Ergonomic Study at Rane Madras Limited

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Abstract- *Productivity is the main goal of every company in the present competitive world. One of the major resources of the industry is the human resource, hence the performance of the operators is of top priority. This can be kept in check with the help of ergonomic studies to assess the comfort and safety of the workstations at the industry. RULA (Rapid Upper Limb Assessment) is a technique used in Ergonomics study conducted at industries to evaluate the comfort and to reduce the risk factor of MSD due to working at improper workstation for the required job. The tools required are RULA assessment sheet to determine the movements of the limbs, trunk and neck. Even the workplace assessment is carried out to arrive at the Ergonomic score. A coding system is referred to assess the comfort and safety of the workstations ergonomically. The purpose of the study at Rane Madras Limited is to determine the ergonomic zone of each workstation throughout the Steering Gear Products Plant. The study will sort the workstations with poor ergonomics from the rest. The prior mentioned workstations are studied in detail determining the problem and it is solved by applying various alternative solutions and the reassessed to determine the impact of the alternative. The cycle is repeated till the ergonomically optimum workstation environment is obtained.*

Keywords- Erogonomics; RULA; Workplace assessment; Ergonomic Score

I. INTRODUCTION

Ergonomics means the study of people's efficiency in their working environment. The practice of designing products, systems, or processes to take proper account of the interaction between them and the people who use them.

The International Ergonomics Association defines ergonomics or human factors as follows Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance Ergonomics means the study of people's efficiency in their working environment. The practice of designing products, systems, or processes to take proper account of the interaction between them and the people who use them.

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A. Ergonomic design

`Ergonomic design' is a way of considering design options to ensure that people's capabilities and limitations are taken into account. This helps to ensure that the product is fit for use by the target users. The principles of ergonomic design can be applied to everyday objects and work spaces. Mass production of products does not take into account that humans come in various shapes and sizes. A thorough understanding of the specific tasks an object is intended for is central to achieving the ergonomic design goal of aiding the human form in executing them. Quality ergonomics is thought to reduce the risk of injury and errors by ensuring that technology and humanity fit and are working together. Greater accuracy and more efficient performance is achieved by meeting human needs with technology. Quality of life is also improved. The need for ergonomic design is thought to have originated during World War II, when it became apparent that military systems could be more effective if they took into account the environmental requirements of the soldiers operating them. After incorporating ergonomic changes in some military systems, efficiency and effectiveness as well as safety were improved.

II. LITERATURE SURVEY

Ergonomic study brings light upon the types of work which pose ergonomic hazards such as Manual handling, Manufacturing and production, Heavy lifting, Twisting movements, and Long hours of working in awkward positions. Deepak Kumar Kushwaha [1], Prasad V. Kane of Department of Mechanical Engineering, VNIT, Nagpur, India, the project has been carried out in an integrated steel plant located in central India where most of the crane operator was continuously suffering from muscular pain in different body parts. Based on the anthropometric data of 50 percentile Indian male, ergonomic assessment, redesign and evaluation

of crane cabin was carried out in CATIA-V5 software. To check the compatibility of the design, rapid upper limb assessment (RULA) for both existing as well as modified crane cabin was performed. This study shows that intervention of ergonomics in workplace reduces the mismatch between man and machine and makes workplace comfortable for work and reduces MSD to a significant extent. An investigation was conducted by Abdulrahman M. Basahel on MSD in warehouse workers in Saudi Arabi. The purpose of the current study was to evaluate musculoskeletal disorders and identify ergonomic factors related to lower back, shoulder and lower arm pain in two types of manual tasks: lifting and pulling objects in supermarket warehouses. A total of 92 male workers (ages 26–38) participated; 45 workers performed lifting tasks and 47 workers performed a task that involved pulling heavy objects. Rapid Upper Limb Assessment (RULA) and a pain self-report chart were used. The heart rate (HR) was continuously recorded to evaluate the physiological stresses of each task posture. The results showed that lifting task highly significantly impacted low back pain among all participants. In addition, the results found a significant correlation existed between trunks, upper arm and lower arm scores and all self-report charts of pain and discomfort in the lower back, upper arm and lower arm region for all participants. Also, the pulling heavy object task posture significantly affected the lower arm score and reflected a highest prevalence of MSDs on wrist body part. The results presented a significant association existed between lower arm and wrist scores and all self-report charts of pain and discomfort in the lower arm and wrist body parts of all participants. There was a significant difference between both task postures overall. The results of the study proved that the RULA method was a useful tool to assess the MSDs on body regions in manual lifting and pulling tasks.

Sandip B. Wanave et al., [2] evaluated the work station to improve the productivity by reducing the back pain, shoulder injury, fatigue etc. Productivity is an important indicator of economic growth and social health. High performance and productivity require the right sitting posture. So for considering this factor operator needs proper seating arrangement such that their problems regarding the MSDs. Itis revealed that the suggested workstation improved working posture and results in reduced postural stress on operators' bodies and consequently reduced prevalence of MSDs symptoms. Analysis and implementation of ergonomic chair give a great difference in the readings taken for different factors. Capability and concentration of workers increases due to less fatigue observed.

Baba MdDeros et al., [3] studied that assembly workstation at Company a need to be redesign to eliminate awkward postures and anthropometric mismatches to lower MSDs problem and improve productivity among assembly workers. Using the RULA assessment the prior mentioned challenge was accomplished.

Vito Modesto Manghisi et al., [4] In this paper, they have presented K2RULA, a real time semi-automatic RULA evaluation system based on Kinect v2. It allows to speed-up the detection of critical conditions and to reduce the subjective bias. K2RULA is able to analyze off-line data and to save the results for deeper ergonomic studies. They have validated the proposed tool with two experiments, using as baseline an optical motion capture system and a RULA expert, proving the reliability of K2RULA as a faster alternative to classical visual inspection evaluation.

S. Krishna Prasad et al., [5] conducted study on the workstation of an assembly cell and came to the conclusion that the use of manual torque wrench would lead to MSD in workers. The implement of a hydraulic wrench with a spring balancer was suggested, showing remarkable results in productivity, and is effective and economic.
MSD – Musculoskeletal Disorders.

III. METHODOLOGY

A. Ergonomic Assessment

Applying a scientific, evidence-based approach to ergonomic assessment is important. The goal is to identify ergonomic risk factors, quantify then, and then make measurable improvements to the workplace, ensuring that jobs and tasks are within workers' capabilities and limitations.

The best approach for doing that is to make ergonomics an ongoing process of risk identification and risk reduction based on objective, scientific analysis of workplace. These are the ergonomic risk assessment tools

- RULA - Rapid Upper Limb assessment
- Workplace assessment
- REBA - Rapid Entire Body assessment
- MAC - Manual Handling Assessment Charts
- ART - Assessment of Repetitive upper limb Tasks

B. RULA- Rapid Upper Limb Assessment Methodology

Application: Entire Body Working
Principle: Postural Scoring method.
Requirement: RULA sheet.

- RULA was developed by Lynn McAtamney & E Nigel Corlett in 1993.
- Accredited by European community directive & Institution of Occupational Ergonomics
- Measures musculoskeletal risk when performing a task. Each part of upper body is rated separately and logarithmic table is used to derive ergonomic score.

RULA was developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSD. The RULA ergonomic assessment tool considers biomechanical and postural load requirements of job tasks demands on the neck, trunk and upper extremities. A single page worksheet is used to evaluate required body posture, force, and repetition. Based on the evaluations, scores are entered for each body region in section A for the arm and wrist, and section B for the neck and trunk. RULA score will be determined from table C, depending on the values derived from Tables A & B.

Fig. 1. Depicts the standard operating procedure of the Rapid Upper Limb Assessment for arriving at the RULA score.

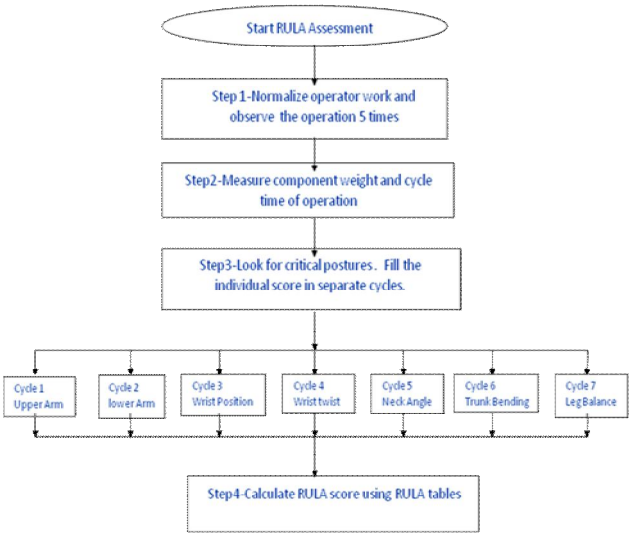

Figure 1. Standard Operating Procedure (SOP) for RULA Assessment

C. Workplace Assessment

Poor working postures, repetitive tasks and heavy workloads can lead to increased risk of workplace injuries. An Ergonomic assessment can identify these risk factors by using a variety of data capture and risk assessment tools. By performing an Ergonomic assessment, business can benefit from: Prevent costly litigation, comply with health and safety citations, decrease injury risk, error rates and lost working days, increase efficiency and productivity. It covers the major areas like Controls and displays, lightings, material Handling, surrounding Environment.

Benefits of carrying out Workplace Audit:

- Improved work conditions for a more content, healthier and productive workforce.
- Better decision-making support based on real-time data and knowledge management.
- Good corporate governance and "preferred supplier" status for implementing a program that is in full accordance with industry best practices.
- Improved confidence in partnerships with suppliers through greater transparency and trust.
- Reduction in excessive auditing and duplication ("audit fatigue").
- RULA is applicable for human postural assessment only. Effect of surrounding system not addressed.
- Hence RML ergonomics team attempted to develop a specific check sheet to check surrounding system.
- It covers the major areas
  - Controls and displays.
  - Lightings
  - Material Handling
  - Surrounding Environment.

D. Composite Ergonomic Scoring System

The next step in the process of ergonomic assessment after obtaining the RULA and workplace assessment scores is to determine the Ergonomic score. The above mentioned Ergonomic score is obtained by using the obtained RULA and Workplace assessment scores in the below formula

Ergonomic Score = RULA Score x Workplace Score

By the obtained the scores the system can be prioritized. The relation between the scores and their priority is as shown below.

Table 1. Rula Score And Recommendations

RULA score	Recommendation by authors
1 or 2	Acceptable
3 or 4	Investigate Further and change may be required
5 or 6	Investigate Further and change soon
7 or more	Change immediately

Table 2. Workplace Score And Recommendation

Work Place Audit Score	Recommendation by authors
0.0-2.0	Comfortable
2.1-3.0	Acceptable
3.1-4.0	Alert
4.1-5.0	Danger

Table 3. Ergonomic Score And Its Remarks

Ergonomic Score	Color	Remarks
1-4	Green	Comfort Zone
5-6	Blue	Acceptable Zone
Greater than 6	Red	Alert Zone

Alert zone is one where the working conditions are unfavorable to the operator with stress and strain.

Acceptable zone is one where the working conditions are favorable but still scope for betterment of working condition.

Comfortable zone is one where the operator produces to the maximum quantity without stress and strain on operator's physical and mental health

IV. ERGONOMIC STUDY AT RML

A. Ergonomics – Understanding

Ergonomics (Definition):

- The science of designing the workstation to fit the operator than physically forcing the operators' body to fit the job. (OSHAS 2002).
- Ergonomics involves an analysis of the production environment including equipment, processes, ambient factors and job procedures. (OSHAS 2002).

B. Objective

To provide a comfortable and risk-free work station and surrounding system to the operator.

C. History of Ergonomics at RML, Mysuru

Rane Madras Limited (RML), Mysore, a Deming Prize Awardee for Total Quality Management in 2007, under the guidance of Mr. Yoshida San from Japan started the implementation of Lean Production System (LPS) in 2005-2006. RML, Mysore adapted the Lean Production System to improve their productivity in order to meet the rising demand from their customers for their quality products.

The steps RML adopted for the implementation of LPS concept in the manufacturing practices are:

- Multi-manning.
- Line Balancing.
- Value Stream Mapping.
- Ergonomics.

Why Ergonomics in RML, Mysore?

- Ergonomics became their major concentration last year as it is the way by which they could improve their productivity being economical.
- This method proved to work wonders in increasing the productivity without major investments by the company.
- Continual efforts are made to ensure ergonomically good facilities and visible improvements seen in,
- Assembly work stations
- Fixture design
- Material handling between stations
- Cell layout design & implementation etc...
- Though many such initiatives are taken across RML to ensure comfortable workstations, State of ergonomics and fatigue levels are not measured.

As the genius mind of Edward Deming said, "We can't improve, where the results are not measured" Hence, the assessment of ergonomic status was taken as a project.

V. RESULTS

The ergonomic study of the SGP Plant showed that most of the machines were in the comfortable and acceptable ergonomic zones with the ergonomic score within 6. This was because of the company's continuous improvement over the years to make the plant more ergonomically sound. Few workstations were present in the alert zone with ergonomic score beyond 6. Most of them were due to the poor work practice by the workers by not following the Standard Operating Procedure (SOP). An ETL box production cell had a workstation in alert zone, and as the same workstation was present in the Productivity Improvement Plan 2016-17 of RML, it had the most priority.

The ETL box had three machining process at the cell. Those are

Base milling:

It was a vertical milling process of the base of the housing to get an even mount of the Steering Gear Assembly on the chassis of the vehicle. This is carried out on a vertical milling machine.

Dowel Drilling

In this machining process 6 holes are simultaneously drilled to the base of the base, which are used to mount the Steering Gear Assembly securely on the vehicle chassis.

Box machining

The last machining process in the cell is carried out in a CNC machine. The various holes meant for mounting of rocket shaft and outer column of the steering rod, are machined to the required dimensions.

As the worker has to manually rivet the nuts of the clamps to hold the workpiece i.e. the box in place in the fixture during the each cycle. This results in repetitive muscle force for each unloading and loading of the workpiece, causing fatigue to the worker and also increase in the cycle time and decrease in productivity of the cell.

The fixture consists of to two clamps with rivets to be loosened and fastened during each cycle for unloading of machined workpiece and loading of the workpiece to be machined. Approximately 80 nos of housing box is machined in a shift i.e. 80 times of fastening and loosening the two sets of clamps. Roughly 4 to 5 turns are made to loosen and fasten the clamps i.e. 80x2x5 = 800 turns/shift. This repetitive work results in fatigue of the upper limbs of the worker, reducing the productivity of the cell.

The time spent for unloading is around 2 min for each cycle and the machining time is close to 3 mins. Hence the production time is increased, decreases the productivity per hour and per shift.

VI. CONCLUSION

The analysis done by ergonomic study as lead to the discovery of a alert zone in the ETL box cell of the SGP plant, which has to be brought to comfort zone by coming up with ideas to the problem and reevaluating the workstation after implementing the various solutions, using RULA assessment and based on the results decide whether it require any more action or the not.

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