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Ergonomics Study of Automobile Assembly Line

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Abstarct: The final assembly of an automobile involves tasks of complex nature. These processes are on the least priority for automation. Manual labor is best suited for assembly operations with the aid of minimal level of automation. All the processes have to be improved continuously in order to reduce the costs and increase productivity .The workers attain various postures, exerts force and works continuously in cycle time to accomplish the assembly task. Working along automobile assembly lines is characterized by repetitiveness. The objective of the work carried out is to identify the ergonomic burden and reduce the same by the application of ISO and CEN standards.

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I. INTRODUCTION

EAWS is an ergonomic tool for measuring the workload generated in a workstation by a given working method (motion sequence, workplace geometries, postures, equipment, parts, conditions) executed according to a given production plan (quantity and production mix) with a given work organization (shift duration, pauses). EAWS can also be used as a an ergonomic 1st level risk screening tool providing an overall risk evaluation, where the risk is due to any biomechanical load.

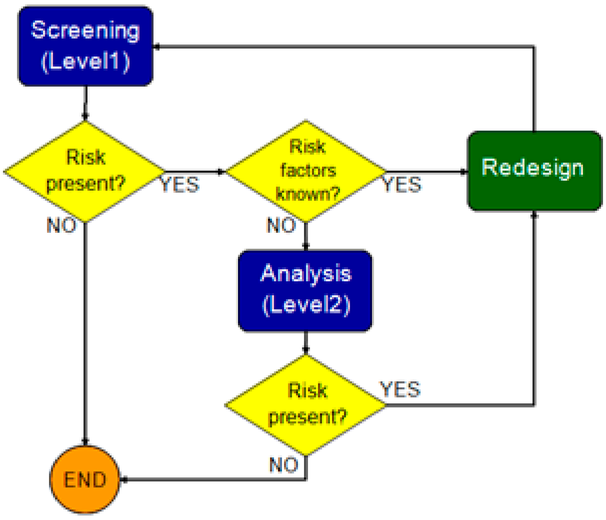

Figure 1: Risk Analysis Structure

The structure of the analysis is as follows:
Macro-Section "Whole body":
Section 0: Extra Points
Section 1: Body Postures
Section 2: Action forces
Section 3: Manual materials handling
Macro-Section "Upper limbs"
Section 4: Upper limb load in repetitive tasks
The EAWS sheet provides one score resulting for each Macro-Section which is exposed in a traffic light scheme (green, yellow, red) according to the Machinery Directive 2006/42/EC (EN 614).

Table 1: Classification of scoring

0-25 points	Green	No risk or low risk - recommended; No action is needed
>25-50 points	Yellow	Possible risk - not recommended; redesign if possible, otherwise take other measures to control the risk
>50 points	Red	High risk – to be avoided; Action to lower the risk is necessary

Second level analysis tools

Ovako Working Posture Analyzing System (OWAS):-

OWAS was developed in conjunction with the finish Institute of Occupational Health. The method allows the analyst to record posture, load and force used according to categories. The method was designed for specific use in medium to heavy assembly tasks in the steel industry. To use this method the analyst observes the posture while simultaneously noting a four digit code to represent the positions of the back, the arms, the legs and the force of exertion. The procedure takes only a few seconds and may be used in conjunction with random schedule of observations to reflect the magnitude of risk (Li and Buckle, 1999).

RULA (Rapid Upper Limb Assessment)

Rapid Upper Limb Assessment (RULA) is used for ergonomic investigations of workplaces where work related injuries are reported. RULA is a simple diagnostic tool that allows surveying various tasks involving the upper limbs at workplace with focuses on use of arms, wrists, position of the head and the posture of the upper body. McAtamney and Corlett (1993) introduce RULA, or Rapid Upper Limb Assessment .It is developed to observe the operators who suffered upper limb disorders due to the musculoskeletal loading. The RULA is used without need for advanced and expensive equipment that's why it is one of the most popular ergonomic investigation tools in industry. It proved a tool which is reliable for use by those whose job it is to undertake workplace investigations.

II. LITERATURE SURVEY

Musculoskeletal disorders (MSD) represent one of the leading causes of occupational injury and disability in the developed and industrially developing countries [1]. Automotive assembly is one of the important industries in certain countries and due to the nature of the tasks, workers in this particular industry are exposed to various working postures that could give rise to MSD[2]. Ghasemkhan et al (2006) reported that the prevalence of MSD was found to be high among automotive assembly line workers [3]. Hussain, T. (2004) conducted study among truck assembly workers and found that as high as 79% of the workers had MSD[4]. Lynn McAanncy and E. Nigel Corlett (1993) proposed a method called RULA [5]. RULA is designed to assess operators who may be exposed to musculoskeletal loading. The Ovako Working Posture Analysis System (OWAS) is an ergonomic assessment tool used to estimate risk of MSDs (Karhu, 1977)[6]. OWAS is posture-based technique that is used to evaluate job-task demands and classifies jobs into risk categories known as "Action Categories" 1 – 4 ranging from 1, which means no increased risk, to 4, which means that severe harm is likely (Karhu, 1977).Schaub[7] et al. state that the European Assembly Worksheet (EAWS) screening tool enables perspective evaluation of individual workstation with respect to their ergonomic design quality. This checklist could be used as an objective and practical method of estimating physical workloads for automobile assembly work. Hentschel[8] et al. described the evaluation of physical workload in logistical activities using the EAWS assembly specific evaluation method.

Kee D. and KarwowskiW. (2007) made a comparison of three observation at all techniques for assessing postural loads in industry [9]. For this study OWAS, RULA are taken as observational techniques. Tarwinder Singh et al.(2014) studied the impact of bad body postures on MSDs in electronics industries using RULA[10]. Himanshu Chaudhary et al.(2013) reported that the exposure of worker in cardboard industries to MSD is high by using RULA[11]. N. A. Ansari et al (2014) evaluated working postures in small scale industries using RULA concluded that there is a moderate to high risk of MSD occurrence [12].

Vignais N et al. (2013) studied a system that permits a real-time ergonomic assessment of manual tasks in an industrial environment [13].A.R. Anita et al.(2014) carried out analysis of awkward posture among assembly line workers using the Rapid Upper Limb Assessment (RULA) technique [14]. A computerized RULA ergonomic assessment was implemented to permit a global risk assessment of musculoskeletal disorders in real-time. Changet al. (2007) proposed a method of conducting work place valuations in the digital environment for the prevention of work-related musculoskeletal disorders and apply a digital human modelling system to the workplace virtual dynamic simulation [15].

Abdullah et al. (2009) studied to identify and quantify ergonomics working postures that contributed to the serious development of musculo skeletal injuries and thus investigated possible contributory their related causes[16]. Asim Zaheer et al. Claims that the application of ergonomic principles would help to increase machine performance and productivity, but mostly help human operator to be comfortable and secure[17].

III. METHODOLOGY

The process of pressure hose assembly carried out along the frame line in an automobile major was chosen for evaluating the physical workloads according to the EAWS method. This process was particularly chosen due to the oral compliant lodged by the process member. The takt time is 167 seconds. The breakdown of the process is given below All the tasks that are carried out in each work cycle were videotaped from different angles Picture frames were taken from these videos to determine the working posture. The force applied is known. The Rapid Upper limb assessment is carried out using human activity analysis workbench in CATIA V5 R14 software. OWAS scoring was obtained using ERGOFELLOW software.

Table 2: Break down of the process

Sl.No	Task	Category	Time(sec)
1	Install RH & LH boot cover	Posture	18
2	Temporarily set pressure tube	Posture	16
3	Install pressure tube	Posture	13
4	Torque pressure tube	Posture	14
5	Hand tighten pressure tube	Posture	8
6	Torque return tube	Posture	12
7	Install P/S hose in tube	Posture	15
8	Tighten intermediate shaft	Posture	10
9	Torque intermediate shaft	Action force	8
10	Walk and setting up	Posture	53

Evaluation of workload:
The process is broken down into sub-tasks and each sub-task is classified as action force, working posture or manual material handling. Scores are granted on the basis of EAWS.
Section 1: Posture
i. Forward bend: 25.8 secs/min→21 points
ii. Standing: 17.6 secs/min→4 points
iii. Standing and walking: 13.6 secs/min→0.5 points
iv. Asymmetric reach: 6 secs/min→5.85 points
Total= 31.35 points

Section 2: Action force
i. Torque intermediate shaft: 3 secs/min→2 points
Whole body score: 33.35 points
Evaluation: Possible Risk (Yellow)
Section 4: Upper limb assessment
Dynamic tasks: 20 real actions/min (5-20N): 2*0.65 = 1.3 points
Final score: 1.3*8.5=11.05 points
Evaluation: Low Risk (Green)

The final score obtained is 33.35 points. Hence this process is found to be in the yellow zone. The redesign of this process has to be carried out to reduce the risk of occurrence of musculoskeletal disorders. The RULA score is found to be 7 which represent a very high risk of the musculoskeletal disorders. The OWAS results clearly demonstrate that corrective actions are required in future. The action level was found to be in second level.

Figure 2: RULA score of intermediate shaft attachment

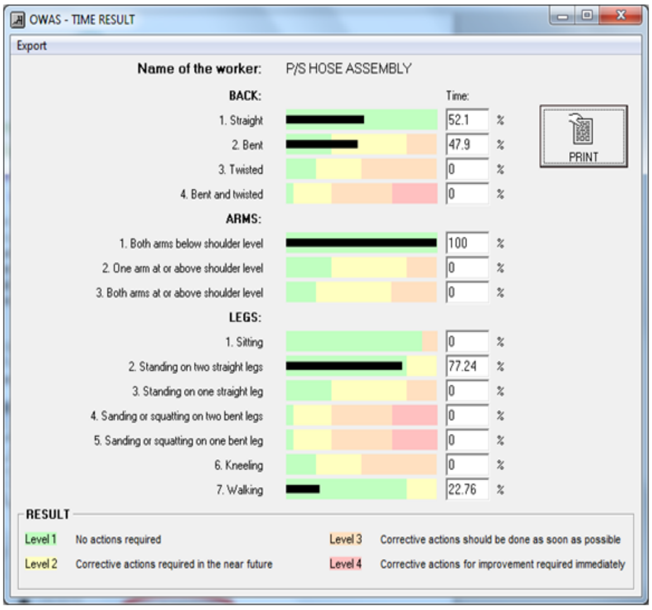

Figure 3: OWAS results before intervention

IV. IMPROVEMENT ACTIVITIES:

The reorientation of working position is based on the Indian anthropometric data [104].

Table 3: Indian Anthropometric Data

Percentile	5	25	50	75	95
Reach	419	529	599	659	769
Height	659	729	779	839	939

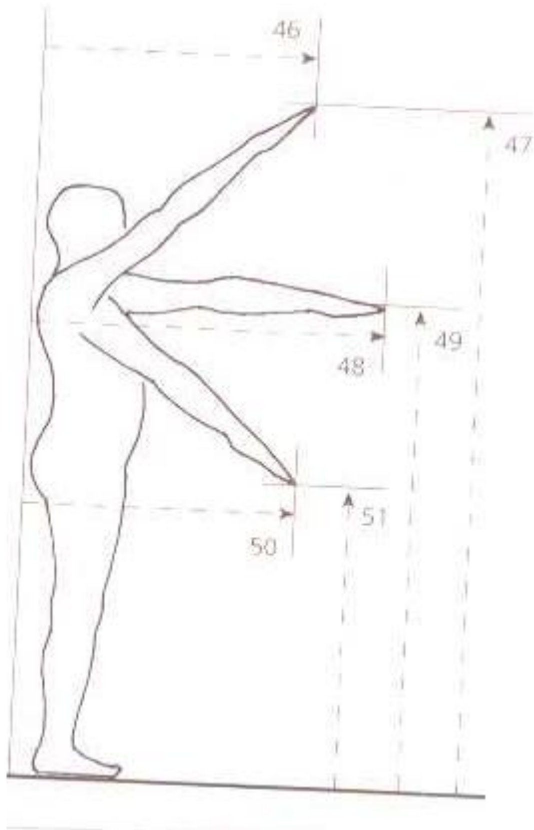

Figure 4: Reach and height representation

The task redesign is based on the general anthropometric measurements encompassing 95 percentile of the male population .The workstation measurements is given below.

Table 4: Workstation measurement

WORKING REGION	FORWARD REACH(mm)	HEIGHT(mm)
Hose connection	470	920
Intermediate shaft	960	1020
Part box	1020	900

1) Change in working position from front to right front side to perform the following tasks

- Hand tighten pressure tube
- Torque return tube
- Tighten intermediate shaft
- Torque intermediate shaft

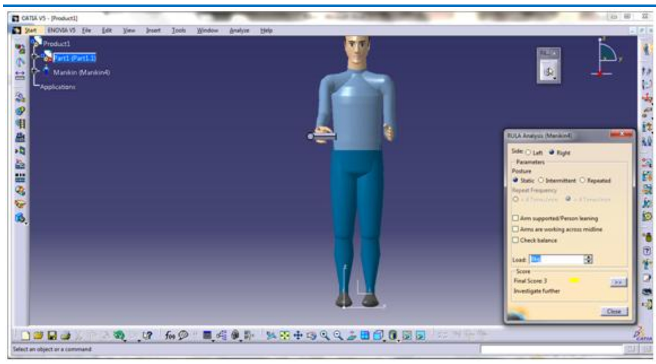

Figure 5: Intermediate shaft & tightening return tube from side on

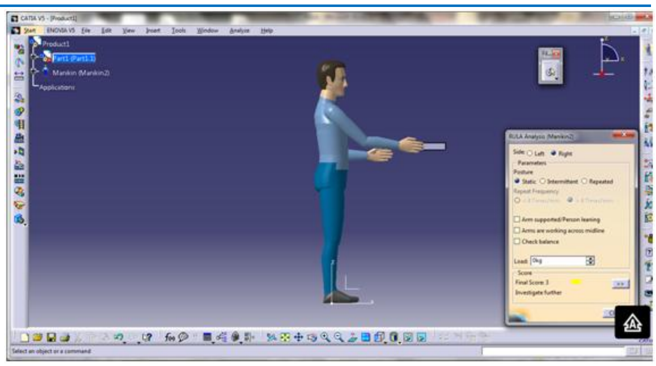

Figure 6: Parts box suspended closer to the body

2) The parts box is suspended closer to the body at a height of 900 mm and a reach of 600 mm. The RULA scores reduced to 3 from 7 which signify a low risk of occurrence of musculoskeletal disorders.

Table 5: EAWS Scoring

Factor	Before	After
Posture	31.35	19.9
Force	2	2
Loads	0	0
Total	33.35	21.9

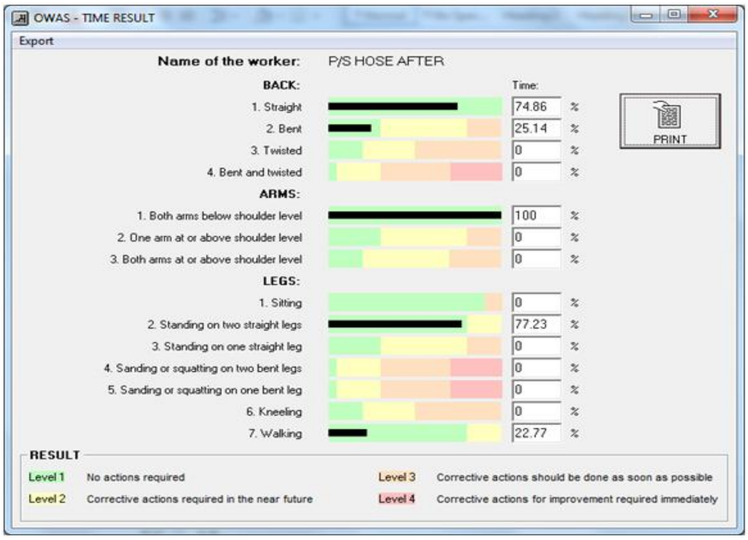

Figure 7: OWAS results after intervention

The OWAS analysis carried out after incorporating the aforesaid changes clearly demonstrates that the risk level reduces to level 1, requiring no further corrective actions. The EAWS scoring carried out post intervention also demonstrates the reduction of risk of occurrence of musculoskeletal disorder. The process now lies in the green zone with a score of 21.9. With the above mentioned changes to the process the task reduces to the low risk zone.

V. CONCLUSION:

The physical workload of the process was clearly quantified by the application of European Assembly Worksheet. The process was found to be in the yellow zone which signified a medium risk level of occurrence of musculoskeletal disorders. Suitable improvements were suggested and carried out to reduce the burden on process member. After implementing the recommendations the process was re-evaluated using the EAWS checklist. The process was found to be in the green zone which signified a very low risk zone.

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