EDAD 38 **HRS. DE TRABAJO** 8

PUESTO Operador

TIEMPO EN EL PUESTO 10 años **DIAS A LA SEMANA** 5

TURNO Matutino [X] Vespertino [ ] Nocturno [ ]

OBSERVACIONES

Su trabajo es generalmente sedentario, el área en donde desmpeña su trabajo es reducida, ya que una cuarta parte de la bodega está ocupada por cajas, mismas que ocupan un lugar mal aporvechado

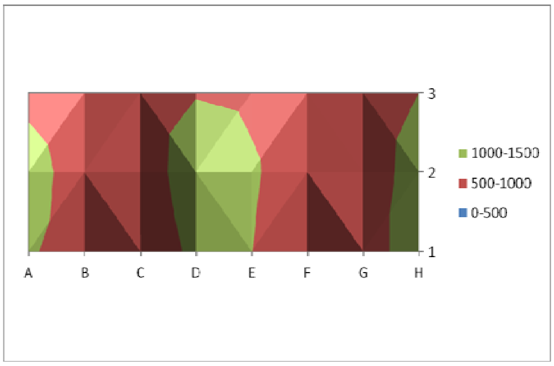
Temperatura 7.5 °C Ruido (db) 77.4 Pico

Iluminacion (Lux)

Directa 167 Humedad 21.2%

Reflección 31

Graphic example



To get the results, the steps are as follows:

1.- Collect information on labor:

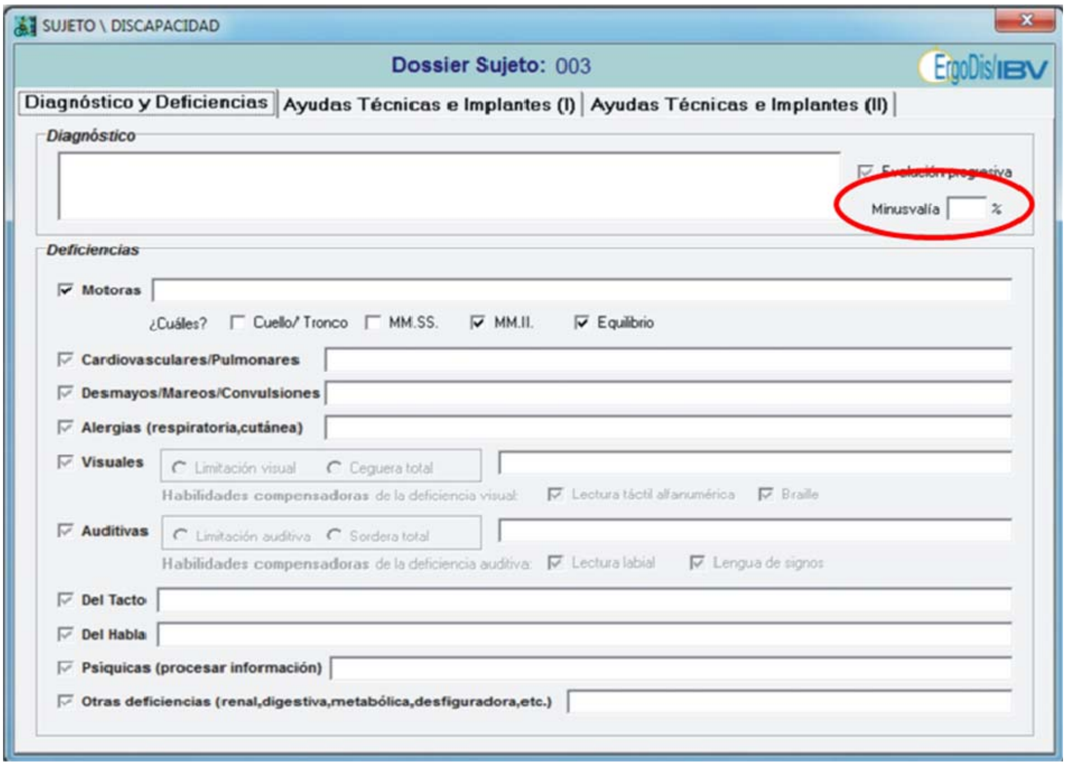
General, tasks, physical demands, demands sensory / communication, mental demands, environment and dimensions, arquitectural barriers and risks analysis and environmental ergonomics. (at this point is important to note first the employee´s duties, this can be done for fifteen minutes if the work is repetitive and has a short course, if more complex tasks should be observed for a longer period).

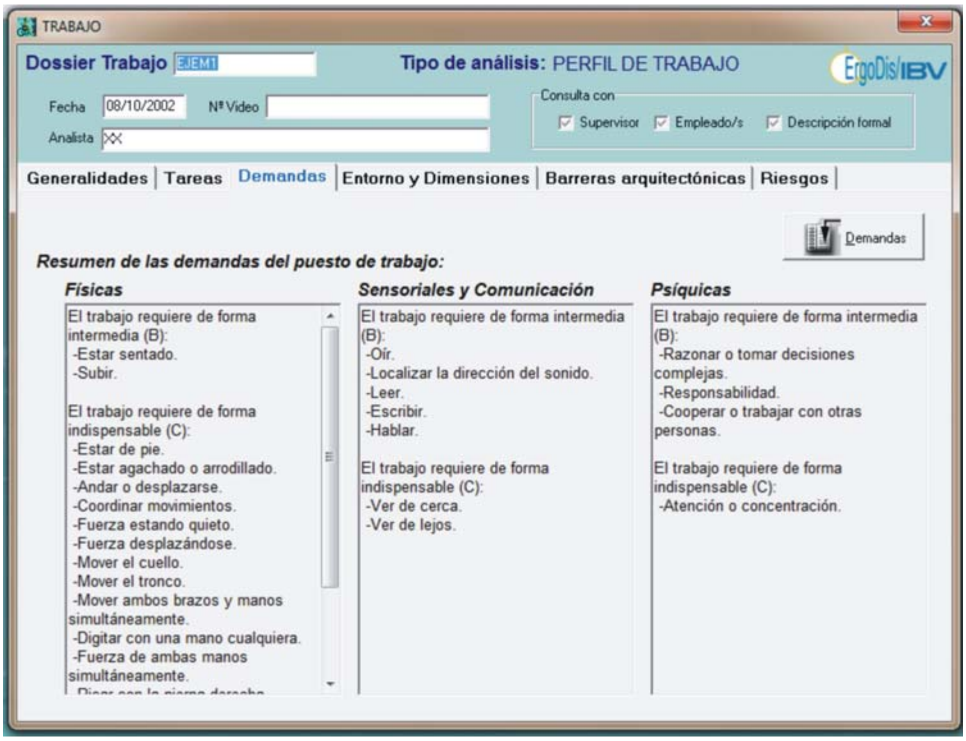
2.- Gather information about the person:

Overview, disability, physical, sensory abilities/communication, pysichic abilities, the environment and dimensional tolerance and above all, talking into account the opinion of the worker. (This is not a traditional medical examination but a functional assessment of the person in realtion to work activities).

In this part, a complete data is the percentage of disability found in the person, which does not have any data. During the investigation, he realized that there is a decree establishing the General Low for Inclusion of People with Disabilities published on Monday May 30, 2011 in the Diario Oficial, in which, referred to in **Article 10** as follows: **"The health sector issued to people with disabilities a certificate of recognition and classification of disability with a national validity",** which, to date, ther is, therefore, left that space blank.

3.- Process the data analyzed:
After the transfer of information collected for the program, it processes the data and obtained a series of results. These results are concentrated in two main mismatches and risks.


SUJETO \ DISCAPACIDAD
Dossier Sujeto: 003
ErgoDis/IBV
Diagnóstico y Deficiencias
Ayudas Técnicas e Implantes (I)
Ayudas Técnicas e Implantes (II)
Diagnóstico
Minusvalía %
Deficiencias
Motoras
¿Cuáles? Cuello/ Tronco MM.SS. MM.II. Equilibrio
Cardiovasculares/Pulmonares
Desmayos/Mareos/Convulsiones
Alergias (respiratoria,cutánea)
Visuales
Limitación visual
Ceguera total
Habilidades compensadoras de la deficiencia visual:
Lectura táctil alfanumérica
Braille
Auditivas
Limitación auditiva
Sordera total
Habilidades compensadoras de la deficiencia auditiva:
Lectura labial
Lengua de signos
Del Tacto
Del Habla
Psíquicas (procesar información)
Otras deficiencias (renal,digestiva,metabólica,desfiguradora,etc.)


TRABAJO
Dossier Trabajo EJEM1
Tipo de análisis: PERFIL DE TRABAJO
ErgoDis/IBV
Fecha 08/10/2002
Nº Video
Analista XX
Consulta con
Supervisor
Empleado/s
Descripción formal
Generalidades
Tareas
Demandas
Entorno y Dimensiones
Barreras arquitectónicas
Riesgos
Demandas
Resumen de las demandas del puesto de trabajo:
Físicas
El trabajo requiere de forma intermedia (B):
-Estar sentado.
-Subir.
El trabajo requiere de forma indispensable (C):
-Estar de pie.
-Estar agachado o arrodillado.
-Andar o desplazarse.
-Coordinar movimientos.
-Fuerza estando quieto.
-Fuerza desplazándose.
-Mover el cuello.
-Mover el tronco.
-Mover ambos brazos y manos simultáneamente.
-Digitar con una mano cualquiera.
-Fuerza de ambas manos simultáneamente.
Sensoriales y Comunicación
El trabajo requiere de forma intermedia (B):
-Oír.
-Localizar la dirección del sonido.
-Leer.
-Escribir.
-Hablar.
El trabajo requiere de forma indispensable (C):
-Ver de cerca.
-Ver de lejos.
Psíquicas
El trabajo requiere de forma intermedia (B):
-Razonar o tomar decisiones complejas.
-Responsabilidad.
-Cooperar o trabajar con otras personas.
El trabajo requiere de forma indispensable (C):
-Atención o concentración.

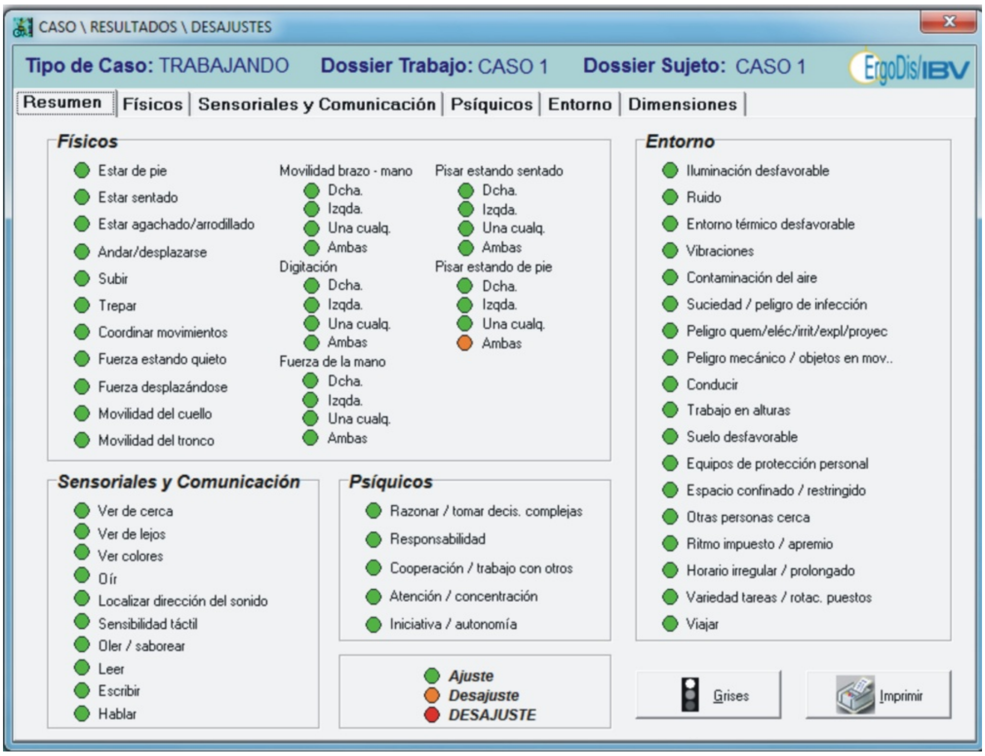
4.- Check the fit or mismatch between work and the subject:

To identify functional disturbances are comapred:

A) The demands of work with the subject´s capacities.
B) The work environment with subject´s tolerance to it

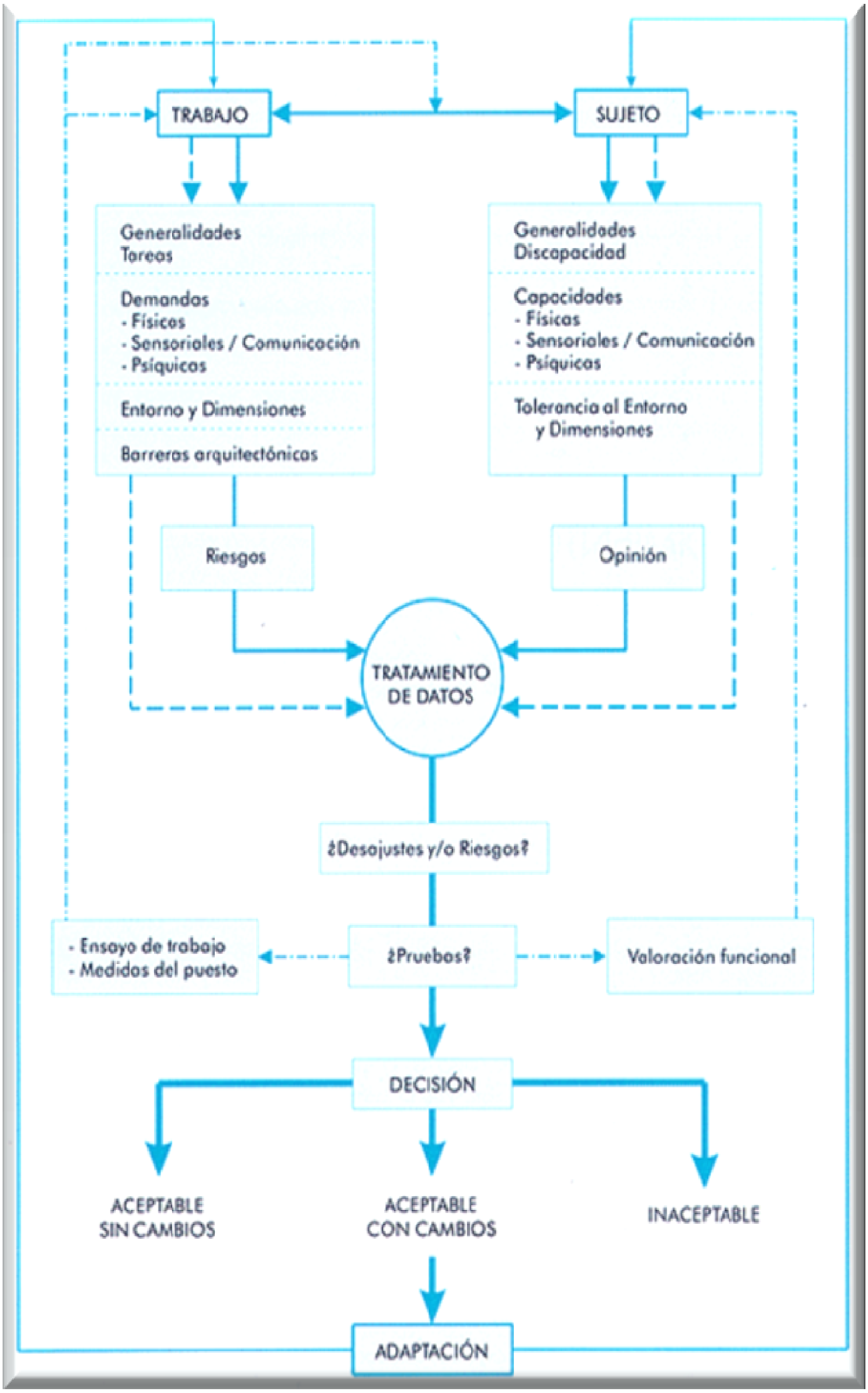
As regards dimensional mismatches:

A) Some are derived directly from the subject´s tolerance (outcomes)
B) Is determined by comparing some of the data of the job (clearences) with the dimensions of the wheelchair user, if it is..



5.- Determine the level of risk associated with the physical and environmental

Only if you previously filled forms WORK-LOAD ENVIRONMENTAL RISK and WORK-PHISYCAL LOAD, the program automatically determines which is level of risk associated with these factors, assigning a score (1 to 5) indicating the need or no changes in the task and / or job, and the priority of such changes.


TRABAJO
SUJETO
Generalidades
Tareas
Demandas
- Físicos
- Sensoriales / Comunicación
- Psíquicos
Entorno y Dimensiones
Barreras arquitectónicas
Generalidades
Discapacidad
Capacidades
- Físicas
- Sensoriales / Comunicación
- Psíquicas
Tolerancia al Entorno
y Dimensiones
Riesgos
Opinión
TRATAMIENTO
DE DATOS
¿Desajustes y/o Riesgos?
- Ensayo de trabajo
- Medidas del puesto
¿Pruebas?
Valoración funcional
DECISIÓN
ACEPTABLE
SIN CAMBIOS
ACEPTABLE
CON CAMBIOS
INACEPTABLE
ADAPTACIÓN

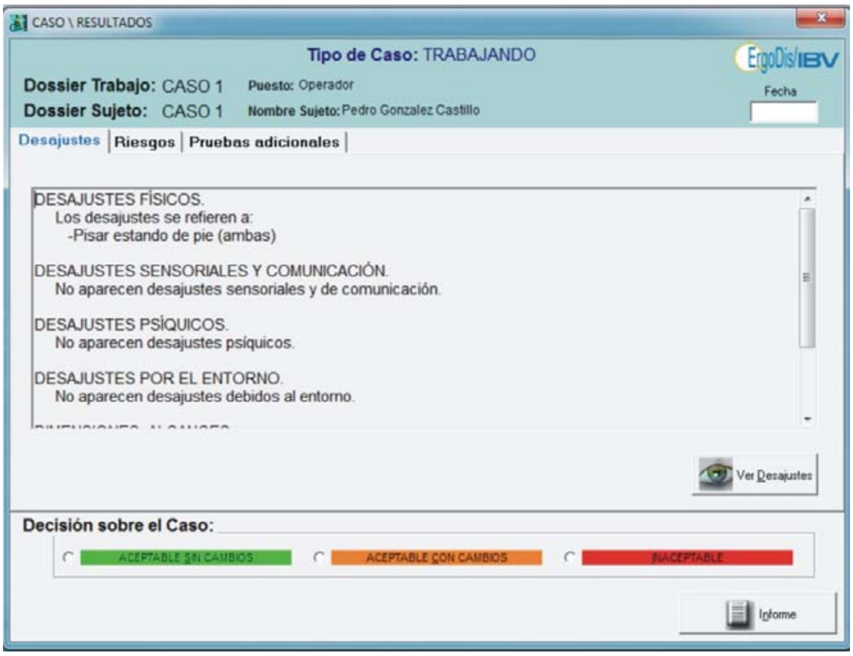
RESULTS

It´s very important to highlight that the decision on the case is not resulting from the method, but this is defined by the analyst of the case, taking into consideration all factors, goals and people involved in the case (analyst, doctor, psychologist, etc…)
This result is scored as follow:

UNACCEPTABLE.- It qualifies as unacceptable to a case that has a large number of mismatches, risk and / or problems also do not support reasonable solutions.

ACCEPTABLE WITHOUT CHANGES.- Is the ideal case, namely, one of that for lack of mismatches, risks and other important issues, it considered acceptable without changes, as it is.

ACCEPTABLE WITH CHANGES.- This involves proposing one or more adaptactions that can be applied to work and / or the subject, for example, to change or amend the conditions of the surroundings of working teams, incorporate other new equipment, removing architectural barriers, reduce activity of the subject, training and provide personal technical assistance to increase functional capacity.



CONCLUSIONS

This method allows to reach the conceptual premises. However, it is necessary to sensitize companies to be taking preventive and corrective measures immediately, namely, to attend the recommendations made as a final result we throw this system.

It is convenient at the work area, to take into account the importance of efficient implementation that leads to continuous improvement; fist, the status of the studied person and then, analyze the workplace to improve productivity as a result of the company, and second, the main idea is a win-win and create an organizational environment motivating an ideal performance tasks.

All these base don the application of ergonomic tools, and decision making within firms, given the sensitization and awareness of the reality of work that exists to improve, allowing to be part of competitive companies including persons with disabilities in the workplace, while considering other areas of opportunity, such a participating in awards such as PRENAT (National Labor Award) wich, and coupled with the same method that brings the strength of a company from the point of view of ergonomic and work.

ERGONOMIC DESIGN WORKSHOP RECYCLED PRODUCTS FOR PHYSICAL REHABILITATION CENTER AND COMMUNITY PASO FIRME IAP IN LOS MOCHIS.

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naniglez_87@hotmail.com

RESUMEN

A partir de una solicitud al Instituto Tecnológico nace el interés por apoyar al centro de rehabilitación física y comunitario PASO FIRME I. A. P, en su búsqueda por ayudar a personas con discapacidad. Se proporciona los principios para distribuir de forma ergonómicamente adecuada el taller de productos reciclados, lográndose tal resultado mediante la aplicación del diseño ergonómico en los puestos de trabajo, considerando para sus dimensionamientos la antropometría de personas con discapacidad (principalmente en sillas de ruedas), los movimientos y alcances. Apoyados de la metodología del diseño arquitectónico como herramienta de trabajo, el objetivo a alcanzar es la generación de un espacio sin limitaciones ni obstáculos, permitiendo libertad de movimientos y desplazamientos, el resultado final integra la rehabilitación, las terapias físicas y ocupacionales, junto con la capacitación para la reintegración social en un taller con diseño ergonómico.

ABSTRACT

From a request to the Instituto Tecnológico de Los Mochis created the interest to support the physical rehabilitation center and community PASO FIRME I. A. P., in their quest to help people with disabilities. It provides the principles for proper ergonomically distributed for recycled products workshop, achieving the results by applying of ergonomic design, considering to its dimensioning anthropometry of people with disabilities (mainly in wheelchairs), the movement and scope. Supported the methodology of architectural design as a work tool, the goal is to reach the generation of an area without limitations or obstacles, allowing freedom of movement and travel,

the end result integrated rehabilitation, physical and occupational therapy, along with the social reintegration training in a workshop with ergonomic design.

KEYWORDS: DISCAPACIDAD, DISEÑO ERGONÓMICO, DISEÑO UNIVERSAL

1. INTRODUCTION

The association PASO FIRME I.A.P. Los Mochis requested the Instituto Tecnologico de Los Mochis, an architectural project for the realization of a community center for the physical and psychological, in order to help people with disabilities to integrate into society. This solicitude has created interest in participation project development, contributing with a proposal to reduce barriers to free movement of users in the areas allocated to the rehabilitation and integration of people with disabilities into the community. APDIS (Asociación Pionera de Personas con discapacidad de Los Mochis) began its work assisting people with disabilities twenty years ago, changed its name to the greatest impact on the market; PASO FIRME, I.A.P. This institution aims to promote social rights and the human development and social integration of people with disabilities through actions of prevention, rehabilitation and equalization of social opportunities. PASO FIRME I.A.P. has programs for people with disabilities within which we find Sport, Art, Labor, Health, orthopedic implements, Recreation, Cultural dissemination of disability.

The PASO FIRME I.A.P. association Los Mochis has a land for the construction of the proposed physical rehabilitation center, located in the northwest of the city with a total of 11,413.80 m2 for the development of the center. (See Figure. 01).

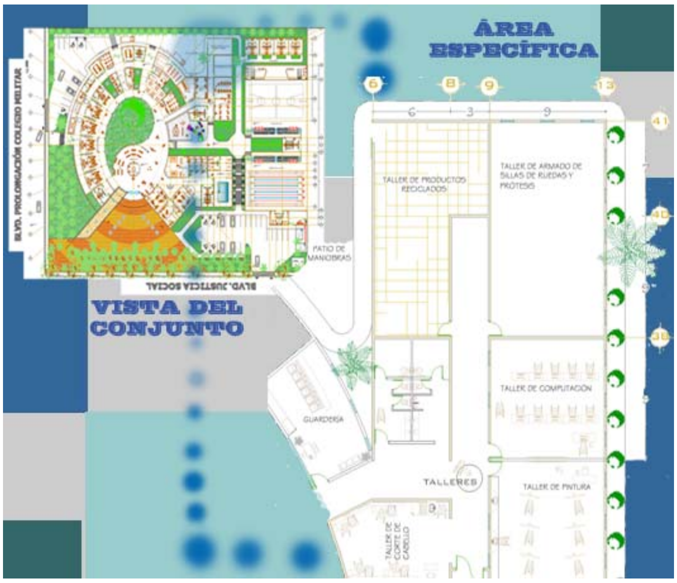


Figure. 01. Location specific area where the project will be developed.

Ahome Township has a population of approximately 8000 people with disabilities, formed by children and adults with motor and visual problems mainly. For this reason the foundation Paso Firme IAP takes as its mission the promotion of rights, integral development and social integration of people with disabilities, through actions of prevention and rehabilitation. Emerging the need of a conditioned space to function as a community center for the physical and psychological, to provide support to people with disabilities in the process of integration into society. The center must conform to a series of spaces for monitoring the rehabilitation of persons among which we mention; medical and rehabilitation areas, workshops, tennis, meeting rooms and common areas.

In order to meet the required security in the rehabilitation center will designed ergonomically so a workshop in which people with disabilities to perform occupational activities, specifically container recycling in plastic (PET), cardboard (Tetra pack), paper or aluminum that allows them to obtain marketable products and get them a financial reward. The recycling workshop will avoid exposing people to risks and work situations that damage their health, allowing them free movement.

The spaces where people with disabilities are physically active need various modifications and adaptations for better integration of disability and activities undertaken. Usually what for most people an interesting activity can motivating to be performed for people with disabilities can become impossible because it prevents the motor type weaknesses or mental suffering, it is impossible because haven´t space adequate.

The recycling workshop has proposed, intended to address a current issue. The use of recycled materials as feedstock in the production of products, will test the creativity of people will attend the workshop, besides being part of the culture of recycling and contribute a little in the decontamination of the environment, while allowing them to have some financial remuneration from the sale of the produce.

1. OBJECTIVES

The overall project objective is to design an ergonomic workshop where people with disabilities (paraplegia Crucial) to physical activity, and mechanical necessary for the conversion of waste materials recycling products, safely and efficiently. And the specific objectives are to design the proper conditioning of space for conducting workshop activities, reduce damage and risk of work, and design a space for these people to be trained to perform activities of integration into society.

2. METODOLOGÍA

Ergonomics uses notions of engineering, physiology, biomechanics and psychology, among other sciences, to meet its goals of efficiency and comfort. Similarly important is considered a motion study as people who will develop in the workshops are disabled, and must have adequate space conditions for movements made during their work.
The study carefully analyzes movements of the body movements used to do a job. Ergonomic design is employed looking for the best man's adaptation to technological means of production and the environment. And the design of workstations being the activity that represents the greatest challenge, due to conflicts between the needs and objectives of the employee, when performing a particular task characteristics of the work itself are changing what we has led to question the traditional models of work searching for the equilibrium.
The architectural design methodology a tool to be used, since this methodology is the application of a method for understanding the elements and their use for the generation of an object as a product of a human need, based on a rational , logic, deductive and intuitive. It seeks to develop

the creative mind and enhance the efforts leading to the solution, which forged a standard of design method and criticism.

Basic conceptual structure consists of the stages of diagnosis, analysis, synthesis, development and evaluation, involving not only the memory, thought or reason, but also the feelings and intuition. Achieve understanding of the forces of the place and the social, economic and cultural factors that influence a project and get a comprehensive view of the design process expressive, rational and formal.

The laws and rules governing the development of the project include, The Constitution of the United Kingdom, Mexico, with its Article 1 of the guarantees of equality and Article 123 which promotes the necessary measures to promote employment of people in conditions of disability. By the Mexican Social Security Institute should consider the rules of general architectural requirements for the disabled. Just as you must also respect and abide by the restrictions that the building regulations of the Municipality of Ahome, point to this type of construction. Among the information gathered I can refer to the following tests and academic texts: (De la Vega et al. 2004)

This study provides anthropometric cards for people suffering from Paraplegia Crucial, specifically the states of Sonora and Sinaloa, as it is intended that these statistics provide a basis for the realization of designs aimed at them, such as: facilities, workspaces and team. And visits to project PROJIMO AC Coyotitán, municipality of San Ignacio Sinaloa. And P.R.O.J.I.M.O B.C. project Duranguito, Dimas, Sinaloa. (See Fig. 02).

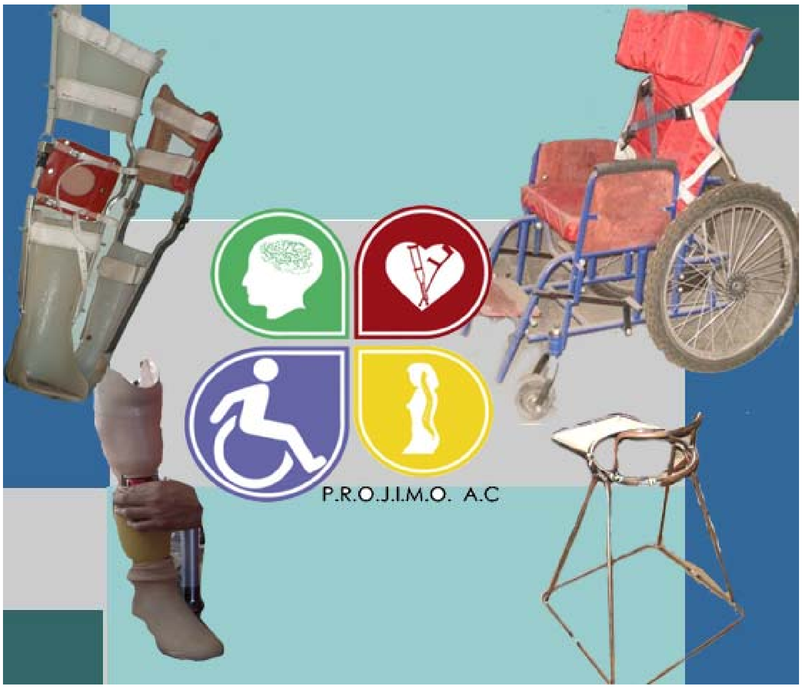


Figure. 02. Projects P.R.O.J.I.M.O. A.C.

(Miralles et al. 2002). The work described in this article attempts to bring special employment centers and vocational centers that have enormous significance for socio-labor integration of disabled people, the basic techniques of job evaluation as a tool to facilitate the said integration.

The main objective is to establish a design methodology, analysis, evaluation and adaptation of jobs and production systems for performance by disabled people. This will require research on the characteristics of the jobs in which working people with disabilities, and to analyze the applicability and adaptability of different techniques of the Study of Labor for both job descriptions for the design and evaluation thereof, also considering ergonomic criteria.

(Guzmán 2008). This article discloses some of the most important applications of ergonomics in occupational therapy, as despite having a great honor in the workplace, where there is a higher prevalence study of ergonomics, it is uncertain many activities that can be performed by these professionals. Occupational therapy involves the study of all stages of the life of the individual, in terms of occupational performance concerns, ensuring a wide range of performance, which produces deeper research in various areas, so that from their experience and results facilitate the contribution to many research projects that require concepts that cut across different disciplines and that can become new knowledge to the scientific society.

(Inche 2010) The study deals with waste containers called Tetra Pak and the development of a commercial prototype in the form of tables. Shows a comparative analysis of technical specifications in relation to the boards, dimensions 30x30x1cm.

(Zero 2010) One of the impacts experienced by the research and development of new polymer-based materials has been in the manufacture of prostheses. Especially after major wars. There are a variety of polymers used for this purpose. The polymers used are thermoplastics and silicone. The polymer most commonly used as prosthesis is polyethylene (PE) because of chemical and physical properties. In this article we review the use of polymers as prosthesis. To get a clearer conception of the problem addressed in this study, we present a description of the key concepts that will be handled during the investigation.

Disability is an umbrella term for impairments, activity limitations and participation restrictions. Impairments are problems that affect a structure or body function, activity limitations are difficulties to execute actions or tasks, and participation restrictions are problems to participate in life situations.

(World Health Organization) Physical disability is an impairment that prevents a human personal development in terms of equal opportunities with other people in the community where you live.

When we refer to a person with disability, we are talking about a person who has had loss of functional capacity secondary to deficits in one organ or function which restrained due to a deficiency, the ability to perform an activity within the range considered normal for human beings and which results in an impairment in intellectual functioning and the ability to meet the demands of the social environment. The consequences of disability depend on the shape and depth with which alter the individual's adaptation to the environment. This adaptation is directly influenced by the category of disability, impairment and disability, as these determined in either case the level of functional limitations of people affected.

A person with motor disabilities, "is one that has temporarily or permanently changes any of your musculoskeletal system due to poor functioning in the nervous system, muscle and / or bone. This disability involves limitation of normal physical movement. People with such disabilities can be semi-ambulatory (mobilize helped by additional factors, such as crutches, canes, walkers, etc.) Or non-ambulatory (can only travel with a wheelchair).

Concept of a person with special educational needs.

PRIVATE CARE INSTITUTIONS (I.A.P)
They are legal entities created by the will of individuals with private resources, by resolution of the Private Assistance Board whose purpose is to conduct humanitarian acts welfare a non-profit. (Sinaloa Private Assistance Board)

RECYCLE
Submit a material used in a process that can be reused.
(Royal Spanish Academy)

3. RESULTS

By applying ergonomic design, considering the anthropometry of people with disabilities (mainly in wheelchairs) was generated sized space, and prepared for circulation and movement of people with disabilities.

Applying the method of SLP, has arrived in the distribution of areas that make up the workshop (see Fig. 03), there were tables and charts activity relationship and the design of spaces, four factors were evaluated to determine a optimal distribution these factors were to properly size the spaces, to avoid obstruction of traffic between stations, providing the basic facilities necessary for the completion of the work, also considering certain special facilities that promote the safety of workers. (See Fig. 04).

Figure 03. Sizing areas, areas needed to work and , adequacy of furniture and circulation areas scope.

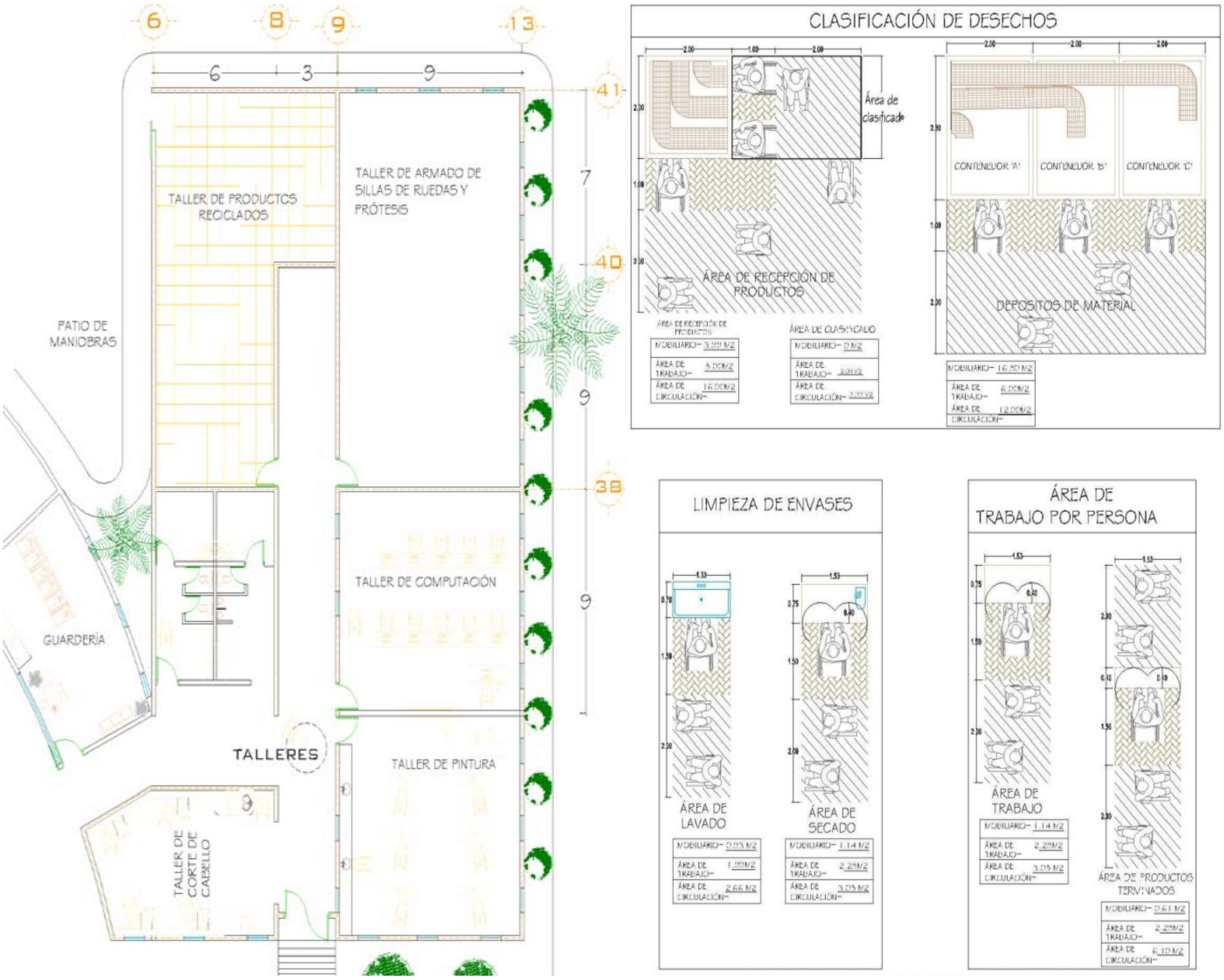
4. DISCUSSION / CONCLUSIONS

The integration of anthropometry, sizing and space in the ergonomic design and the proper conditioning in spaces for disabled people, will reduce damage and risk, allowing them to deal adequately the activities barriers-free unobstructed.

It would be very important for people with disabilities are included and regulated in the laws and regulations our society that govern business support to people with disabilities enable them to exercise their labor rights, training and preparation, in order to have greater integration with the productive society.

It is recommended to train e people with physical disabilities as entrepreneurs, for in future not dependent on welfare institutions and they can be independent and generate their own employment opportunities.

By using the methods and techniques ergonomically designed as tools for development of this work and to consider the anthropometry of people with disabilities, the study of their movements and their ability to perform in a work environment, we the overall result is satisfier object of a social need, a workshop with comprehensive adaptation between the abilities of people with Paraplegia Crucial media and working environment, enabling them to train and prepare.


TALLER DE PRODUCTOS RECICLADOS
TALLER DE ARMADO DE SILLAS DE RUEDAS Y PRÓTESIS
PATIO DE MANIOBRAS
TALLER DE COMPUTACIÓN
GUARDERÍA
TALLERES
TALLER DE PINTURA
TALLER DE CORTE DE CABELLO
CLASIFICACIÓN DE DESECHOS
Área de clasificado
CONTENEDOR 'A'
CONTENEDOR 'B'
CONTENEDOR 'C'
ÁREA DE RECEPCIÓN DE PRODUCTOS
DEPÓSITOS DE MATERIAL
LIMPIEZA DE ENVASES
ÁREA DE LAVADO
ÁREA DE SECADO
ÁREA DE TRABAJO POR PERSONA
ÁREA DE TRABAJO
ÁREA DE PRODUCTOS TERMINADOS

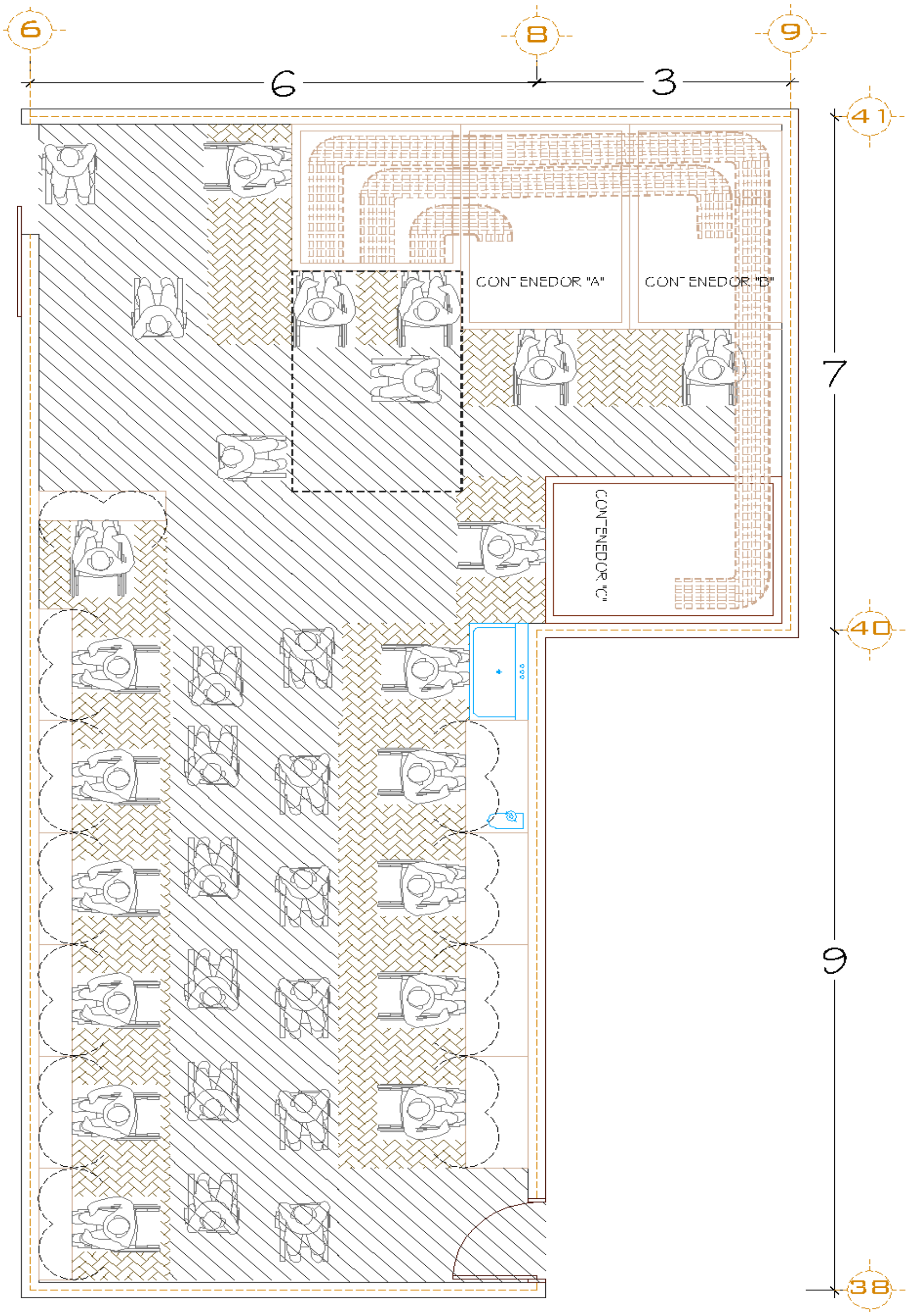


Figure. 04 Zoning of the workshop sized areas.

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2. (Andrés Romano Carlos, García Sabater José Pedro, Miralles Insa Cristóbal 5-6 Septiembre 2002), II Conferencia de Ingeniería de Organización Vigo,
   Development of a Methodology for the Design, Analysis and Evaluation of Jobs for Performance by Disabled Persons.
   Centro de Investigación de Gestión e Ingeniería de Producción (CIGIP)
   Dpto. de Organización de Empresas
   Universidad Politécnica de Valencia.)
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7. World Health Organization
8. Concept of a person with special educational needs.
9. Sinaloa Private Assistance Board
10. Spanish Royal Academy

HIERARCHICAL TASK ANALYSIS AND MENTAL WORKLOAD ASSESSMENT IN A SYSTEM CONFIGURATION TASK FOR A VIDEOGAME CONSOLE

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Resumen: Este artículo presenta un caso de estudio descriptivo de un análisis de tarea. La tarea a analizar es la configuración total de un dispositivo de almacenamiento USB en una consola de videojuego. El método aplicado en este estudio es el Análisis Jerárquico de Tareas para determinar las sub-tareas cognitivas realizadas por el usuario. También se evalúa la carga mental generada por la tarea mediante el método NASA-TLX. El estudio comprende una muestra de conveniencia de 10 estudiantes universitarios. Los resultados muestran la descomposición de la tarea en sub-tareas, así como la carga mental en cada uno de los participantes. Finalmente se obtienen conclusiones sobre los métodos aplicados y se dan recomendaciones sobre la tarea, los artefactos implicados en ésta y los métodos.

Palabras clave— Análisis Jerárquico de Tareas, sub-tareas, carga mental, NASA-TLX

Abstract: This paper shows a descriptive study case about a task analysis. The task under analysis is the total configuration of a USB storage device in a videogame console. This study applies the method of Hierarchical Task Analysis in order to find the sub-tasks that are performed by the user. The mental workload arisen by the task is also assessed by mean of the NASA-TLX method. The study includes a convenience sample of 10 university students. The results show how the main task was divided into sub-task, and the mental workload in each of the participants. Finally, conclusions are drawn about the methods, and suggestions are provided about the task, the artifacts involved in it and the method.

Keyword--- Hierarchical Task Analysis, sub-tasks, mental workload, NASA-TLX

1. INTRODUCTION

In a task analysis it is difficult to catch all the cognitive and behavioral aspects. A method to achieve this objective is the Hierarchical Task Analysis (HTA), since it is a flexible, exhaustive and systematic (Phipps, Meakin and Beatty, 2011). The mental workload is a cognitive aspect that when it increases, the worker´s performance trends to decrease (Stanton, Salmon, Walker, Baber y Jenkins, 2005). The modern videogames systems demand physical and cognitive effort from the user, who must pay attention at all times and process high information levels in order to achieve his/her goal. This study analyzes the task of configuration of a videogames console which demands these aspects.

1.1 Problem statement

In this section the problem that motivated this study is stated. The problem root cause is explained, and the way in which the data that support it were collected.

Technological advances in fields such as manufacture, communications and transports, to name a few, demand a faster update of the people on the existence of new technology, so as its operation and handling. The field of the videogames is not the exception as regards technological advances. Every time the videogames features trend to provide a greater number of functions and they require greater knowledge from the users. One of the videogames that provides a great variety of functions is the console analyzed in this study. Among the functions that the console provides is the function of setup a storage device Universal Serial Bus (USB) by the user. In a survey applied to 10 university students, who have more interaction with the technology and the information management, it was found that the main difficulties when a USB is configured in the console are:

a) Not knowing where to find the device within the interface.
b) Not knowing how much memory space is free and/or configured after the configuration.
c) Interact with the control and display.
d) Problems to detect the USB by the console.
e) Not knowing where to connect the device to the console.

The students said the configuration process caused them mental load, affecting their performance and causing frustration.

1.2 Objectives

In this section are exposed the general objective of this study, and also the particular objectives.

According to the problem stated, the main objective of this work is analyze the task in order to find the cognitive tasks that the user performs, and also determine the mental workload generated by these tasks.

The particular objectives are the following:

a) Analyze the cognitive tasks applying the HTA method.
b) Find the mental workload of the analyzed task by applying the NASA-Task Load Index (TLX) method.

1.3 Justification

The justification of this work is that it will allow a better understanding of the task by the users. It will allow, by mean of the analyses carried out, to detect design errors, what can be taken as a benefit for the designers on the future videogame versions. This work will also help to the analysts because it will serve as a reference point to analyze tasks that are more complex.

1.4 Delimitations

This study will include the Hierarchical Task Analysis and the NASA-TLX methods in order to analyze the task of configure a Universal Serial Bus (USB) memory in a videogame console where the user interacts with 4 artifacts: USB memory, videogame console, remote control and display. The only one constraint for the USB device is that it must have a free memory space over than 1 Gigabyte (Gb). The study was conducted with a convenience sample of university students.

2. LITERATURE REVIEW

2.1 Hierarchical Task Analysis (HTA)

The Hierarchical Task Analysis (HTA) is the "best task analysis known technique". HTA is based on a human performance theory, which in turn is based in a goal-directed behavior which contains a hierarchy of sub-goals linked by plans (Stanton, 2006). The HTA uses the concept of "operation", a behavior unit defined in terms of its objectives, degree of complexity and duration. The operations are divided into sub-operations, which in turn are divided into simpler sub-operations (Hodgkinson and Crawshaw, 1985).

The plans determine the conditions under which the sub-goals are put into operation. The steps to develop a HTA are (Stanton et al., 2005):

1. *Define the task under analysis.*
2. *Collect the data of the task.*
3. *Determine the overall goal of the task.*
4. *Determine the sub-task of the main task.*
5. *Decompose the sub-goals.*
6. *Add the analysis' plans.*

The application of HTA has multiple benefits among which are: identifying the tasks and sub-tasks on which the operator needs a better training, design systems with improvements in the human-machine interaction. The HTA also allows highlighting inconsistencies on the training, processes and design of systems; it allows the analyst to understand the nature of the problem and the domain of this; the design of handbooks and visual aids work can be improved by mean of the HTA.

The NASA-TLX method is applied to find the mental workload level generated by the task and then make improvements to the task design or the artifacts.

2.2 Mental workload

The mental workload is defined as the difference between the cognitive demands of a Workstation or a task and the worker´s attention span. The mental workload is a multidimensional concept and, therefore, it is determined by different factors or dimensions. Among the factors most accepted by different authors are: mental demand, physical demand, temporal demand, effort, performance and frustration (Rubio, Díaz y Martín, 2001). The science in charge of the mental workload is the Cognitive Ergonomics (Cañas, 2001).

2.3 NASA-TLX method

There exist many methods with very different methodologies to assess the mental workload (Stanton et al., 2005).

This paper applies the NASA-TLX method, which is a multidimensional assessment procedure that gives an overall score of the mental workload, based on a weighted average of scores in six subscales (De Arquer y Nogareda, 2001). The NASA-TLX distinguishes the six dimensions of the mental workload: mental demand, physical demand, temporal demand, performance, effort and frustration.

The application process of the NASA-TLX consists of the following steps (Stanton et al., 2005):

1. *Define the task under analysis.*
2. *Make a HTA for the task.*
3. *Select the participants.*
4. *Inform participants about the study.*
5. *Perform the task under analysis.*
6. *Make paired comparisons of the dimensions.*
7. *Perform the process of weighting each of the dimensions.*
8. *Compute the total score of the mental workload by mean of the following equation:*

$$\mathbf{MWL} = \sum_{i=1}^{6} \frac{c_i w_i}{15} \quad (1)$$

c = paired comparison value for dimension *i.*
w = weighting value of the dimension *i.*

The technique has been applied into a large number of experimental tasks from flight simulators to power control rooms. The results show that the technique provides good diagnostics of the sources of mental workload with low variability between the subjects and the sub-scales (Rajil). The technique is very simple and requires little of time for its application.

3. METHODOLOGY

This chapter presents the materials and methods used in this work. At first, there is a list of the resources used to carry out it, and then there is a description about the methodology. This study is descriptive and does not present an inferential statistical analysis on the data neither the results, it describes the procedure applied to collect the data, the task execution and how the outcomes were obtained.

3.1 Materials

This study required only paper and pencil and the questionnaire formats of NASA TLX method. Also an USB storage device, a videogame console, a remote control and a display were used during the task. The paper and pencil were used in an initial survey that allowed detecting the problem, and also in the NASA-TLX questionnaire. The USB storage device, the videogame console, the remote control and the display were used during the task execution. Figure 1 shows the remote control and the display with which the user interacted.

3.2 Method

The problem was detected by mean of a survey applied to a first convenience sample of 10 college students. The students were asked to answer if at some time they had used a videogame console and/or an USB storage device, if they had configured an USB in the console, and if so, what were the difficulties they had; and which one of the six dimensions of the NASA-TLX generated more pressure to them, and another questions

Figure 1. Control and display whit which the user interacted.

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For the task analysis the HTA method was applied. At first, the main task was defined as *Total Configuration of USB Memory in a Videogame Console.* Then, this task was divided into sub-tasks called as *Connect Memory on Console, Turn on Console,* and *Configure USB device.*

The same decomposition process was applied for the others sub-tasks. Finally, the plans were stated. For example, for the sub-tasks of the main task it was got the plan:

Plan 0: 1-2-3.

The same process was applied for the lower levels sub-tasks. To apply the NASA-TLX the main task must be defined and perform a HTA for the task. These steps were already done during the task analysis.

Regarding the selection of participants, a second convenience sample of 10 university students was selected, this time to perform the task. Every student was explained on what the task was about, and which the study´s objective was. Once the participants knew the task and the objective of this work, they were asked to perform the task without getting any help. According to the survey applied to the first sample, one of the sub-tasks that was more difficult for the users was the sub-task *connect the USB device on the console* because of it was difficult to find the entry to connect it. Because of this, it was specified, as much as possible, where the entry to connect the USB is. Figure 2 shows the entries' location to connect the USB device on the console.

Figure 2. Entries for the USB device on the videogame console.

When the participants finished the task, they were informed about the dimensions that the NASA-TLX handles, and they were asked to perform paired comparisons of the 6 dimensions. The user selected, on each paired comparison, the dimension that more influenced on his/her mental workload level. The scores for every dimension are in a range of 0-5, where 0 means not relevant and 5 means more important than any other factor. This leads to the c_i value for the dimension *i* (see equation 1). Then, the user were asked to assess separately each of the six dimensions within a range of 0-100, divided into five-units intervals, according mental workload level generated by each dimension. In this way the w_i value for the dimension *i* (see equation 1) was derived.

The total score of the mental workload was computed by mean of the equation (1), it means, by multiplying the value of the paired comparison c_i for each dimension by its rating assigned w_i. The scores of the 6 dimensions are added up and this sum is divided by 15 (number of combinations). The final outcome of the mental workload must be between 0 and 100. On the interaction user-control there is a great variety of buttons and levers, so it was necessary to define each button and lever, and the function they perform during the task. Figure 3 shows the buttons and levers used by the user during the task.

4. RESULTS

This section provides the results obtained by the methods applied in this study: Hierarchical Task Analysis and the mental workload assessment´s NASA-TLX method.

Figure 3. Buttons and levers used during the task.

4.1 Results of the Hierarchical Task Analysis

To find the final hierarchy of the task, it was necessary to carry out an exhaustive Hierarchical Task Analysis by passing by several revisions. An example of this was that if the USB device will be configured by second time, the three sub-task of plan 3.4 (Table 1) will disappear, but they appear if a new USB device is configured by first time. The outcomes of the HTA suffered several modifications before derive a final HTA. Revisions helped to detect possible failures on the current task design and/or the artifacts with which the user interacts.

Table 1 shows the final Hierarchical Task Analysis on a tabular way, where the plan 0 belongs to the main task. The tasks belonging to the same level are numbered without indent. The sub-tasks are numbered and with an immediate indent with regard to the task they belong to.

Table 1. Hierarchical Task Analysis of the task Total Configuration of the USB memory in a videogame console.

0. Total configuration of the USB memory in a videogame console. Plan 0: Do 1, then 2 and then 3.
1. Connect memory in the console. Plan 1: Do 1 and then 2.
1. Search on the rear of the console a USB input symbol. 2. Connect the USB device in the USB input.

2. Turn on the console. Plan 2: Do 1.
1. Press for 3 seconds the gray button with the letter “X” on the center of the control.
3. Configure USB device Plan 3: Do 1, then 2, then 3, then 4, then 5.
3.1 Select "System configuration". Plan 3.1: Do 1, then 2, if 2 then 3 else 1.
1. Move the lever from left to right. 2. Watch if the display shows the “System configuration” menu. 3. Press the green button with the letter “A”.
3.2 Select “Memory”. Plan 3.2: Do1, then 2, if 2 then 3 else 1.
1. Move the left lever down. 2. Watch if the option “Memory” is selected on the display. 3. Press the green button with the letter “A”.
3.3 Select “USB storage device” Plan 3.3: Do 1, then 2, if 2 then 3 else 1.
1. Move the left lever down. 2. Watch if the option “USB storage device” is selected on the display. 3. Press the green button with the letter “A”.
3.4 Select “Configure now”. Plan 3.4: Do 1, do 2, if 2 then 3 else 1.
1. Move the left lever up. 2. Watch if the option “OK” is selected on the display 3. Press the green button with the letter “A”.
3.5 Wait for device configuration. Plan 3.5: Do 1, then 2.
1. Watch the display until it shows a “”Configured device” message. 2. Press the green button with the letter “A”.

As it was said above, the tasks with the same indent belong to the same hierarchical level and the tasks with a bigger indent are sub-tasks belonging to the tasks immediately above them.

4.2 Results of the mental workload analysis with the NASA-TLX method

Results of the mental workload provide a general vision about the load generated by the task on the participants. The description of the results shows that the mean of the mental workload was 44.23 and the median was 41.66. With these results it was concluded that the mental workload level was acceptable because of the mean and median are below the mean of the scale 0-100. If the mental workload is greater than 75 it can be stated that the task causes a high mental workload level. Only one participant was with a mental workload greater than 75. The results are within the range [13.33, 76]. Table 2 shows the mental workload for the 10 participants.

Table 2. Mental workload level generated by the task "Total Configuration of the USB Memory in the Videogame Console".

Participants´ mental workload										
Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mental workload	**58.33**	**28**	**24**	**76**	**62**	**32.66**	**65.66**	**13.33**	**38**	**44.33**

5. CONCLUSIONS Y RECOMMENDATIONS

This section states the conclusions and recommendations of this work; the objectives are compared with the results in order to find the grade in which the results were achieved.

It was achieved to apply the HTA and NASA-TLX methods stated in the particular objectives and so the main objective was also achieved. Analyzing a task makes it easier to learn, but analyzing a task with universally validated methods also allows detecting possible features on the tasks process and the artifacts design. Facing the failures promotes the creativity of the analyst, the artifacts' designer and the users.

Among the faults detected several recommendations emerged, which are listed below.

1) It is recommended to provide a help menu about the different functions that the videogame console offers and demands. The menu should be always visible on the screen for easy user access.
2) Decrease the usage of the remote control on the functions configuration and management of the console's resources, but not when the game is being played. To achieve this it is recommended the user-display interaction is by touch and access to the options and selected them more easily.
3) For a task analysis it is recommended to apply methods with validity and reliability such as the HTA and NASA-TLX. To analyze a task it is recommended to do it by video, identify the tasks and it is very useful that the analyst perform the task by himself/herself in order to detect failures that are not always visible. Finally, it is recommended to apply questionnaires to the operator/user to detect failures from the cognitive point of view.

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METHODOLOGY APPLIED TO THE OCCUPATIONAL HEALTH SAFETY AND THERMAL STRESS IN GREENHOUSES

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RESUMEN.
En un sistema ergonómico (Hombre-Máquina-Medio ambiente) aplicado en la industria maquiladora se deben hacer las adaptaciones necesarias para el buen desempeño del hombre pero en un invernadero hidropónico (hidroponía es cultivar plantas sin tierra) el funcionamiento es al revés; el hombre debe llevar a cabo ciertas actividades bajo las condiciones necesarias para el optimo desarrollo del producto. Al desarrollar dichas actividades, el empleado puede tomar posturas no naturales y lleva a cabo movimientos repetitivos que pueden ocasionar lesiones en manos, muñecas, cuello, hombros y/o espalda. Además, por las condiciones de temperatura requeridas por el vegetal, es posible que el empleado sufra estrés térmico ya que la temperatura varía constantemente 17 a 25 grados centígrados.
Si se considera que el trabajo físico desarrollado por el empleado genera calor en el cuerpo y para regularlo el organismo humano posee un sistema que permite mantener una temperatura corporal constante en torno a los 37 grados centígrados por lo tanto, el cambio de temperatura intempestivo y la frecuencia originan un equilibrio térmico en el organismo de los trabajadores. Las malas condiciones ambientales pueden ocasionar efectos negativos en la salud que variaran en función de las características de cada persona para aclimatarse, esto puede ocasionar problemas como resfriados, congelación, deshidratación y hasta golpes de calor los cuales pueden producir incluso la muerte.
Palabras Clave: Invernaderos Hidropónicos, Evaluación Ergonómica, Estrés Térmico

ABSTRACT.
In an ergonomic system (Man-Machine/tool-environment) applied to manufacturer industry, it must take the necessary adaptations for the proper performance of man but, in a hydroponic greenhouse (hydroponic is growing plants without soil) the operation is different; the man must carried out certain activities under specific conditions for the optimal plant development. When the man develop such activities he can take unnatural postures and performs repetitive movements that can cause injury to hands, wrists, neck and back, moreover, by the temperature conditions required by the plant, the employee may suffer thermal stress as the temperature varies continuously from 17 to 25 degrees Celsius.
If it is considered that the physical work developed by the employee, he generated heat in the body and to regulate it, the human body has a system to maintain a constant body temperature

around 37 degrees Celsius, thus change temperature untimely and often cause a balance heat in the worker body.

The poor conditions environment can cause adverse health effects that vary depending on the characteristics of each person to acclimatize; this can cause problems such as colds, freezing, dehydration and thermal stress which may produce death.

Keywords: Hydroponics Greenhouses, Ergonomic Assessment, Thermal Stress

1. INTRODUCTION

Ergonomics is defined as the interactions between humans and the elements of a system, taking into account three main factors, man-processing-tools, and using the results obtained by applying the methods of assessment, propose solutions to ensure the working conditions for employees without affecting the employer (Houghton, 2002).

The evolution of production systems and automation has revolutionized the way we produce. These changes have been very significantly in the mass production of articles or objects but also in agriculture, gradually stopped hearing about farmers and hear more of the greenhouses.

Agricultural production through greenhouses has become very important in the country due to low production in this field probably low levels of rainfall or in some cases excess of those which has ruined crops in recent years and also for companies exporting methods in gases are carried out are of great importance by the great production that can be given because of their characteristics. A greenhouse (or hothouse) is a closed, static and accessible on foot, which is intended for the production of crops, with a usually translucent outer shell of glass or plastic, which allows control of temperature, humidity and other environmental factors to promote plant growth (Houghton, 2002). Several types of greenhouses, among which is the hydroponic greenhouse.

According to Filippetti, 2012, was in 1860 when the German botanist Julius von Sachs made which can be considered the first scientific findings that prove, under certain characteristics, the possibility of soilless culture. Half a century later, the scientific community accept the conclusions of Von Sachs and for the year 1930, William F. Gericke place tomatoes in a large scale by the hydroponic system. This during the day, accumulated heat inside the greenhouse should not exceed the maximum temperatures critical for proper plant development.

Which affects humans due to heat exchange and so the process is vital thermo regulator. According to McIntyre, 1980 and Parsons, 1993, the heat transfer can occur through three processes:

- Conduction,
- Convection,
- Radiation.

Which are involved in the thermal balance of the body which depends on the requested heat which is latent in the middle of the greenhouses by sweating through the skin and lungs by breathing. According to the theory of heat transfer can be demonstrated that the three processes are similar and follow the same basic rules, the rate of heat transfer depends on:

- The temperature gradient between the skin, the surface of the clothing and the environment.

- The area available for the process.

Human beings respond to a wind chill, and the change of posture is an example of the sensation, which can be seen immediately. When it comes to thermal comfort and heat balance in the human body, posture and its relation to the area available for transfer thereof become an important factor.

2. METHOD

The recording of the position in the areas of work has a long history in the study of ergonomics. Iftikhar (1996) expresses concern for the consequences thermal posture, since a change in it can modify the actual body surface area available for heat exchange with the environment and therefore, the metabolic rate per unit body surface area. This effect is systematized in a coding method which reflects the degree postural changes in the effective area of body surface area available for heat exchange.

Human beings behave in response to the wind chill; a change in posture is a response to it and can be observed immediately. The main reports suggest that in studies carried out in a climatic chamber, subjects in light clothing, exposed to cold, tend to reduce heat transfer surface, clenching his fists and bringing the arms close to body but remember that in the workplace, must continuously maintain a standard position (Parsons, 1993). When it comes to thermal comfort and heat balance in the human body, the position on the area available for heat transfer becomes very important. To examine the relationship between thermal comfort and posture, we need a method, both for recording and estimating the area covered or uncovered surface in different positions.

2.1 POSTURAL RECORDING

The plan of recording the posture is based on dividing the body into different segments, digital encoding and measurement of total body surface area covered in a certain posture. The basic idea of digital coding is taken from Karlhu (1977) recording technique postures (OWAS) used in ergonomics. OWAS is based on three-digit coding to record a given posture. However, looking at different postures (in relation to thermal comfort) in different workplaces that involve various activities, it was found that at least six digits are needed to identify a particular posture.

- The first digit describes the position of the head and neck (three options).
- The second and third digits refer to the position of the upper extremities; the first digit corresponds to the left arm and the second to the right arm (nine options).
- Fourth digit describes the position of the trunk. (Four options).
- Fifth digit to the pelvis. (Four options).
- Sixth digit for the thighs and legs. (Four options).

2.2 CALCULATION OF AREA COVERED

To evaluate the effect of a particular posture on body surface area, it requires the area of the body parts are in contact with each other or with an external surface. As an approximation in the present study these data are taken from an existing anthropometric (Diffrient, 1974).

Nine parts of the body (Table I) are used to define a posture. The boundaries of these nine parts shown in Figure I. The figure also identifies the most appropriate to make the dimensions (length and width of the body). Also shown (Table I) values for the tentative portion of the body surface that represents the body part.

Table 1. Representative body parts for evaluation of covered area.

Codes	Body parts	Proyect area %
A	Head/Neck	1.94
B	Upper arm	0.92
C	Fore arm	1.07
D	Hand	0.86
E	Trunc	10.25
F	Pelvis	1.15
G	Thigh	2.50
H	Lower leg	2.50
I	Foot	1.21

The values have been estimated from anthropometric data for the average person and calculating the surface area of the whole body, using the equation of weight and height (Dubois and Dubois, 1916). The relationship is: $A_D = 0.202\ W^{0.425}\ H_m^{0.725}$ where A_D is known as body surface according to Dubois, W is the weight in kilograms and H_m is the height in meters.

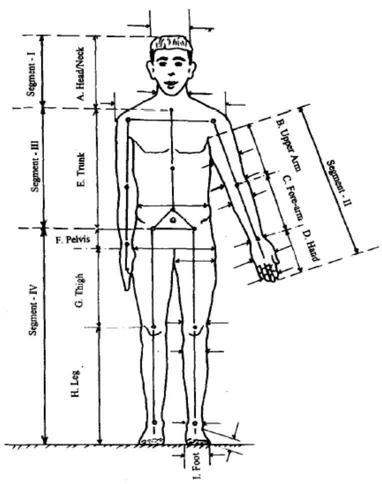

Figura 1. Segmentos del cuerpo para el cálculo de la superficie cubierta en la postura

3. RESULTS

The technique used for the analysis presented is based on completing a posture diagram using the following steps:

- Observation (visual / video) and the coding of the different positions
- Computerization of the positions coded
- Estimates of the total area
- Evaluation of the effective surface area available for heat transfer.

The encoding technique is shown schematically in Figure 2 for a typical coded position 031132.

To demonstrate the application of the scheme was carried out a survey based on visual observation of the postures in the various workplaces in Oxford Brookes University (offices, conference room, and library and computer room). Using six-digit codes, 1278 postures were recorded and evaluated the areas covered in different postures for the average person (78 kg and 174.8 cm in height). The results of some selected postures are shown in Table 2 as the percentage of the total body surface area. From the obtained results excel two extreme positions, standing (minimum covered area) and squat (maximum area covered).

To demonstrate physically the relationship between posture and indoor temperature, was carried out a brief survey. 736 positions were recorded with a temperature variation between 20-26 ◦ C. The subjects were university students and researchers and the activities in question were typing, writing, reading and relaxed sitting. We calculate the area covered by the mutual contact of body parts (A_{mc}) in different postures and the total area covered (A_{tc}) by body contact and contact with other surfaces. The area covered in different postures is averaged over an interval of 0.5 ◦ C in temperature.

Table 2 Area covered in different posture as percentage of total body area

Codes	Area covered by contact		Total area Covered	Codes	Area covered by contact		Total area Covered
	Body	Surface			Body	Surface	
0 0 0 0 0 0	0.00	2.42	2.42	0 5 8 1 3 4	10.00	12.71	22.71
0 0 0 0 2 0	0.00	6.07	6.07	0 6 5 0 3 0	1.72	10.50	12.22
0 1 1 0 3 0	11.40	8.57	19.97	0 6 6 0 2 0	3.44	6.07	9.51
0 1 1 1 2 0	11.40	8.63	20.03	0 6 6 0 2 4	13.44	4.86	18.30
0 1 1 1 2 1	21.40	8.63	30.03	0 6 6 0 3 0	3.44	8.57	12.01
0 1 1 1 2 3	12.65	7.42	20.07	0 6 6 0 3 4	13.44	7.36	20.80
0 1 1 1 2 4	21.40	7.42	28.82	0 6 6 1 2 0	3.44	8.63	12.07
0 l 1 l 3 0	11.40	11.13	22.53	0 6 6 1 3 4	13.44	9.92	23.36
0 1 1 1 3 1	21.40	11.13	32.53	0 6 7 0 2 4	13.56	5.72	19.28
0 1 1 1 3 3	12.65	9.92	22.57	0 6 7 1 2 4	13.56	8.28	21.84
0 1 1 1 3 4	21.40	9.92	31.32	0 6 8 0 2 0	1.72	6.93	8.65
0 3 3 0 2 0	3.68	6.07	9.75	0 6 8 0 2 4	11.72	5.72	17.44
0 3 3 0 2 3	4.93	4.86	9.79	0 6 8 0 3 0	1.72	9.42	11.15
0 3 3 0 2 4	13.68	4.86	18.54	0 6 8 0 3 4	11.72	8.22	19.94
0 3 3 0 3 0	3.68	8.57	12.25	0 6 8 1 2 0	1.72	9.49	11.21
0 3 3 1 3 3	4.93	9.92	14.85	0 6 8 1 2 4	11.72	8.28	20.00
0 3 3 1 3 4	13.68	9.92	23.60	0 6 8 1 3 4	11.72	10.78	22.50
0 5 5 0 2 0	0.00	9.93	9.93	0 7 7 0 2 0	3.68	7.79	11.47
0 5 5 0 2 3	1.25	8.72	9.97	0 7 7 13 4	13.68	11.64	25.32
0 5 5 0 2 4	10.00	8.72	18.72	0 8 8 0 2 0	0.00	7.79	7.79
0 5 5 0 3 0	0.00	12.43	12.43	0 8 8 0 2 4	10.00	6.58	16.58

0 5 5 0 3 3	1.25	11.22	12.47	0 8 8 1 2 0	0.00	10.35	10.35
0 5 5 0 3 5	10.00	11.22	21.22	0 8 8 1 2 4	10.00	9.14	19.14
0 5 8 0 2 0	0.00	8.86	8.86	0 8 8 13 0	0.00	12.85	12.85
0 5 8 0 2 4	10.00	7.65	17.65	0 8 8 1 3 4	10.00	11.64	21.64

The analysis (Table 3) shows a strong relationship between temperature and posture. The average values are plotted as percentages of the area covered to the total body surface area (area A_D in Figure 3). The figure shows that with increasing temperature, open postures are preferred within the limits that the activities to allow them.

Table 3 Relationship between posture (area covered) and temperature. (Correlation coefficient r, probability p)

	A_{mc}		A_{tc}	
	r	**p**	**r**	**p**
All postures	0.399	0.000	0.404	0.000
Average	0.802	0.003	0.869	0.001

4. CONCLUSIONS AND DISCUSSIONS

Heat transfer between human body and its environment is similar to the transfer of it between two physical objects. In studies of thermal comfort has been considered that the total body surface area available for heat transfer by conduction and convection in the effective area according to the posture. According to the results reported in studies much remains unknown because of the effects of heat transfer depending on the posture adopted.

Considering that in a greenhouse, the temperature is varied based on the needs of the plant, the human body will be constantly adjusting the temperature, which is what causes thermal stress and the same accident that can lead workers even death.

Working in a greenhouse is rigid because the worker must adapt to it, because the amendments are not permitted because the workspace is the plant, and adding highly repetitive movements that are performed during the process, we conclude that it is more common for a worker suffers cumulative trauma injuries.

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DESIGN STANDARDS TO LINK FORCE POSTURE AND SUSTAINED EFFORTS

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1. Introduction

Occupational health has been plentifully studied; risks factors, illnesses, disorders and much more. The benefits of occupational health or occupational ergonomics programs have been probed so many times, for instance the relationship between the work station design and the discomfort of the people. But the point is how the occupational ergonomics program should be design. A six sigma approach for instance, Chengalur et al (2004), it is basically a problem solving methodology and, of course, it is a very useful tool, but mainly deals with engineering controls and it is oriented to proactive approach. The ergonomic program proposed by NIOSH (1997), includes an assessment of risk to development work musculoskeletal disorders as a part of the process. Mostly of ergonomic assessment methods or ergonomic programs, are focused to find ergonomic issues and then design controls, administrative or engineering controls.
This paper tries to go a little forward, once assessment and controls has been set, what´s next. Where the risks begin? How many people are exposed to risk?
The purpose is design a set of tables with relations between height, weight, force and angle with the percent of female population on low risk due these factors. This work is limited to female population and basically to standing and sitting work posture. The joint is only for shoulder area.

2. Method.

The tool used to develop the tables was the 3DSSPP program (2012). The methodology was the follow:

- Find the height limits for female population, it´s 155 to 180 cm.
- Find the weight limits, it´s 51 to 80 kgs.
- Set the minimum force (lbs) in combination with the maximum shoulder angle until the 95% population is reach, and then determinate the interval when the values remain unchanged.
- Increase the force until the shoulder angle reaches 30°.
- Force increases on one pound until reach 75% of population. For higher population than 75% was set an interval of angles which changed degrees while percent population remains the same.
- These method was used for both postures; sitting and standing.
- Each table contains a combination of posture, height, weight, force, shoulder angle and population on low risk to suffer a WMSD.

3. Results.

Tables for sitting posture are listed below:

Sitting position		
Height: 155 cm.		
Weight: 51 Kg.		
Force	Angle	%Pob low risk
7	65-99	95
8	63-98	93
9	63-98	91
10	68-98	85
11	67-97	80
12	66	74
13	52	74
14	43	74
15	36	74
16	31	74

Sitting position		
Height: 157 cm.		
Weight: 55 Kg.		
Force	Angle	%Pob low risk
6	71-99	96
7	70-99	95
8	57-98	93
9	74-97	87
10	68-97	83
11	79	75
12	60	74
13	48	74
14	40	74
15	34	74
16	29	74

Sitting position		
Height: 160 cm.		
Weight: 60 Kg.		
Force	Angle	%Pob low risk
7	51-99	95
8	76-99	89
9	72-99	85
10	82-97	78
11	69	74
12	53	74
13	43	74
14	37	74
15	31	74

Sitting position		
Height: 165 cm.		
Weight: 60 Kg.		
Force	Angle	%Pob low risk
6	64-99	95
7	69-99	92
8	50-99	92
9	79-99	82
10	75-99	76
11	59	74
12	48	74
13	40	74
14	33	74
15	28	74

Sitting position		
Height: 165 cm.		
Weight: 65 Kg.		
Force	Angle	%Pob low risk
6	58-99	95
7	71-99	91
8	80-99	86
9	74-99	81
10	75	74
11	58	74
12	46	74
13	38	74
14	32	74
15	27	74

Sitting position		
Height: 170 cm.		
Weight: 65 Kg.		
Force	Angle	%Pob low risk
6	61-99	95
7	70-99	90
8	72-99	85
9	72-99	79
10	65	74
11	51	74
12	42	74
13	35	74
14	29	74

Sitting position		
Height: 170 cm.		
Weight: 70 Kg.		
Force	Angle	%Pob low risk
6	50-99	95
7	79-99	88
8	76-99	83
9	73-99	77
10	62	74
11	49	74
12	40	74
13	34	74
14	28	74

Sitting position		
Height: 175 cm.		
Weight: 70 Kg.		
Force	Angle	%Pob low risk
6	52-99	95
7	76-99	87
8	73-99	82
9	74-99	76
10	57	74
11	47	74
12	39	74
13	33	74
14	27	74

Sitting position		
Height: 175 cm.		
Weight: 80 Kg.		
Force	Angle	%Pob low risk
5	60-99	95
6	75-99	89
7	74-99	84
8	75-99	77
9	62	74
10	49	74
11	40	74
12	33	74
13	28	73

Standing position		
Height: 180 cm.		
Weight: 80 Kg.		
Force	Angle	%Pob low risk
5	56-99	95
6	52-99	92
7	76-99	82
8	75-99	75
9	58	74
10	46	74
11	38	74
12	32	74
13	27	73

Tables for standing posture are listed below:

Standing position		
Height: 155 cm.		
Weight: 51 Kg.		
Force	Angle	%Prob. low risk
7	66-99	95
8	76-95	92
9	72-99	89
10	78-94	84
11	70-92	78
12	68	74
13	53	74
14	44	74
15	37	74
16	31	74

Standing position		
Height: 157 cm.		
Weight: 55 Kg.		
Force	Angle	%Prob. low risk
6	69-99	96
7	72-99	94
8	75-97	91
9	77-94	87
10	77-94	82
11	75-86	76
12	60	74
13	48	74
14	41	74
15	35	74
16	29	74

Standing position		
Height: 160 cm.		
Weight: 60 Kg.		
Force	Angle	%Prob. low risk
6	76-96	95
7	70-99	93
8	80-92	89
9	74-97	85
10	95	80
11	70	74
12	54	74
13	44	74
14	37	74
15	32	74

Standing position		
Height: 165 cm.		
Weight: 60 Kg.		
Force	Angle	%Prob. low risk
6	70-98	95
7	72-98	92
8	74-98	88
9	74-96	83
10	78-93	76
11	61	74
12	49	74
13	41	74
14	34	74
15	29	74

Standing position		
Height: 165 cm.		
Weight: 65 Kg.		
Force	Angle	%Prob. low risk
6	72-99	95
7	85-93	91
8	83-93	83
9	83	81
10	82	79
11	57	74
12	47	74
13	39	74
14	33	74
15	28	79

Standing position		
Height: 170 cm.		
Weight: 65 Kg.		
Force	Angle	%Prob. low risk
5	63-99	96
6	77-94	93
7	72-99	90
8	88-93	88
9	78-93	79
10	69	74
11	53	74
12	43	74
13	36	74
14	30	74
15	25	74

Standing position		
Height: 170 cm.		
Weight: 70 Kg.		
Force	Angle	%Prob. low risk
5	73-98	95
6	67-87	93
7	72-99	89
8	82-90	83
9	88-93	77
10	68	74
11	50	74
12	41	74
13	35	74
14	29	74
15	23	73

Standing position		
Height: 170 cm.		
Weight: 75 Kg.		
Force	Angle	%Prob. low risk
5	65-100	95
6	70-100	92
7	82-90	87
8	70-96	83
9	78-93	75
10	58	74
11	48	74
12	40	74
13	33	74
14	28	74

4. Conclusions.

The ergonomic program is a core element on occupational health. Assessment risks of WMSD are very important in order to ser administrative and engineering controls. Involving people on every level is important too. But going to next level on ergonomic programs depends on standard developments; it provides a reference to work design.
Standards needs to include more factors, for instance recovery times, yet can be recommended a 85% of work load, that means 54 seconds of work and 6 seconds for recovery time for a 60 seconds cycle time.
These paper present tables up to 90° shoulder angle plus a 10°, but over shoulder posture should be observed.

It is necessary set standards for:

- Force limits on: thumbs push, pinch grip, hand grip, manual material handling.
- Weight, vibration and torque for tools.
- Weight of containers and materials.

Standards could be development for the ergonomic process too; the follows are some opportunity elements:

- Anthropometric chart and data,
- Anthropometrics criteria to assign people to workstations
- Buy-off procedures for tooling and MMM
- A LEC (Local Ergonomics Committee)
- A responsible for ergonomics,
- Training on ergonomics
- Periodicity for updating the risk map,
- Excel© templates for assessments,
- Medical records related to occupational complains.
- Engineering and administrative controls

Standards represents an excellent opportunity area to still growing up on ergonomics, understanding that ergonomics increases health people at work as well increases people moral, and contribute to social responsibility for management.

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ERGOPHTALMOLOGY: QUANTITATIVE MEASUREMENT OF VISUAL FATIGUE IN FINAL INSPECTION STATIONS AT A BLIND MANUFACTURING FACTORY IN AGUA PRIETA, MEXICO

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Resumen: El presente trabajo tiene como finalidad la medición y análisis de factores cualitativos que provocan fatiga visual en el área de inspección de metales de una fábrica de persianas en Agua Prieta, México.

La agudeza visual, la cromaticidad y los niveles de iluminación son medidos a través de los métodos de Optotipos de Snellen, el Método Farnsworth-Munsell 100 y los métodos LEST/NOM STPS-025 respectivamente.

La primera etapa consistió en un diagnóstico de las condiciones de iluminación, luego se realizaron las mediciones antes mencionadas encontrándose deficiencias considerables que se presentan mediante gráficas. Finalmente, se presentan las conclusiones generales y una propuesta de mejora en el diseño de las estaciones de trabajo.

Palabras clave: iluminación, ergoftalmología, fatiga visual.

Abstract: The purpose of this paper is to measure and analyze qualitative factors that cause visual fatigue in the Metal Inspection Area at a Blind Factory in Agua Prieta, Mexico.

Visual acuity, chromaticity and lighting levels are measured through the Snellen Optotypes, Farnsworth-Munsell 100 and LEST/NOM STPS-025 methods respectively.

The first stage consisted in an actual diagnose of the lighting conditions, then the mentioned measurements were performed which provided evidence of considerable deficiencies that are presented graphically. Finally, the conclusions and an improvement proposal for the workstation design are presented.

Keywords: lighting, ergophtalmology, visual fatigue.

1. INTRODUCTION

The visual demand in industrial manufacturing operations could lead to health consequences for the workers, as well as to affectations to their detection capacity. It is of special interest then the case of the visual inspection operations due to the observation is a critical factor when detecting quality defects. (Solano, 2006)

1.1 Problem Diagnose

A diagnose visit to the facilities was scheduled where a general tour and observation of the critical area of interest took place. The findings of such a visit are exposed in the Delimitation area of the present document.

As a result of an Analytical Process and Conceptualization, the asthenopy (visual fatigue) seemed to perfectly explain the general problematic of the inspection area in terms of lighting conditions and detection deficiency. Some visual fatigue's quantitative variables (factors) and their respective measurement methods are presented below:

Table 1. Ergophtalmological Factors & Measurement Methods (Solano, 2006)

FACTORS	MEASUREMENT METHOD
Visual Acuity	Snellen optotypes
Chromaticity	Farnsworth-Munsell 100
Lighting Level	LEST/NOM STPS-025 Method
Visual Tangent	Vision Angle

1.1.1 Snellen Optotypes Method for Visual Acuity Measurement

For the visual acuity measurement in final inspection operators the Snellen Optotypes Test was utilized at the beginning and end of a normal shift so that results and possible tendencies could be compared. The test consists in correctly identifying the letters (optotypes) in a graph known as Snellen Graph or Snellen Table (Snellen, 1962). Only 9 optotypes are used: C, D, E, F, L, O, P, T and Z. The optotypes have a decreasing size depending on the level the involved individual is looking at. The identification of a level lower than 2/10 means blindness. One of 10/20 is the minimum level demanded in order to get the driver's license in most countries and a 20/20 is considered a normal vision (Stroebel, *et al,* 1993).

1.1.2 Farnsworth-Munsell 100 Hue for Chromaticity Measurement

In order to detect the capacity of an individual for color vision and discrimination, the Farnsworth-Munsell 100 Hue Method was performed at the beginning and end of the normal shift for comparison purposes.

Farnsworth-Munsell 100 Hue Method is a useful method for measuring the color vision of an individual in an effective and easy-to-administer manner. The test consists of colored caps (see figure 1) observed under C illuminant, correspond to a Full Hue Circle, so that all of them have approximately the same luminosity and present the same chroma level. The caps are organized into four trays containing 21 or 22 pieces each, from which the first and last ones are not to be moved since they are considered references for the test taker (Luque *et al,* 2001).

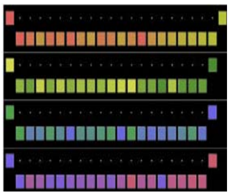 

Figure 1. Farnsworth-Munsell 100 Hue caps and typical Test Kit.

1.1.3 Lighting Intensity

A proper lighting intensity can improve the task performance of the operators, the appearance of the area and also positively affect in the worker's psychology.

The lighting levels were measured with a luxometer on each inspection area in four spots: to the left, to the right, in front of and behind the area where the operator moves when inspecting the blinds.

The reference parameter in order to consider the lighting level as pertinent was the norm *NOM-25-STPS-2008. Condiciones de Iluminación en los Centros de Trabajo.* This norm has the objective of establishing the lighting requirements at the workcenters for different visual activities, providing a safe and healthy environment for the workers.

The norm is valid in Mexico and applies for all workcenters (Secretaría del Trabajo y Prevención Social, 2004).

1.1.4 Global Evaluation LEST Method

Finally, for executing a general evaluation of the work conditions the LEST Method was used. The method pretends an evaluation of the work conditions as objective and global as possible, establishing a final diagnose that indicates if every considered situation for the position is satisfactory, unpleasant or harmful (Diego-Mas & Sabina, 2011).

The information that is required to be gathered for the method application has a double objective-subjective character.

For the diagnosis of the situation, the method considers 16 grouped variables in five aspects (dimensions) as follows: physical environment, physical load, mental charge, psychosocial aspects and worktime. The evaluation is based on the scores obtained for each of the considered variables.

With respect to the objectives of this study the physical environment variables to be taken in consideration are those related to the lighting environment. These variables are:

The lighting level in the Workstation, the average general lighting, the contrast level in the Workstation, the perception level required for the task, the presence of artificial light and the existence of dazzling sources.

With the obtained information through the study and observation *in situ*, different values are calculated for each variable which oscillate between 0 and 10 that are then interpreted as follows:

Table 2. LEST Method Scoring System (Diego-Mas & Sabina, 2011).

SCORING SYSTEM	
0, 1, 2	Satisfactory Situation
3, 4, 5	Low discomfort
6, 7	Moderate discomfort. Fatigue risk

8, 9	Strong discomfort. Fatigue
10	Harmfulness

2. OBJECTIVES

1. Detect the factors that cause visual fatigue in the visual inspection stations.
2. Determine if the conditions of operation in the inspection area are adequate to ensure a reliable and productive execution of the tasks.
3. Find out if the lighting in the inspection area meets the requirements of NOM-025-STPS-2008 in terms of lighting conditions of the workcenters.
4. Propose an improvement to be implemented for the visual inspection workstations in order to reduce the incidence of asthenopy in workers and contribute to the productivity of the organization.

3. DELIMITATION

The present research work took place at a blind manufacturing factory in Agua Prieta, Mexico. The area of interest is the Final Inspection Station (see figure 2) where constant cosmetic defects are detected (predictably related to a poor lighting design). Frequent complaints of headaches from inspection workers have also been detected.
A total of six inspection operators (one for each running product family) participated. All of them were female-gendered (20-42 years old) with seniority from 3 months to 8 years in the position.

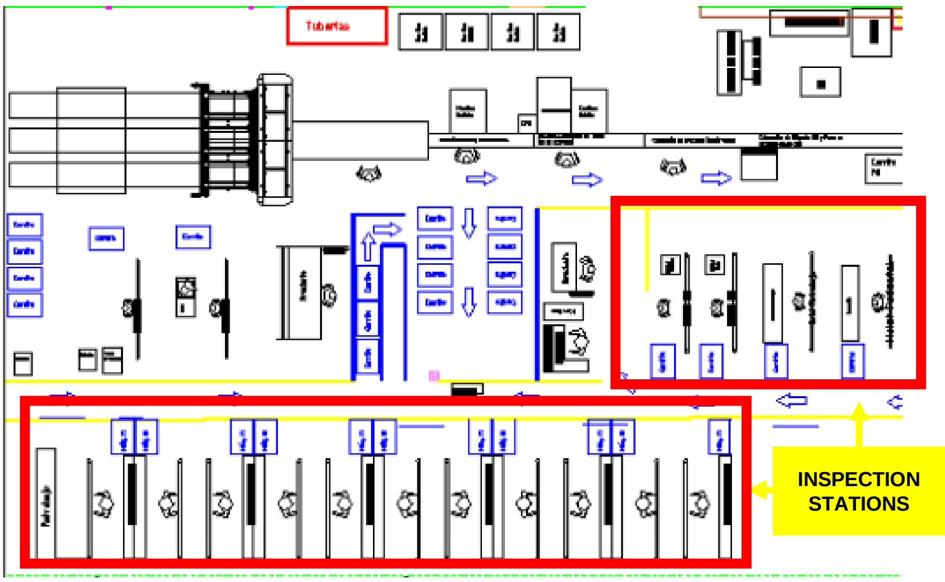

Figure 2. Plant layout and presentation of the Final Inspection Area (in red).

A general tour of the facilities and the area of interest took place where the following conditions were observed:

The lighting conditions were not standardized, the luminaries were not uniformly distributed and generated shadows in distinct parts of the workstation (see figure 3), and the height of the ceiling was not constant either.

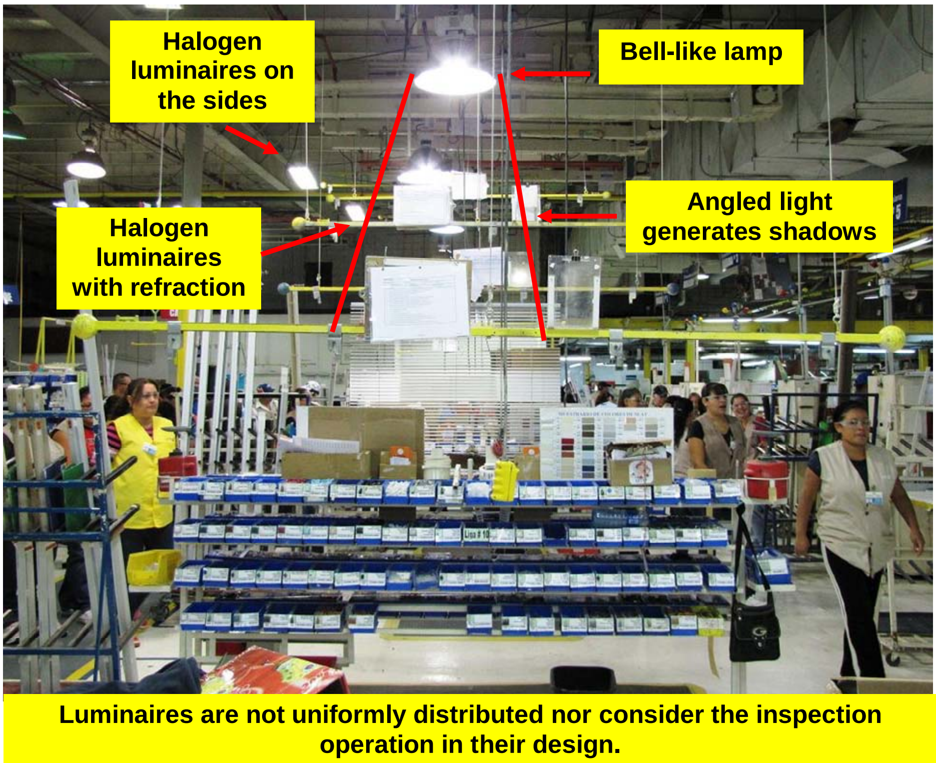

Figure 3. Luminaries Distribution in the area of interest.

4. METHODOLOGY

4.1 Measurement Process

The measurement process covered a complete working day. The visual acuity and chromaticity tests were initially performed to the six randomly selected inspectors (figure 4). These measurements took place from 6:10 a.m. to 8:30 a.m.

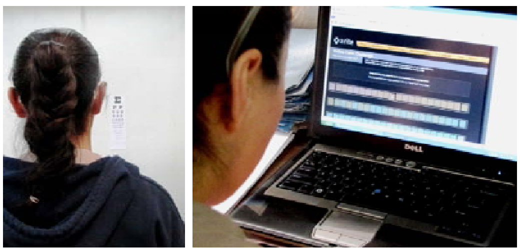

Figure 4. Visual Acuity & Chromaticity Tests Application

Subsequently the inspectors were allowed to continue working. During this lapse of time the measurements related to the lighting levels were executed on each final inspection workstation. This process spanned from 10:30 a.m. to 1:30 p.m. using a precision photo diode, color correction filter and cosine/color corrected luxometer.

Finally the visual acuity and chromaticity tests were repeated close to the end of the shift in order to contrast the results with the ones obtained at the beginning. This last process was performed from 2:00 p.m. to 3:45 p.m.

5. RESULTS

The results of the measurement process are presented graphically as follows:

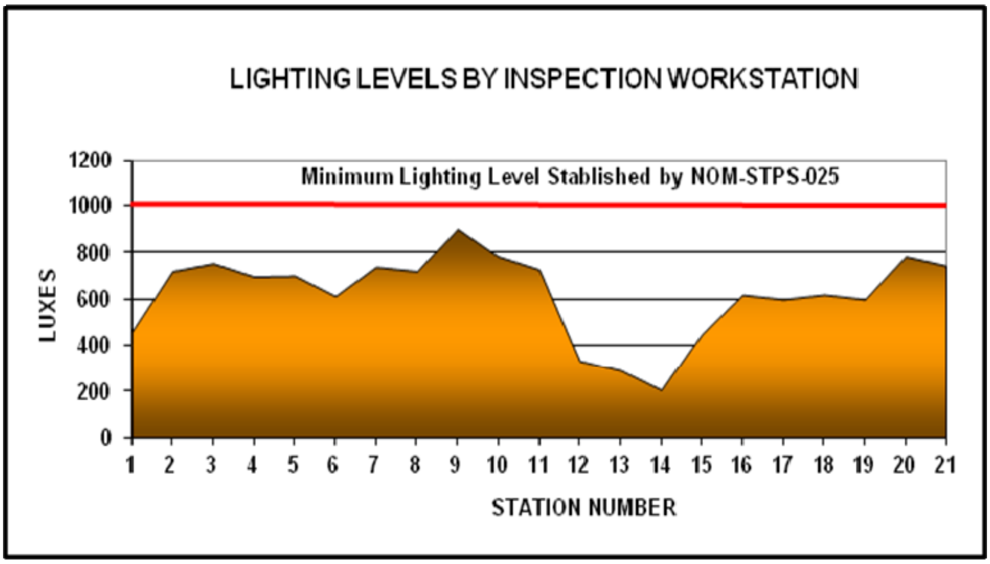

Figure 5. Lighting Levels by Inspection Workstation

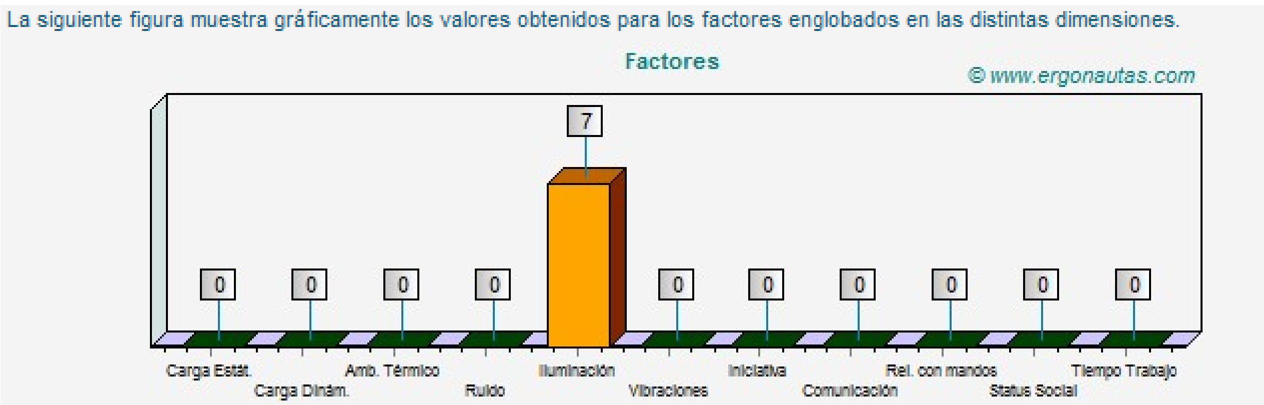

Figure 6. Results provided by the LEST software

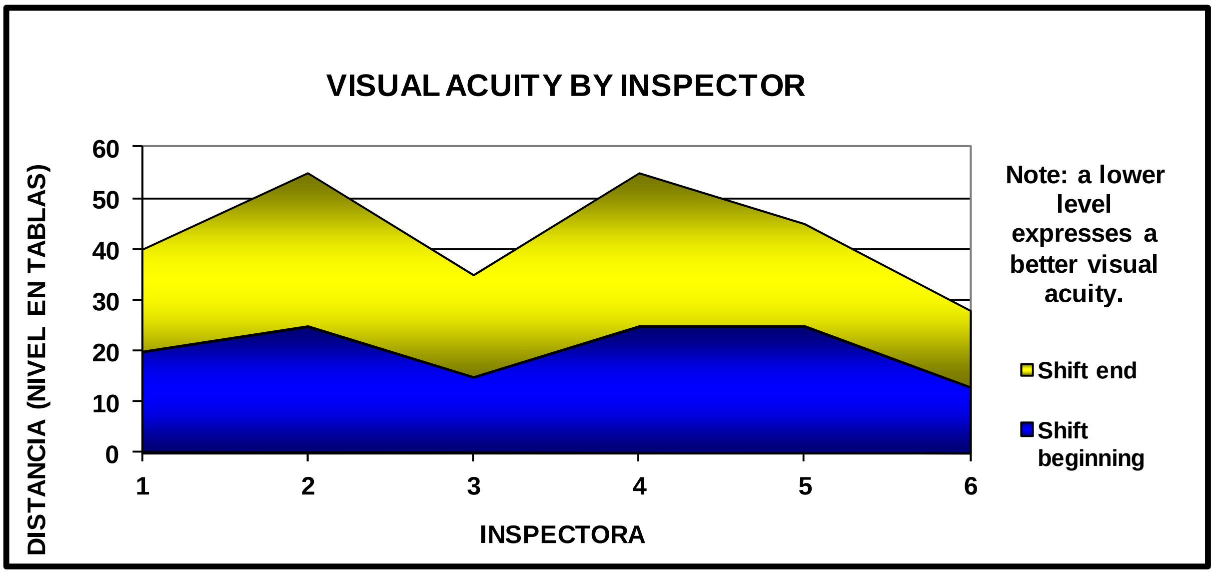

Figure 7. Visual Acuity by Snellen Optotypes in Quality Inspectors

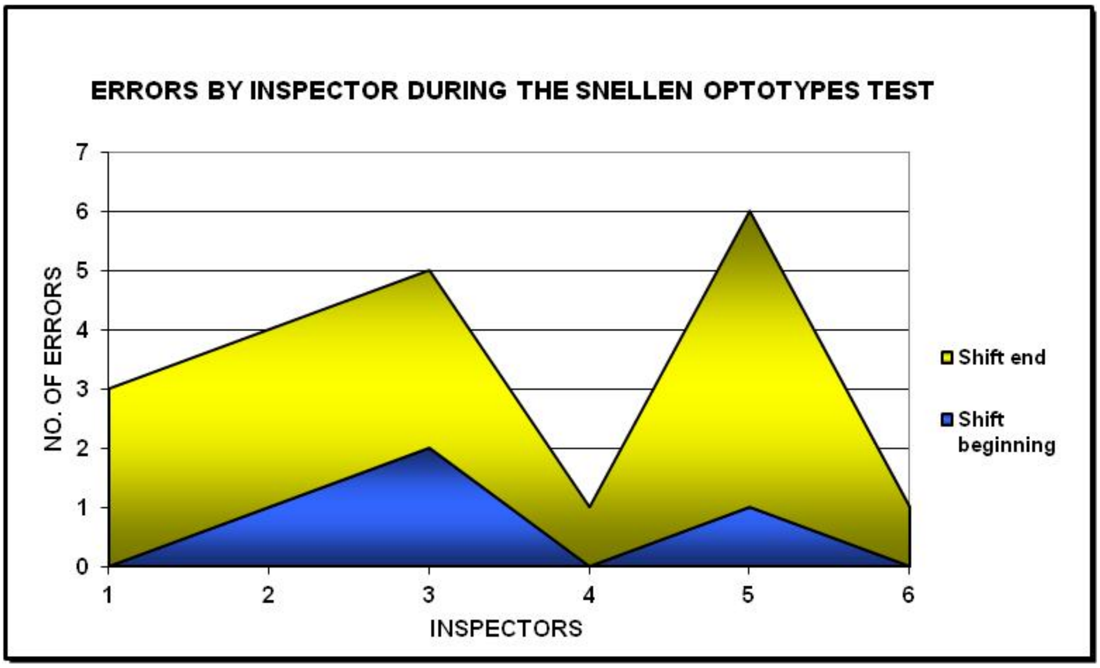

Figure 8. Detected Errors during Snellen Optotypes Test

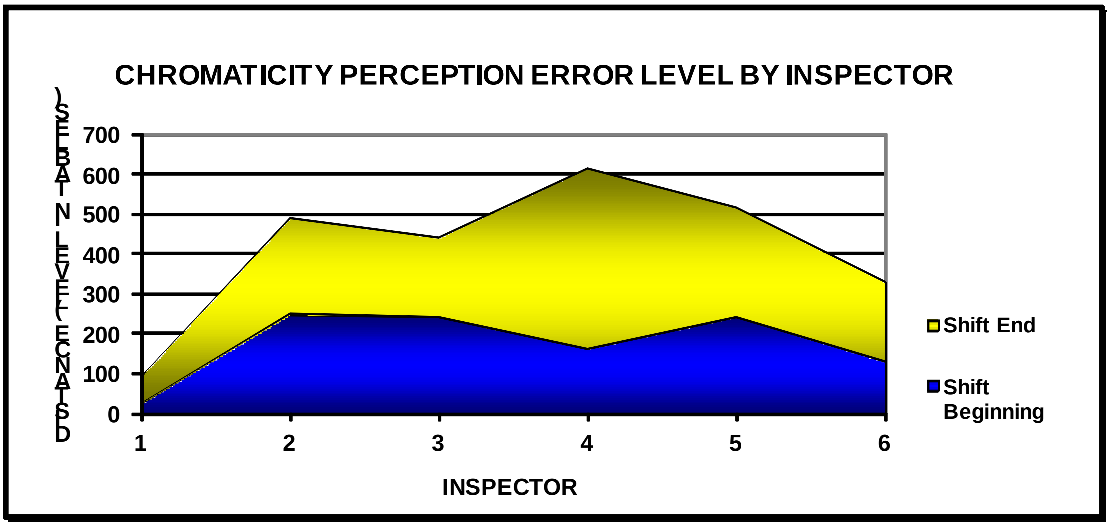

Figure 9. Chromaticity Perception Error Level by inspector

5. CONCLUSIONS

With the previous results is observed that the lighting conditions in the inspection stations are below the requirements established in Norma Official Mexicana NOM-025-STPS-2008 (see figure 5).

Data was also subjected to evaluation through the LEST method, obtaining a grade of 7, which means that the lighting conditions can generate moderate to high discomfort and the risk of visual fatigue is present (see figure 6 & table 2).

There is also a clear relation between the factors that present more number of errors, less visual acuity and less capacity to distinguish hues at the end of the shift with respect to the data obtained at the beginning of the shift. As a result of the prior observation, a couple of improvements are proposed in order to achieve the adequate work conditions that meet the norm so that the detection level increases avoiding the visual fatigue of the operators (see figures 7, 8 & 9).

The uniform installation of fluorescent, halogen or LED-Type luminaries is recommended depending on the acquisition capacity of the organization. The particular use of halogen with interior reflecting mirrors is advised. This will allow better energy efficiency (see figure 10).

Likewise, it is advised to place a surface at the back of the blind so a greater contrast is achieved. This can be done by adapting pedestal hoists instead of the hanging ones that are currently used (see figure 11).

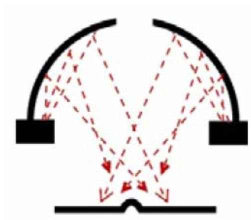

Figure 10. Reflecting Mirror-like Luminaries

Figure 11. Pedestal Hoist

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EXPERIMENTAL SOFTWARE FOR THE EVALUATION OF ERGONOMIC ATTRIBUTES IN ADVANCED MANUFACTURING TECHNOLOGY

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Resumen: Este artículo presenta la descripción del programa de cómputo desarrollado para la evaluación ergonómica de Tecnología de Manufactura Avanzada (TMA). Los objetivos del artículo es describir las partes del programa y las funciones que efectúa a partir del manual del usuario. Así mismo, difundir el conocimiento sobre el Modelo de Evaluación de Compatibilidad Ergonómica para la Selección de Tecnología de Manufactura Avanzada (MECE) y facilitar la comprensión de los resultados que el software ofrece sobre la evaluación realizada. Se presentan las partes del programa, sus distintos menús y submenús, las funciones que realiza y el despliegue de resultados. El programa facilita la comparación de equipos de TMA con un mismo propósito de manufactura, al utilizar de manera más eficiente el Modelo de Evaluación de Compatibilidad Ergonómica (MECE) para la Selección de Tecnología de Manufactura Avanzada propuesto por Maldonado (2009). La utilización del programa en las empresas potencialmente ayudará a crear bases de datos sobre los equipos de TMA más utilizados, así como de expertos en el área para su evaluación y los diagnósticos ergonómicos efectuados por el programa de diversos equipos para su uso y referencia que ayude a guiar la toma de decisiones.

Abstract: This article presents the description of the software that has been developed for the evaluation of ergonomic compatibility attributes for advanced manufacturing (AMT) selection and comparison. The objectives of the article are to describe the parts of the program and the functions carried out from the user's manual. Likewise, disseminate knowledge about it and facilitate the understanding of the outcomes of the conducted evaluation. The article presents the parts of the program, the functional menus and submenus, the general functions performed and the deployment of results. The program facilitates the comparison of AMT equipment with a same manufacturing purpose, also promotes an efficient way of use and comprehension of the Ergonomic Compatibility Evaluation Model (ECEM) for the Selection Advanced Manufacturing proposed for Maldonado (2009). The generalized use of the program in modern companies potentially will help create databases about the most used AMT equipment, as well as knowledge from participant experts in the area, also for ergonomic diagnoses made by the software for reference as an aid for decision making.

Keywords: Advanced Manufacturing Technology, Ergonomic Evaluation, Ergonomic Compatibility Attributes, Ergonomic Compatibility Evaluation Model

1. INTRODUCTION

Ergonomic Evaluation of Advanced Manufacturing Technology is considered a complex problem that involves multiple attributes. These ergonomic compatibility requirements (attributes) are not precisely determined in the literature and such evaluation must take into account quantitative and qualitative aspects. Also, its complexity and vagueness make the problem even more difficult to solve. For Karwowski (2005) advanced technologies with human interaction constitute complex systems that require a high level of integration; in this way, the design integration of the interactions between hardware (computer-based technology), organization (organizational structure), information system, and people (human skills and training) must be evaluated in such design. Maldonado (2009) and Maldonado et al. (2009) propose the Ergonomic Compatibility Evaluation Model (ECEM) for the Selection of Advanced Manufacturing Technology that includes the Ergonomic Compatibility Attributes (ECA) for the evaluation of Advanced Manufacturing Technology (AMT). They were established from an extensive literature review and based on the design manual for ergonomics of workspaces and machines design by Corlett and Clark (1995). This model can be used to compare and select the best alternative of AMT using a novel fuzzy axiomatic design approach. The application of this model can be enhanced by the design of software that can manage and execute evaluations systematically. Also, it can be used to generate data bases about decision making processes related to AMT, experts who may perform the evaluations, AMT characteristics and suppliers, among other information. This paper presents the description of experimental software that effectively applies the ECEM to select AMT.

1.1 Objectives

The objectives of the article are to describe the fundamentals of the ECEM and ECA. Describe the parts of the software and the functions carried out from the user's manual. Likewise, disseminate knowledge of it and facilitate the understanding of the outcomes of the conducted evaluation.

1.2 Ergonomic Compatibility Evaluation Model

Ergonomic Compatibility (EC) is a construct used in this model and it is defined reminding the concepts of human-system and human-artifact compatibility introduced by Karwowski (1997, 2001), which emanate from the need of having comprehensive treatment of compatibility in human factors discipline. It intends to measure in a subjective way, the probability of a design to satisfy ergonomic requirements using the Ergonomic Incompatibility Content (EIC). For this purpose, the Theory of Axiomatic Design extended by Helander (1995) y Helander & Lin (2002) and adopted by Karwowski (2006a) was applied. These authors are introducing Ergonomics Theory for design and evaluation purposes and offer an interpretation of the Independence Axiom and Information Axiom addressing ergonomic designs. Particularly, an adaptation of the information axiom under fuzzy environment was required to obtain the EIC. Also, the science of artifact-human (system) compatibility (Symvatology) proposed by Karwowski (2000, 2006b) was considered, as it tries to develop a quantitative way of measuring such compatibility. The model proposed by Maldonado-Macías (2009) establishes the ECA in a multiattribute hierarchy, also this author proposed a survey and a procedure to obtain information and compare alternatives using the EIC. In these procedures, experts must determine Design Ranges and System Ranges during the evaluation via linguistic terms. Then, Design Range (DR) denoted by the fuzzy number (α,θ,β) represents what is desirable from an ergonomic perspective; whereas the System Range Area(SR) is denoted by the fuzzy number (a,b,c); represents what can be complied by the artifact design in relation with the particular DR. The overlap between DR and SR is called Common Range Area and represents the probability of a design to satisfy such ergonomic attribute or ergonomic requirement. These ranges are established using linguistic terms. The alternative that has the lowest EIC is the best for our goal, and represents the alternative that can satisfy ergonomic attributes. Figure 1 shows the fuzzy representation of these areas. Systematically, these linguistic terms are converted to fuzzy numbers following a mathematical procedure. It is recommendable the work of Maldonado-Macías et al. (2009) for further reading.

The proposed evaluation applies to the selection of alternatives of AMT with a very similar or same manufacturing purpose (i.e. alternatives of CNC Milling Machines). Also, the importance weight of each attribute for the model uses the AHP (Analytic Hierarchical Process) methodology proposed by Saaty (1980). Ergonomic Compatibility Attributes are explained in the following paragraph.

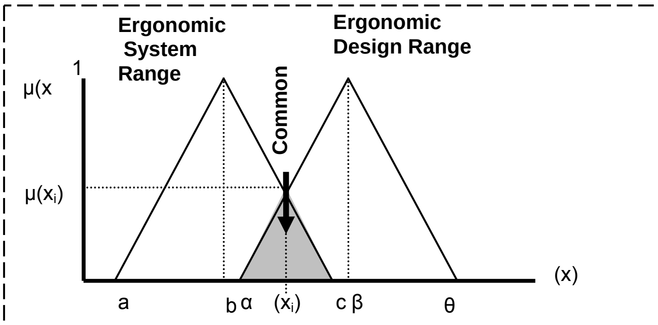


Figure 1. Ergonomic System Range, Design Range, Common Area

1.2.1 <u>Ergonomic Compatibility Attributes</u>

Ergonomic compatibility attributes (ECA) were divided into five main attributes: compatibility with human technical skills and training (A11), compatibility with physical work space (A12), usability (A13), equipment emissions requirements (A14) and organizational requirements (A15). The main attribute A11 includes two sub-attributes: compatibility with user´s technical skill level (A111) and compatibility with training (A121). The main attribute A12 includes five sub-attributes: access to machine and clearances (A121), horizontal and vertical reaches (A122), adjustability of design (A123), postural comfort of design (A124), physical work and endurance of design (A125).

The main attribute A13 includes seven sub-attributes: controls' design compatibility (A131), controls' physical distribution (A132), visual work space design (A133), information load (A134), error tolerance (A135), man machine functional allocation (A136), design for maintainability (A137). The main attribute (A14) includes four sub-attributes: temperature (A141), vibration (A142), noise (A143), residual materials (A144). The main attribute (A15) includes two sub-attributes: rate of work machine compatibility (A151) and job content machine compatibility (A152). Table 1 presents the attributes for evaluation purpose.

Table 1: Description of the Ergonomic Compatibility Attributes

Attribute	Description
A11 Human Skills and Training Compatibility: Set of attributes that define the compatibility of the equipment with technical skills and training of users.	
A111 Skill Level Compatibility	Attribute of design of equipment regarding its adaptability to differences on technical skills of users. (Allowing safe and efficient operation for expert and novice users).
A112 Training Compatibility	Attribute of design of equipment in terms of the training required (quality and duration) that will be available taking into account needs of users.
A12 Physical Work Space Compatibility: Set of attributes that define the compatibility of equipment with the physical work space through the allowance of comfortable reaches and postures as well as taking into account the strength and endurance required for its operation promoting safety and effectiveness.	
A121 Access to Machine and Clearances	Attribute of design of equipment concerning the allowance of mobility and secure access to arms, hands, legs, head, trunk, and knees of the operator through its space and clearances.
A122 Horizontal and Vertical Reaches	Attribute of design of equipment concerning the allowance of comfortable, safe and effective human vertical and horizontal reaches (upper and lower extremities).
A123 Adjustability of Design	Attribute of design of equipment concerning the allowance of adjustment and / or change on its physical structure (size, position, etc.) or on its components that would be satisfactory to operator.
A124 Postural Comfort of Design	Attribute of design of equipment regarding the allowance of neutral and diverse body postures for a safe and effective operation.
A125 Physical Work and Endurance of Design	Attribute of design of equipment concerning the level of physical work and endurance that will required of operator during interaction.
A13 Usability: Set of attributes that promote easiness of use on design of equipment.	
A131 Compatibility of Design of Controls	Attribute of design of equipment regarding the type and design of controls and sensors (as buttons, knobs, levers, switches, sensors stoppage of movement, etc.) providing an effective and safe operation.
A132 Physical Distribution of Controls	Attribute of design of equipment regarding the physical distribution (location) of the controls (buttons, knobs, levers, switches, etc.) providing a safe and effective manipulation.
A133 Visual Work Space Design	Attribute of design of equipment concerning the size and location of screens and displays of information: size and type of characters used, colors, contrast, resolution and brightness facilitating human visual tasks during human-machine interaction.
A134 Information Load	Attribute of design of equipment which allows and facilitates a safe and effective operation through a satisfactory human understanding, learning and processing of the information (visual, auditory, sensory) during human-machine interaction.
A135Error Tolerance of Design	Attribute of design of equipment which allows and facilitates to the operator the management and prevention of errors, through simple and clear messages and dialogues on the human-machine interface.
A136 Man-Machine Functional Allocation of Design	Attribute design of equipment concerning difficult tasks for operator such as quick response, short term storing information, high accuracy and repeatability, among others are allocated in the equipment design preferable to the machine.
A137 Design for Maintainability	Attribute of design of equipment considering whether a simple, rapid, effective and safe maintenance tasks will be allowed, during repairing, installation and dismantling, transportation, loading, cleaning, assembling and disassembling among other maintenance activities.
A14 Equipment Emissions Requirements: Set of attributes related to temperature, vibration, noise and residual materials generated by the equipment and may adversely affect operator and/or environment.	
A141 Temperature	Attribute of design of equipment related to the temperature (hotness/coldness) emitted by the equipment and its components and that may adversely affects operator and/or environment.
A142 Vibration	Attribute of design of equipment which related to the vibration emitted by the equipment and that may adversely affects operator and/or environment.
A143 Noise	Attribute of design of equipment related to the noise emitted by the equipment and its components and that may adversely affects human

Attribute	Description
	operators and/or environment.
A144 Residual Materials	Attribute of design of equipment related to the amount and kind of residual materials generated by the equipment and its components and that may adversely affect the operator and or environment.
A15 Equipment Design Organizational Requirements: Set of attributes that define the compatibility of equipment with the pace and speed of work as well as with the total content of the work according human limitations and capabilities.	
A151 Rate of Work Machine Compatibility	Attribute of design of equipment considering that it avoids or prevents inappropriate pace and speed of work for operator.
A152 Total Work Content Machine Compatibility	Attribute of design of equipment considering that it supports the prevention of excessive force application, long term awkward postures, repetitive tasks and high-risk task (i.e. manual handling of loads) on complementary tasks of the machine operation (total content of work).

2. ERGONOMIC COMPATIBILITY EVALUATION EXPERIMENTAL SOFTWARE

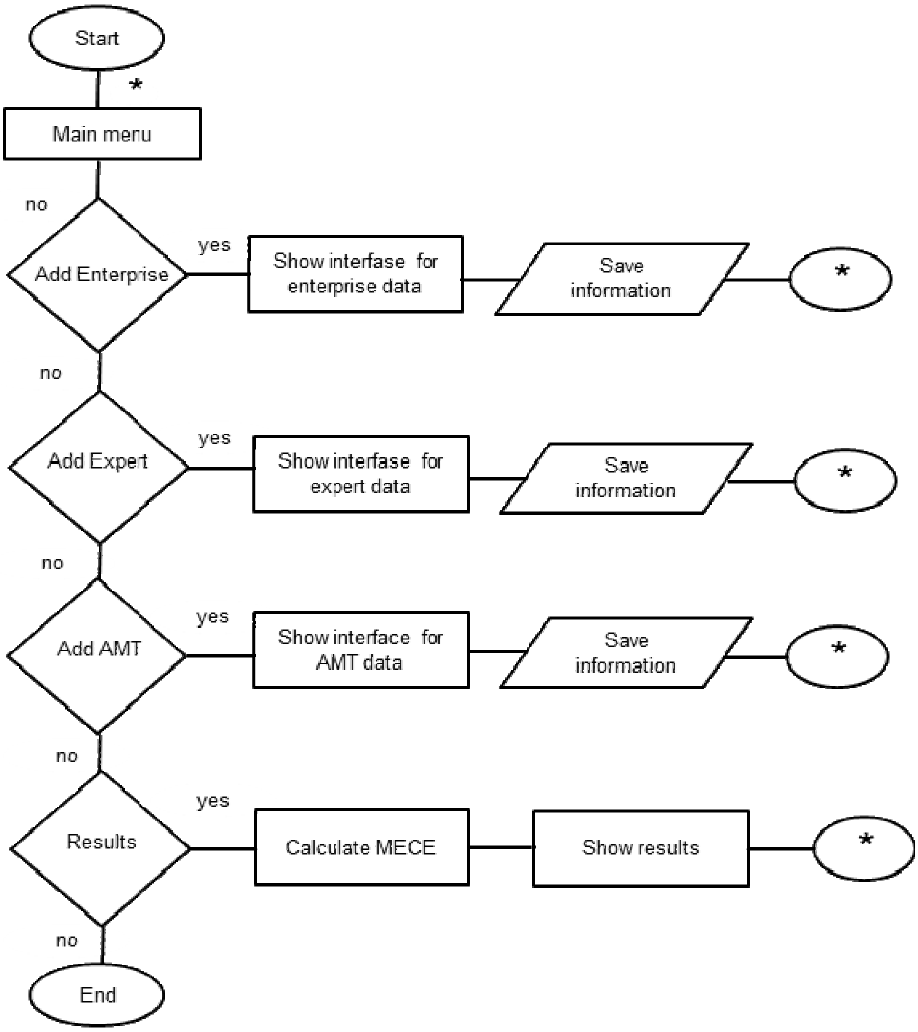
The proposed software was designed following an incremental methodology. Maldonado et al. (2012) exposed this methodology which is developed in four phases: Analysis, Design, Coding, Testing. The flowchart of the basic functions of the software is shown in Figure 4.

The software design includes several groups of menus containing functions and procedures that are listed below:

- Main Menu: Responsible for being the connection among all system functions.
- Add Enterprise Menu: Capture information of a general nature such as personnel, infrastructure, process data acquisition equipment etc.
- Add expert menu. Capture information about the experts who will perform the evaluations about the alternatives.
- Add AMT menu. This area of the system enables to include a new alternative to be compared. Also, provides detailed information about the characteristics of alternatives (equipment) to be evaluated and compared. Also, this menu provides access to the evaluation process which enables experts to capture the scores and ranking of each attributes and sub attributes for each alternative. In this part, the Ergonomic Design Range, System Design Range will be captured via the experts´ evaluations.
- Results Screenshot. This is the critical part of the system, because the information about the evaluations is presented. Also, calculations to obtain the Ergonomic Incompatibility Content (EIC) and the “spider” chart for the comparison are shown in this part. As a result, system delivers which alternative is the best in terms of satisfying established Ergonomic Functional Requirements. Also, in this section results can be displayed showing the general comparison of alternatives and the detailed information of the evaluation of attributes and sub attributes separately for analyzing the final decision.

In the following sections the description of these parts

Figure 2. System Flow Chart



2.1 Software Description

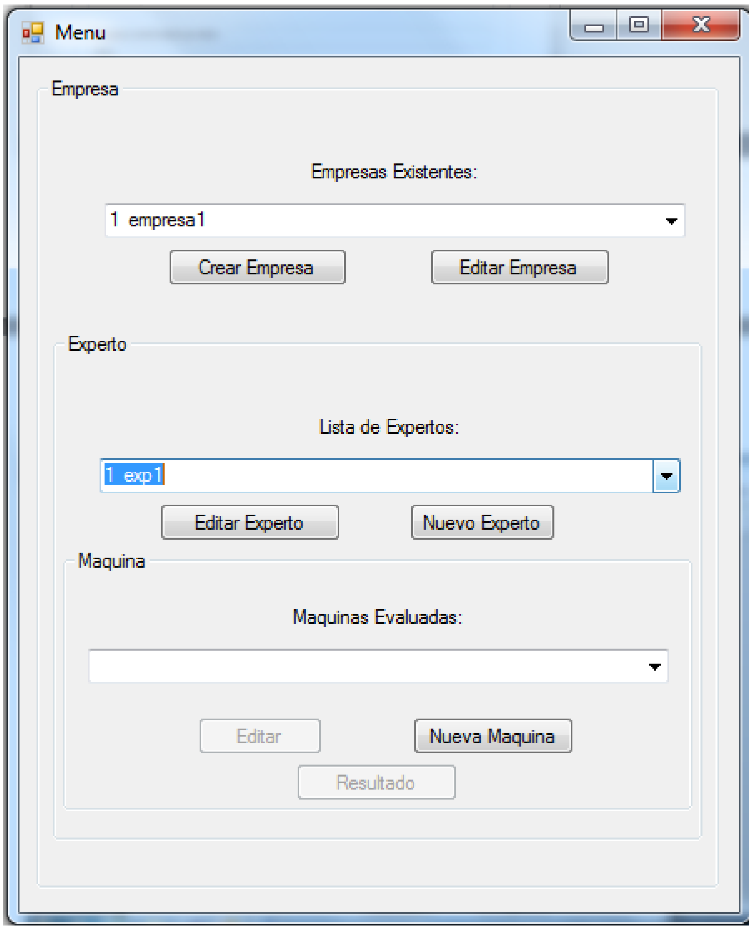
This part describes the software interfaces, first the enterprise data interface; at this part data about the company is acquired, also information about decision making processes related to AMT and data about AMT equipment is obtained. Then, the experts interface; at this part data about the experts is required. Then the evaluation interface is presented and finally the results interface is explained.

2.1.1. <u>Main menu interface</u>

In this part, in the main menu you can select one of the companies from existing list of enterprises or press the button Create Enterprise 

in order to create and save a new one. The button Edit Enterprise Editar Empresa allows modifying some existing enterprise. Also, through the main menu the expert interface and evaluation process can be accessed. Figure 3 shows the main menu access (information is shown in Spanish).

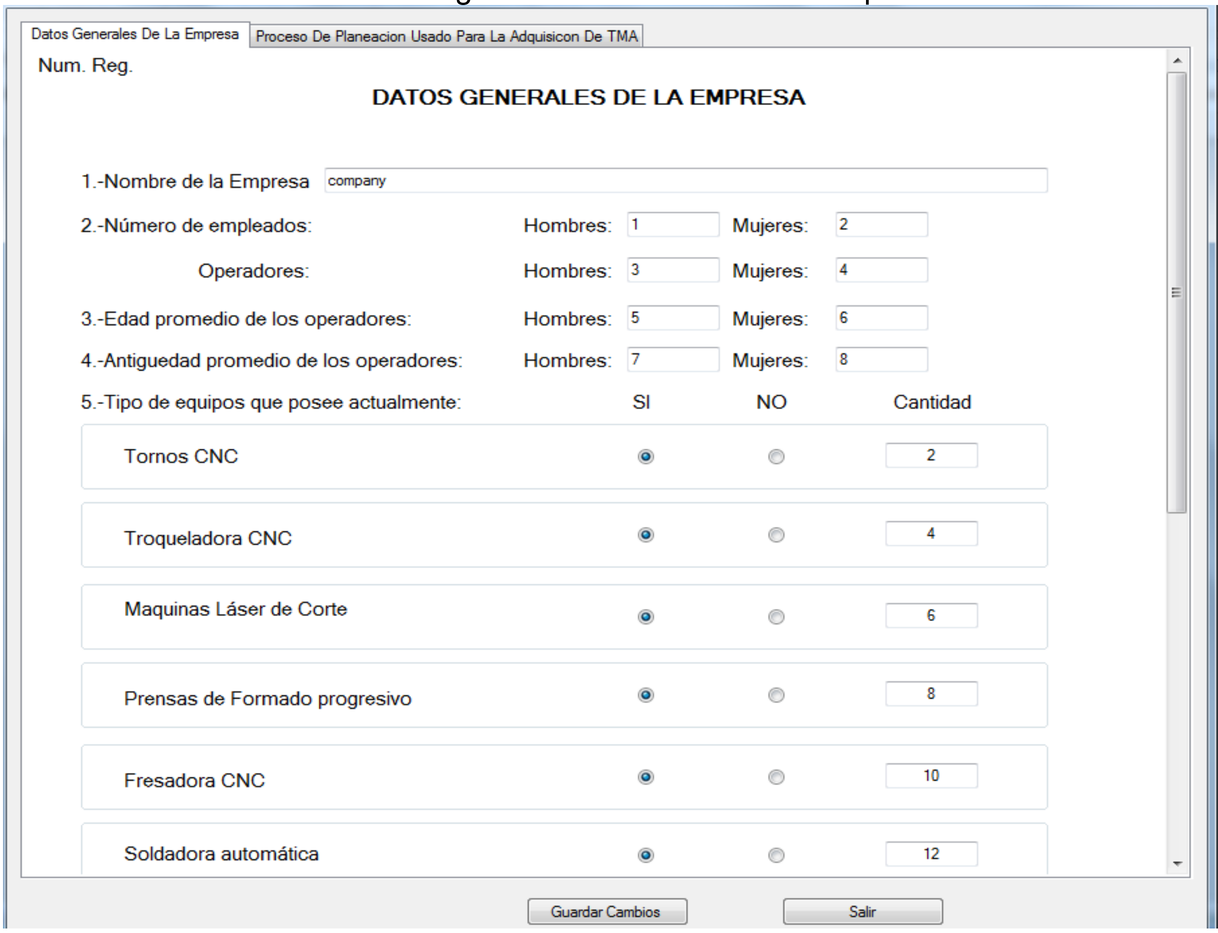
Figure 3. Enterprise interface: create an enterprise



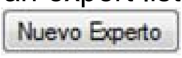
2.1.2 Enterprise data interface

The information required for the enterprise data can be entered using this interface by pressing the buttons to Create Enterprise Crear Empresa or Edit Enterprise Editar Empresa to modify an existing one. In this interface it will appear the menu that is shown in Figure 4, (information is shown in Spanish). Here, are specified the features that the new enterprise will have, or you can modify an existing Enterprise such as the name, demographic information of employees and also a unique option list in order to choose or change the company´s actual equipment. Also, this part includes the access through second tab to a survey about decision making processes for AMT acquisition, it was designed to increase knowledge in relation to who would participate in these processes and company's main practices to find and select AMT.

Figure 4. General Data of Enterprise



2.1.3 Experts' interface

From the main menu, the software gives access to the expert interface. In it, there is an expert list or it gives the option to create any new one by pressing the button New Expert 

(icons are shown in spanish), or selecting one of the list and editing it by pressing the button Edit Expert 

. In this part information related to expert identification can be input.

2.1.4 Ergonomic Compatibility Evaluation Interface

At this point, the evaluation of every ergonomic compatibility attribute is made for each alternative of AMT equipment. It is important to note that the evaluation is made to compare equipments with a similar or the same manufacturing purpose. (i.e. Computer Numerical Controlled Milling Machines). This interface allows experts to make the evaluation for the establishment of Desirable Ranges and System Ranges for every attribute and each alternative. Figure 5 shows an example of the evaluation for one attribute only, the (a) section helps create a desirable range and the (b) section evaluates each alternative to establish a System Range. Software will process this information using fuzzy logic and a mathematical procedure based on a Fuzzy Axiomatic Design methodology (Kulak et al., 2005, Kahraman et al. 2008, Maldonado-Macías et al. 2009, Maldonado-Macías 2009), to obtain the final result.

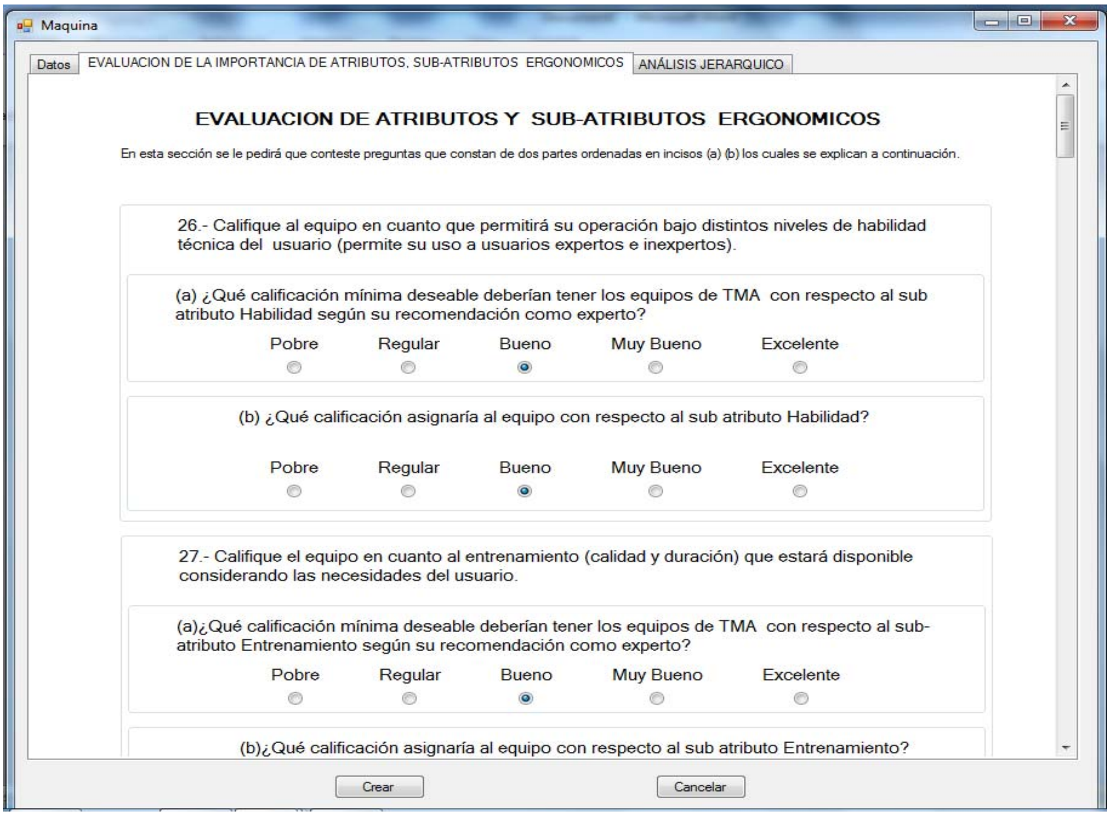


Figure 5. Evaluation of Ergonomic Compatibility Attributes

2.1.5 Analytic Hierarchy Process (AHP) Interface

At this part, pairwise comparisons among ECA are made. The Analytic Hierarchy Process methodology proposed by Saaty (1980) was used. This multiattribute methodology formalizes the intuitive comprehension of a complex problem using a hierarchical structure. It is used in this model for weighting the ECA according to their importance. Experts' knowledge is required to assign importance via pairwise comparisons. Figure 6 shows software questionnaire scheme for onecomparison only.

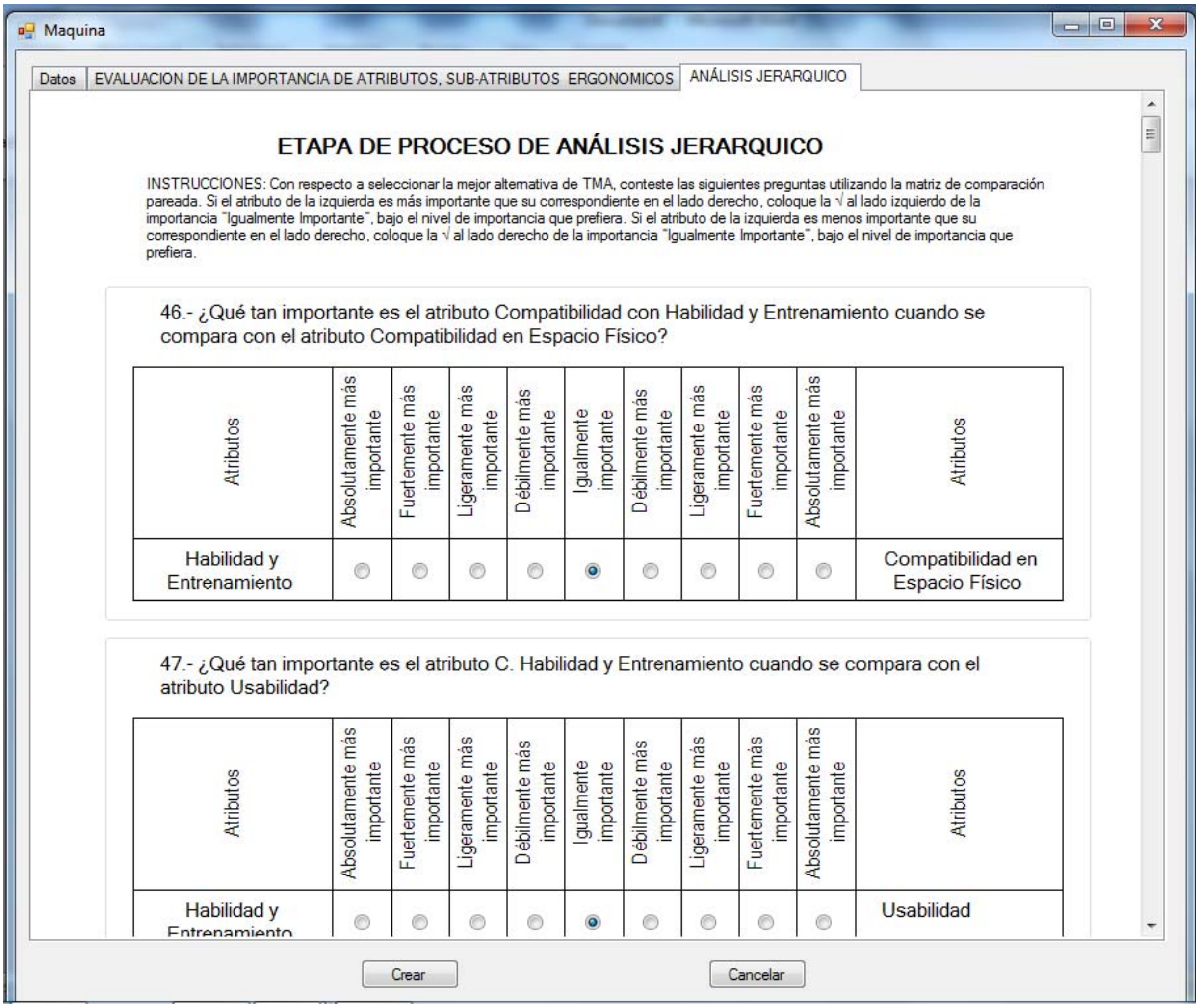
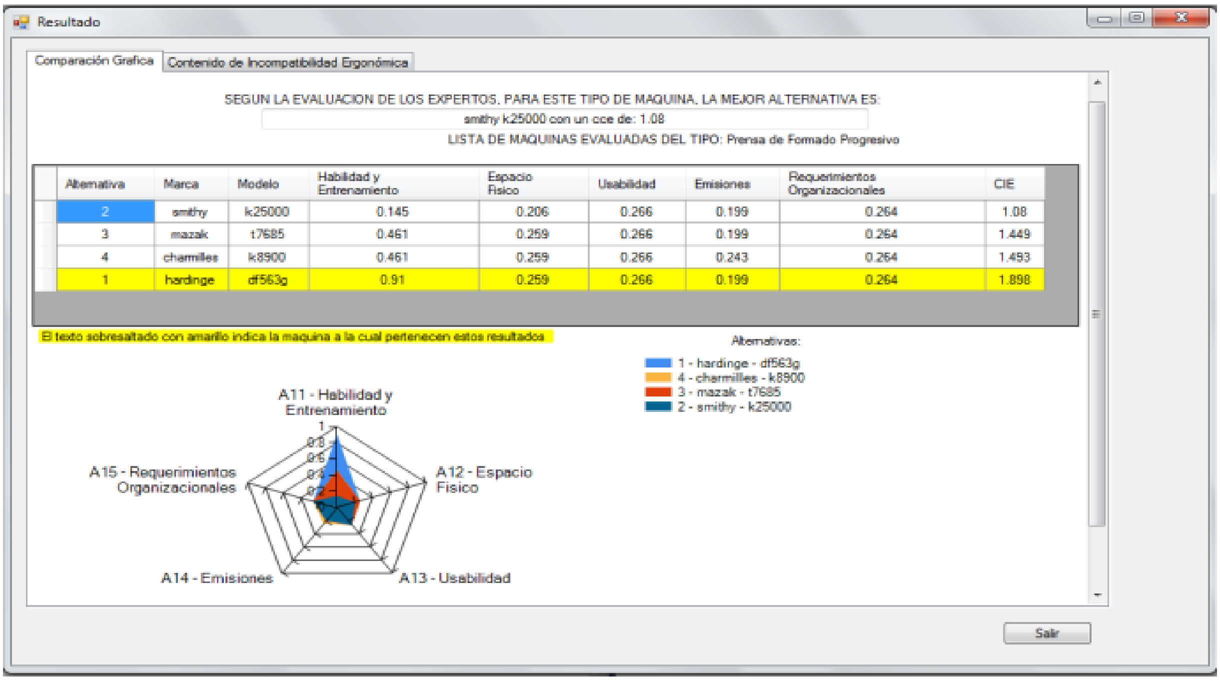


Figure 6. Analytic Hierarchy Process Interface

2.1.6 Results' interface

The software enables experts or users to enter the information required to deploy results. At this part software can show the evaluation made to finde the best alternative. The final step is to press the button Result 

,a study will be shown, according to the experts. The study indicates which alternative is the best; in this way is the one that can satisfy ergonomic requirements. Figure 7 shows an example of an evaluation if four alternatives. A "spider" graph is also deployed to help identify the best choice. The best alternative can be found at the center of the graph and numerically have the smallest Ergonomic Incompatibility Content (EIC) according to the model.



3. CONCLUSIONS AND RECOMMENDATIONS

Some conclusions can be made about this work. The objectives were accomplished since explanations of the fundamentals of the Ergonomic Compatibility Model were presented. This model is innovative in the way it combines a multiattribute approach based on extensive literature review to generate the group of ergonomic attributes needed for the evaluation of AMT; with a fuzzy axiomatic methodology. Additionally, the Ergonomic Incompatibility Content (EIC) and the procedure for obtaining it is the main issue to develop the software. A description of the software was completed by explaining each of its main interfaces by which the evaluation can be conducted via participation of experts. Results of the software shows the best alterative and allow decision makers to include an ergonomic perspective guiding to a more complete decision. The use of this software can enhance the application of this model with the intention of manage and execute evaluations systematically. Also, it can be used to generate data bases about decision making processes related to AMT, experts who may perform the evaluations and AMT characteristics and suppliers, among other information. The future application of this software in manufacturing companies, can promote the acquisition of AMT that can be more human compatible helping to have more ergonomic and safer workstations.

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Management capabilities and its impact on occupational health

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Resumen

Este trabajo analiza la importancia de las habilidades administrativas para generar un ambiente de trabajo eficiente que mejore la calidad de vida de los trabajadores y reducir o, en el mejor de los casos, evitar los riesgos inherentes al puesto de trabajo, fomentando la motivación, la satisfacción en el trabajo y el compromiso para que el empleado aumente su niveles de productividad y eficiencia de la organización.

Palabras clave: Capacidad administrativa, salud ocupacional.

Abstract

This paper analyzes the importance of management skills to generate an efficient work environment that improves the quality of life of workers and reduce or at best, avoid the risks inherent to the job, encouraging motivation, job satisfaction and commitment to enable the employee to raise their levels of productivity and organizational efficiency.

Keywords: Management capabilities, occupational health.

1. Introduction

Improving quality of work life has been, in recent decades, a recurrent issue. Much of the efforts are driven to improve workplace conditions to protect the health and welfare of workers improving their positions and developing a climate of confidence and respect.

These efforts also look to increase productivity levels, reducing risk of injury or illness by encouraging involvement and commitment of workers resulting from the application of motivational programs that allow employee satisfaction and therefore, their involvement in the actions defined by the company.

In relation to this, the support and involvement of management is a required element for achieving the commitment and involvement of the worker, it is up to managers to find the mechanisms to generate an adequate organizational environment that fosters a sense of belonging and worker satisfaction enabling it to efficiently develop and achieve business goals in a clear and transparent.

Research has shown that human capital is a priority for the organization and considering its importance, companies are forced to implement programs to prevent exposure to risks that affect their heal and integrity.

Given the above, managements should seek internships focused on developing and improving processes, to which workers are involved, create a work environment safe and comfortable is a priority for companies. The International Labor Organization, 2009 (ILO) has provided agreements that refer to occupational health programs that search for personal and collective benefit of the workers in their respective occupations.

There is no doubt that occupational health has a strong relationship with the management capabilities to provide safety and protection for workers in their jobs and work stations to look pleasant. Hence lays the importance of the manager to develop and integrate into its labor, adequate practices focused on promoting the welfare and health of their workers achieving productivity and safety at work.

2. Management capabilities.

These are the skills required by the administrator to ensure the effectiveness of the company, for instance, it is necessary that the manager, entrepreneur or middle management of the organization, meets specific characteristics that allow workers to encourage better performance within the organization within a safe and pleasant work environment.

Castellanos (2003), referring to studies of Boyett and Boyett (1999) discusses six current and interesting topics for modern management, these issues are: leadership, change management, continuous learning, high performance organization, market and direction and motivation of human resources.

In the same area, we can find in the literature review realized by Marchandt and Castro (2005), elements of management skills necessary to lead to good administrative manager of the company, the following are some of this:

• Staff Motivation: Ability to make others maintain an intense work pace, having a self-directed behavior to important goals
• Conduct of Working Groups: Ability to develop, build and lead a working team encouraging its members to work with autonomy and responsibility.
• Leadership: Ability needed to guide the action of human groups in a given direction, inspiring actions and development scenarios in order to anticipate the action of this group. Set goals; give appropriate monitoring and feedback, integrating the views of others.
• Effective Communication: Ability to listen, ask questions, express concepts and ideas effectively. Ability to listen and understand to others, ability to give recognizes verbal, expressing positive emotions, which strengthens and motivate individuals and the team.
• Personnel Management: Efforts to improve training and development, caring for both their own and by others, from a proper prior analysis of the needs of people and organization.
• Change Management and Organization Development: Ability to manage change to ensure the competitiveness and effectiveness in the long term. Ask conflicts openly, effectively manage solutions to optimize the quality of decisions and the effectiveness of the organization.

According to the above, Tovilla (2010) says that there are several management models that analyze the behavior between managers and employees, some based on the human perspective and others in the personality of the worker. In relation to the first and according to the author, stressed that within organizations managers identify people according to their nature, for example, as trustworthy, altruistic, selfish or conformist, linking individual behavior within the organization. In models based on the worker's personality, it´s makes reference to various types of workers such as the rational economic man which is governed solely by economic incentives to be able to withstand extreme operating conditions so as to obtain benefits; in this case is necessary to consider providing some financial reward to get the employee to work. There is also talk of the type of worker who called social man and argues that "All workers carry a social world to the factory. Once there, create an environment which essentially seek to meet social needs, i.e. needs not leave when they enter the premises of the organization. Looking for company and want to create a sense of belonging and need to intimate a sense of identity and meaning to their daily lives. "

This theory results in the idea that the best managements seek to promote social and welfare activities among its workers, providing better working conditions. He also speaks of Man self-realized and in this case states that all persons require use human resources and talent at their disposal, skills, imagination, etc. He comments the author that the role of managers and supervisors is to try to give authority and freedom within the preset limits and make you feel that that is what workers want.

The human resources management of companies should contribute to create correct practices focused to meet both the goals of the organization and the employee. Several authors (Werther and Davis, 2000, Davis and Newstron, 2000, Robbins, 2000) have analyzed the management practices carried out on behalf of generating an adequate working environment so as to increase productivity and safety in response to staff satisfaction companies, finding that dimensions such as participation in decision making improves both organizational climate and productivity, (Werther and Davis, 2000)

Moreover, Davis and Newstron, (2003) recognize the importance of the participation process in human resource management and define it as "mental and emotional involvement of individuals in a group setting that encourages them to contribute for the group goals and share responsibility for them. "(pp. 246), in relation to the benefits of worker participation, the authors also point to the involvement of not only the skills but in all the emotional aspects of the worker, thus generating higher levels of productivity and work quality.

Studies have shown that job dissatisfaction and poor work environment are both stressors which tend to increase when are not being addressed by management. The ILO states that European Union countries spent between 3 and 4% of GDP in solving health problems caused by anxiety at work. (CNN Expansion 2011)

The same article reports that in Mexico work stress decreases up to 30 percent the country's productivity, results displayed according to the study of the Industrial Security Group Multisistemas which was conducted in 2,000 companies refer absenteeism as one of the main problems submitted by employees under high levels of stress.

In the same vein, the German Insurance company AOK, Germany's University Bielefeld and Berlin Technical University did a study with little more than 28,000 workers surveys 147 companies. (CNN Expansion 2011). The results imply that the tools needed to decrease complaints and disability by health problems are related to the ability of the manager to communicate what is expected of employees, feedback and recognition for their work in the company. Interesting data is the reporting that about the 100% increase from 1994 to date in work absenteeism due to psychological reasons.

Studies (Moen et al, 2011), which involved more than 600 employees from a major U.S. company, report that measure the performance of employees considering their needs and avoiding excessive controls it was found that with increasing flexibility of the leaders and the companies were reduced sickness absence and increased commitment by the employee. Other results indicate that employees who participated in this study of "flexible work" reported being able to sleep one more hour at night before work.

2. **Conclusions**.

The research force us to verify that the ability to have the heads for flexible work schedule brings improvements in the work environment, encouraging more welfare and health of workers presenting lower rates of absenteeism and occupational hazards and increasing satisfaction commitment, loyalty and belonging to the company.

Then depend on the ability of the manager that the employee feels in a relaxed atmosphere that allows you to reduce work stress and stay healthy "happy employees are sick less often." Proper management of the management tools such as motivation, communication, teamwork, leadership, etc. increased worker satisfaction and therefore the sense of commitment to the company which will result in responsibility in their job functions while avoiding unnecessary risks and negative attitudes that both reduce productivity of companies.

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