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Ergonomics Study Conducted To Identify The Burden Points In The Machining Line Of A Leading Automotive Industry

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Abstract:

The significance of this study is to identify the burden points in the machining line to ensure a healthy and safe working environment. Industrial fatigue can cause occupational injuries and musculoskeletal disorders in the long run. This can also lead to the decrease in the productivity and increase in absenteeism. To identify the burden points; method study, time & motion study and video ethnography should be performed. Based on the Standardized Ergonomics Study Chart, the burden points in the line need to be evaluated on all work elements in the work station. The evaluated burden points in some cells may be beyond the acceptable value, such elements need to be recognized and recommended for Kaizen. With the increasing customer demand it is very important to set up a correct ergonomically designed work place in the industries as the worker performs repetitive jobs for 8hrs in a day. Fatigue not only leads to injury but also to incorrect working postures. So these incorrect postures needs to be identified and the burden points should be rectified. The main emphasis of this study is to reduce the burden and to improve the feasibility of working conditions.

Keywords: *Burden points, Ergonomic Study, Kaizen, Machining line, Video Ethnography.*

1.Introduction

Ergonomics comes from the Greek words for work (ergon) and law (nomos) and can be interpreted as "a study of the laws of work." However, we generally think of ergonomics in the workplace as the science of designing work to fit the capabilities of workers, thereby enhancing worker well being. When there is a mismatch between the physical requirements of the job and the physical capacity of the worker, musculoskeletal disorders can result. Ergonomics study various risk factor brought to a job: a) risk factors inherent in the worker b) risk factor inherent in the task c) risk factor inherent in the environment.

Workers come in all shapes and sizes, each with unique attributes that present certain ergonomic risk factors to a given job. The tasks of the job, itself, can present risk factors that increase the likelihood of an injury. Finally, the workplace environment, within which the worker and job exist, may also contain exposures to risk factors. Risk for developing MSDs increase for workers who perform repetitive operations, perform tasks in an awkward position, use a great deal of force to perform their jobs. The level of risk depends on how long a worker is exposed to these conditions, how often they are exposed, and the level of exposure [1].

Workstations are often designed without much consideration of workers and their attributes. Without the application of ergonomic principles, workers are often forced to adapt themselves to poor working conditions [2].Applying ergonomics to the workforce in any organization or industry can help in reduction of occupational injuries or illnesses to the employees decrease the disability costs for workers, and lowering absenteeism thereby sustaining productivity and quality of work done resulting in improved quality of life for all workers. Advances are being made in industrial ergonomics and this is done for the safety of the workers or employees in the long run [3].

Industrial ergonomics has been helpful in designing products, jobs, environments and systems. This helps in creating and making the physical assets compatible with the needs, abilities and limitations of people. Study of industrial ergonomics, which are related to human comfort and benefits, are vital. Industrial ergonomics include safety, comfort, ease of use, productivity or the performance, and aesthetics [4]. Workplace injuries are costly to business, in the form of lost time, worker compensation claims, reduced productivity, and adverse effects on product quality. Good ergonomic practices should be mandated by good business sense, because they pay off.

2.Literature Review

Ergonomics is the scientific study of the relationship between man and his working environment. In this sense, the term environment is taken to cover not only the ambient environment in which he may work but also his tools and materials, his methods of work and the organization of his work, either as an individual or within a working group. All these are related to the nature of the man himself; to his abilities, capacities and limitations. Human factors is the discipline science that discovers and applies information about human behavior, abilities, limitations, and other characteristics to the design of tools, machines, systems, task, jobs, and environments for productive, safe, comfortable, and effective human use [5].

Many research studies have shown positive effects of applying ergonomic principles in workplace design, machine and tool design, environment and facilities design. Research studies in ergonomics have also produced data and guidelines for industrial applications. The features of ergonomic design of machines, workstations, and facilities are well known. However, there is still a low level of acceptance and limited application in industries, especially in developing countries. The main concern of work system design is usually the improvement of machines and tools. Inadequate or no consideration is given to the work system design as a whole. Therefore, poorly designed work systems are a common place in industry. Neglect of ergonomic principles brings inefficiency and pain to the workforce. An ergonomically deficient workplace can cause physical and emotional stress, low productivity and poor quality of work.

Workstation should be laid out such that it minimizes the working area so that while carrying out the operations the worker could use shorter motions and expend less energy and thus reduce fatigue. Das and Grady [12] reviewed the concept of workspace design and the application of anthropometric data. It indicated that an adjustable workbench of standard size were highly desirable at the workplace. However, the standard height of the workbench could not be defined without the anthropometric data of the user population. Many of the user population do not have anthropometric data. It is therefore, desirable also to have the worktable adjustable [6].

A study by Yeow concentrated on improving productivity as well as health and safety of workers in a printed circuit assembly (PCA) factory. The improvement involved the use of an ergonomically designed workstation with other ergonomic intervention such as clear segregation of tested and untested boards to prevent mix-up and retraining of operators by more qualified trainers. This had resulted in an improvement in quality and

productivity of the workers, reduction in rejection rate as well as an increase in the revenue. The use of an ergonomically designed workstation and better structured processes along with other features, such as improved lighting, shelves and containers for parts and display boards, had helped and solved the problems of assembly processes at a German company [7]. The objective of this study is to create a feasible working environment for a repetitive manual task to sustain productivity, safety, quality & HRD.

3.Case Study: Background

The purpose of doing this ergonomic study is because the company believes in continuous improvement, so to improve the feasibility of the workplace the study was conducted.

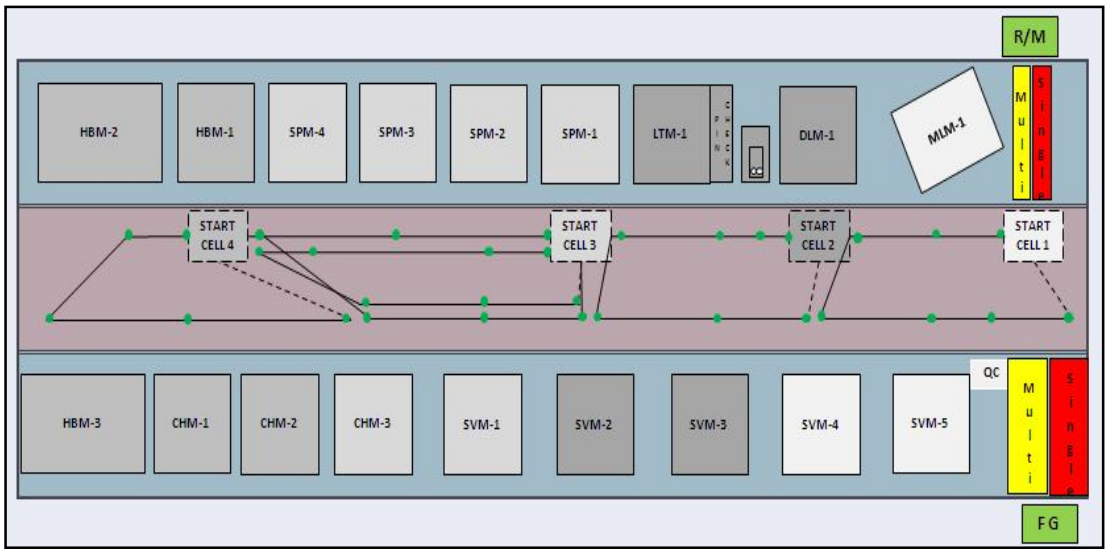

Figure 3: Loop Layout

The machining line is a production line where the raw materials come from the supplier in the form of forged materials and is converted into the finished goods and these raw materials should undergo several operations to arrive at the finished goods.

The study is been conducted in the machining line of the Part A, which in itself contains 4 interlinked cells (1,2,3,4) and my study will be focused on all the four cells, Fig 3.1. The team member works in the cell performing several manual operations such as loading, unloading, quality check and moving parts from one operation to another. The weight of the part being 5.8kg, the member performs these operations throughout the shift for 8hrs, while performing these operations member's body is subjected to many strains on the back and arms. These repetitive manual works done throughout the shift

may cause musculoskeletal disorder, though the impact of these injuries may be of low intensity but in the long run it may lead to several occupational injuries and illness.

As the company follows safety and health first attitude it is very important to ensure an ergonomically designed worksite to reduce the burden of the worker. These illness may also leads to absenteeism and can further leads to decrease in the production and profit of the company.

By performing an ergonomic study in all the cells, the burden points are identified and evaluated based on the set standards of the company. The acceptable burden point of each category is 20. After evaluation, the elements which are above the acceptable burden point needs to be recommended for the Kaizen. Kaizen elements are then discussed with the group leader, team member and corrective measures are taken to improve the feasibility of working conditions.

4.Methodologies

The methodologies used are a) Method Study b) Time & Motion Study c) Video Ethnography d) Ergonomics Study Calculations Sheet.

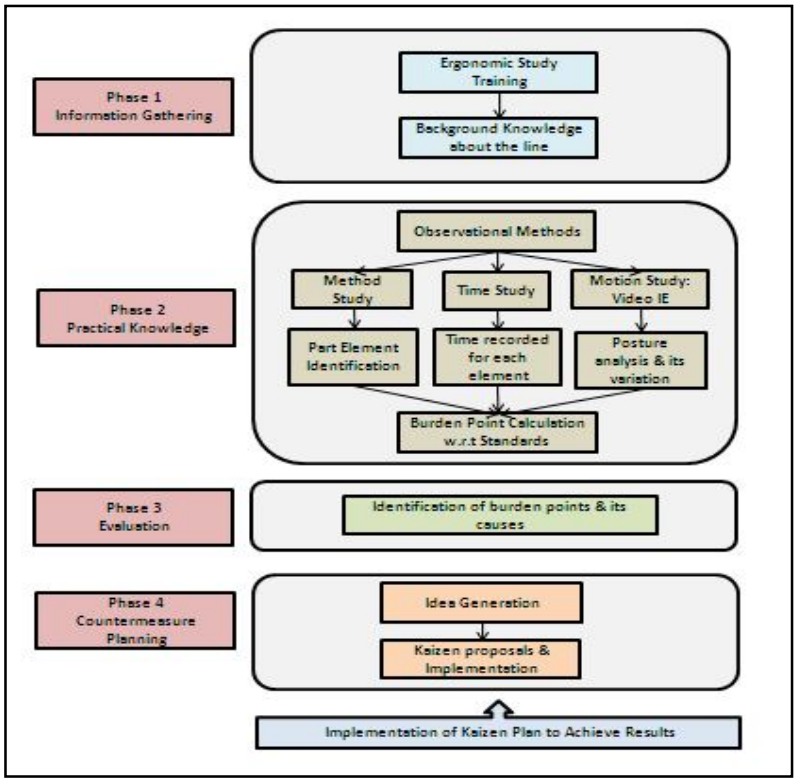

Figure 4: Flowchart of the methodologies

Prior to carrying out all the methods, knowledge about the ergonomics and background of the study area was gathered. The observation of the all the cells were done based on the Standardized Work method and ideal working postures. The work elements were listed down and then the time was recorded for each of these elements, Fig. 4.2.

WORK ELEMENTS

CELL 1		
Sl. No.	ELEMENTS	TIME (Secs)
1	PICK THE R/M FROM THE BIN	2
2	SMM-0006 UNLOAD	2
3	SMM-0006 LOAD	2
4	SGC-0029 OPEN DOOR	1
5	SGC-0029 UNLOAD	2
6	SGC-0029 LOAD	3
7	SGC-0029 DOOR CLOSE	1
8	SGC-0028 OPEN DOOR	1
9	SGC-0028 UNLOAD	2
10	SGC-0028 LOAD	3
11	SGC-0028 DOOR CLOSE	1
12	VISUAL CHECK	12
13	PLACE IN FG IN THE BIN	2

CELL 2		
Sl. No.	ELEMENTS	TIME (Secs)
1	SSP-0087 UNLOAD	1
2	CLEAN	1
3	SSP-0087 LOAD	2
4	DO PIN CHECK	4
5	SLA-0003 OPEN DOOR	1
6	SLA-0003 UNLOAD	2
7	SLA-0003 LOAD	2
8	SLA-0003 CLOSE DOOR	1
9	SGC-0032 OPEN DOOR	1
10	SGC-0032 UNLOAD	2
11	SGC-0032 LOAD	3
12	SGC-0032 DOOR CLOSE	1
13	SGC-0030 OPEN DOOR	1
14	SGC-0030 UNLOAD	2
15	SGC-0030 LOAD	3
16	SGC-0030 DOOR CLOSE	1

CELL 3		
Sl. No.	ELEMENTS	TIME (Secs)
1	SGC-0034/ SGC-0019 OPEN DOOR	1
2	SGC-0034/ SGC-0019 UNLOAD	3
3	SGC-0034/ SGC-0019 LOAD	2
4	SGC-0034/ SGC-0019 DOOR CLOSE	1
5	CARRY PART NEAR SGC-0019	1
6	SGC-0017/ SGC-0018 OPEN DOOR	1
7	SGC-0017/ SGC-0018 UNLOAD	3
8	SGC-0017/ SGC-0018 LOAD	2
9	SGC-0017/ SGC-0018 DOOR CLOSE	1
10	CARRY PART NEAR SGC-0018/ SGC-0017	1
11	SCH-0008 DOOR OPEN	1
12	SCH-0008 UNLOAD	2
13	SCH-0008 LOAD	2
14	SCH-0008 DOOR CLOSE	1
15	SGC-0031 OPEN DOOR	1
16	SGC-0031 UNLOAD	2
17	SGC-0031 LOAD	2
18	SGC-0031 DOOR CLOSE	1

CELL 4		
Sl. No.	ELEMENTS	TIME (Secs)
1	SGC-0009 UNLOAD	4
2	SGC-0009 LOAD	2
3	SGC-0008 UNLOAD	4
4	SGC-0008 LOAD	2
5	SGC-0007 UNLOAD	4
6	SGC-0007 LOAD	2
7	SCH-0017 DOOR OPEN	1
8	SCH-0017 UNLOAD	2
9	SCH-0017 LOAD	2
10	SCH-0017 DOOR CLOSE	1
11	SCH-0007 DOOR OPEN	1
12	SCH-0007 UNLOAD	2
13	SCH-0007 LOAD	2
14	SCH-0007 DOOR CLOSE	1

Figure 5: List of Work Elements

Video of the workers' motion was also recorded for the assessment of postures and its variation. All these recorded data was then entered to the specifically designed Ergonomics Burden Point Calculations Sheet. Referring to the company's Ergonomics standards the evaluation of the burden points was done. By performing all these methods the burden point of each cell was identified. After the identification of the burden points and its causes, the idea was generated and the kaizen proposal plan was prepared. This kaizen plan was then discussed with the concerned personnel and submitted to the kaizen dept. for further implementation.

5.Ergonomics Study: Burden Point Calculations

The Company sets three categories for work condition assessment.

- Back Burden Point
- Arm Burden Point
- Neck Burden Point

5.1.Back Burden

BB is evaluated based on two criteria, a) Posture burden point: the back postures for each element is identified b) Weight burden point: concerned with the lifting of part during loading and unloading.

BB= Posture Burden Point + 2 x Weight Burden Point

Where

Posture Burden Point= Posture Burden Element Point x Retaining Time

Weight Burden Point= Weight (part) x number of lifts/shift x Movement Coefficient x Time Coefficient

5.2.Arm Burden

AB is evaluated based on four criteria, a) Arm Movement Point: Arm postures for each element is identified b) Tool Burden Point: if any tool is used (ex: spray gun, impact wrench) c) Hand Work Burden Point: if any work is done using the hand (ex: pushing, pressing) d) Hand Weight Burden Point: concerned with the lifting of part during loading and unloading.

AB= Arm Movement Point + Tool Burden Point+ Hand Work Burden Point + Hand Weight Burden Point

Where

Arm Movement Point= Arm Movement Element Point x Retaining Time

Tool Burden Point= (Operating Point x Operating Time) + (Holding Point x Holding Time)

Hand Work Burden Point= Hand Work Element Point x Hand Work Time

Hand Weight Burden Point= Weight x Holding Coefficient x Retaining Time

5.3.Neck Burden

Neck burden calculations are done using the below mentioned formula:

Neck Burden Point= Neck Posture Element Point x Retaining Time

Referring to the company's standards* all the above calculations are done in the Burden Point Calculations Work Sheet. If the Burden Point of any cell is above 20, the Kaizen element has to be recognized and worked up to reduce the burden.

6.Evaluation/ Analysis

- Ergonomics Standards have not been shown as they are classified information of the company

Based on the set standards Burden Points were calculated for all the loops using their respective formula.

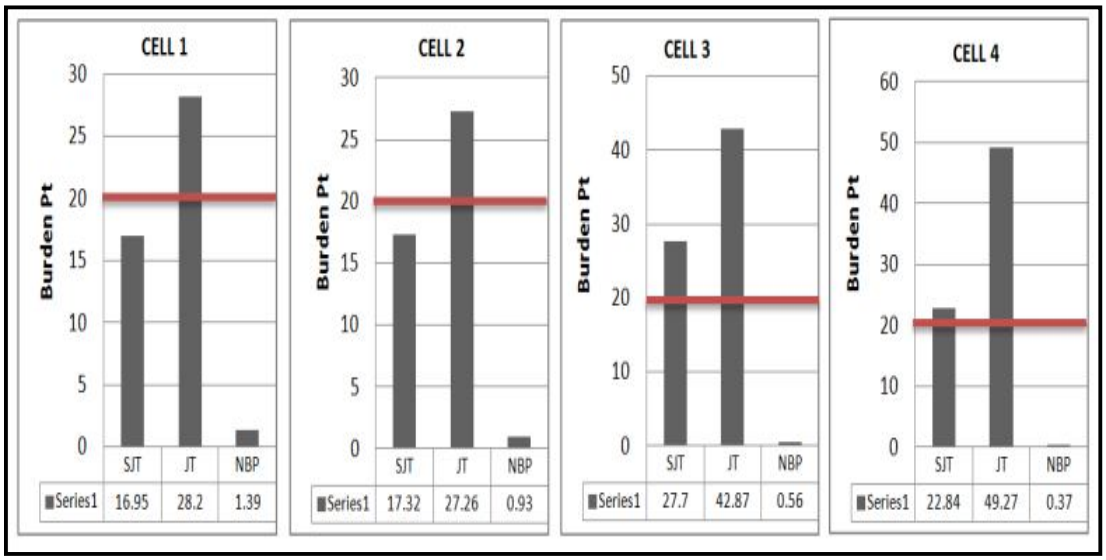

Figure 6: . Burden Point Calculations

As we can see from the graph the burden seen more in the cell 3 & 4 compared to the rest of the loops, Fig.6.1.

Cells	Burden Element	Problem
Cell 1	SVM-4 Load	Posture Retaining Time
	SVM-5 Load	Posture Retaining Time
	Visual Check	Posture Retaining Time
Cell 2	SVM-2 Load	Posture Retaining Time
	SVM-3 Load	Posture Retaining Time
Cell 3	SPM-1/2 Unload	Posture Retaining Time & Weight
	SPM-3/4 Unload	Posture Retaining Time & Weight
Cell 4	HBM-1 Unload	Posture Burden Point & Retaining Time
	HBM-2 Unload	Posture Burden Point & Retaining Time
	HBM-3 Unload	Posture Burden Point & Retaining Time

Figure 7: Problem List

In cell 3, the burden is seen in both Posture & Arm Burden Point during the unloading operations of the SPM-1, 2, 3 & 4 m/c. In cell 4, the burden is seen in both Posture & Arm Burden Point during the unloading operations of the HBM-1, 2 & 3 m/c. In cell 1 & 2, the burden is slightly seen only in the Arm Burden Point during the loading operations of SVM-1, 2, 3 & 4 m/c. All the above identified Burden Point elements from all the four cells will be recommended for Kaizen.

7.Discussion

The identified Burden elements will be carefully analyzed and the Kaizen proposals will be submitted after discussing with the concerned personnel. The kaizen which can be implemented soon will be implemented first. As most of the kaizen is concerned with the machine it takes longer time to implement after getting approval from the top management. But the expected result would be to improve the feasibility of workplace to sustain productivity, Quality & Safety. The demand for speed, accuracy & co-ordination is high which can affect the psychosocial factors as well. Positive attitude of the worker towards the work is inversely related to increased monotony & fatigue and is also directly related to job satisfaction. So it should favor HRD as well.

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