

# Ergonomics Study to Improve Workstation Productivity in Manufacturing Sector

<sup>1</sup>Maheshkumar M D, <sup>2</sup>Dr.B R Narendra Babu, <sup>3</sup>Ganeshkumaran, <sup>4</sup>Dr.K.Chandrashekara

<sup>1</sup>Student, Production Technology, Mechanical Department, VVIET, Mysuru, Karnataka, India

<sup>2</sup>Associate Professor, Mechanical Department, VVIET, Mysuru, Karnataka, India

<sup>3</sup>Production Manager Rane Madras Pvt. Ltd. Mysuru, Karnataka, India

<sup>4</sup>Professor, Mechanical Engineering Department, SJCE, Mysuru, Karnataka, India

**Abstract: Problem Statement:** Ergonomics is an important aspect in a manufacturing industry. The ergonomics factors play an important role in the effective running of a company, so these factors are to be seriously. High demand for products in the manufacturing sector had driven the operator to work and faster and adapt to their un-ergonomically workstation. Observation were made and recorded with respect to working postures practiced while performing the operator activities. Now, manufactures found that instead of investing lots of money on man, machine, material, method (4m), improving ergonomics of workplace is cost saving. Ergonomics found great need when customers demand is high and manufactures need more output within short period. To improve the productivity by reducing the back pain, shoulder injury, fatigue etc. Musculoskeletal disorders (MSDs) continue to be a tremendous burden in industry with back injury and shoulder disorders being among the most common and costly disorders because of not having proper workstation. The ergonomics problem will affect the worker in a negative way; this will leads to decrease in productivity, non-achievement of target value, etc.

**Approach:** This was conducted at a Rane Madras Pvt. Ltd, Mysore. The main objective of this study is to find out the ergonomics problem that is dominant in a sector and to give a suggestion to overcome this problem. So for considering this factor operator about the working condition provided by the industry needs proper arrangement such that their problems regarding the MSDs can be reduced and productivity will increase.

**Keywords:** Ergonomic Evaluation, Musculoskeletal Disorder, RULA, Workplace Layout, Reliability Checking, Flexible Workstation.

## I. INTRODUCTION

Ergonomics is concerned with the man, machine and environment to be efficient, safe and comfortable as possible to operator. Effective application of ergonomics in workplace area can achieve a balance between worker and activity. This can enhance operator productivity, provide worker safety and physical and mental and job satisfaction. There are still low level of acceptance and limited application in manufacturing industry. Therefore, poorly designed work planning is a common place in industry. Neglect of ergonomics principles 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 place so that while carrying out the operation the worker could use shorter motion and expend less energy and thus reduce fatigue.

A literature review on past researches are few studied with respect to new workstation to solve MSD's and ergonomics problems faced by standing workers performing the various activities. Efficient ergonomics in workstation changes shows better interaction between man-machine systems. Lot of research has been done on analyzing and improving ergonomics of workstation, facility layout. Study regarding operator performance and comfort in repetitive activities has been done. Methodology has been proposed to analyses and classify assembly workplace layout configuration in relation to both technological and environmental. Study of discomfort experienced by operator during process has been studied and analysis of working postures to find out awkward postures. Proper ergonomics design is necessary to prevent repetitive strain injuries and other musculoskeletal disorders, which can develop over time and can lead to long term disability. Ergonomics improvements improve quality and operators productivity. Usually, ergonomics evaluations are performed by ergonomics, while workplace layout are designed by planning engineers, and the result are often unsatisfactory and do improve productivity. productivity. So a study of ergonomics facilities affecting workers in an

industry is important. In an industry ergonomics plays an important role, if proper ergonomics facilities are not provided it will affect the performance of the industry. A case study is conducted regarding ergonomics in a manufacturing industry. Production department is selected for the case study. In various ergonomics sectors are considered has effect to the employee while working. Considering these ergonomics factors is conducted regarding the satisfaction of the operator while working. Such as improved lighting, shelves and container for parts and display board, has provided and solved the problem of running at the company. Motion analysis for each motion element of operator's body postures and movement of others body related. Result of motion study revealed various causing and maximum time consuming factors relation to work and workstation places.

## II. METHODOLOGY

### *Motion Study:*

Complex analysis of workstation is done by using flow study. Each activity performed by man or machine including body members and their movements. The main purpose of such flow study is to found and understand problem related to human effort and system. In order to achieve objective is need to go into details of postures movements and best possible and most economical way of motion can be develop to perform comfort efficient activity. This type of research study involves making motion flow of an operation to analyse method and result of each frame postures like bending, lifting, twisting etc.

### *RULA:*

RULA is a quick research method is used in ergonomics investigation of workplace station where MSD's are informed. It is a clear screening that assess of postures loading on the body. It completely zooms on the neck, trunk and upper limb, and for ideal sedentary employee. It is a simple, fast and easy to complete. RULA scores identify the level of intervention requirement to reduce MSD risk activity.

### *RULA ACTION LEVEL*

#### *RULA-6 Steps*

1. Observe the task
2. Select postures for assessment
3. Score the postures
4. Process the score

5. Determine final score
6. Confirm action level



Fig: 1 Forward Bending and Neck Angle

Rula for the validation of work:

After investigating the MSD's in the industry, it has been observed that there is need of investigation. So with the help of Rula the postures are evaluated for finding the severity of the problem. Workers angles are evaluated by method and which are evaluated through RULA. This method investigates body parts as upper arm, lower arm, wrist, wrist twist, neck, trunk and limb. It can be observed the upper arm and lower angle of the workers posture and by selecting the related position of the mannequin in the worksheet of the database of Rula the score of '+3' and '+2' has obtained respectively. While working the shoulder get raised and arm get abducted so it gives score of '3' individually and it will be get added to the previous score. So the final score of upper arm is '3'. In the same way for lower arm, by selecting the mannequin score of '2' has been obtained and as the arm is working across midline of the body and while working operator has to move the arm out of the side of the body. So the grand score of the lower arm is '2'. We can observe the neck angle of the postures of the worker and related to that the mannequin from worksheet is selected and it gives the score '3'. Now the neck movement forwarded to the operation of the transform winding. Then the operator is bending on the operation side while working., so the neck side bend gives score of '3', inclination of trunk gives the score '3'. Final score '5' indicates that, "investigation and changes are done frequently".

<b>Module:</b>	<b>Date:</b>	<b>RULA ASSESSMENT SHEET</b>	<b>Operation:</b>	
<b>Station:</b>			<b>Operator:</b>	

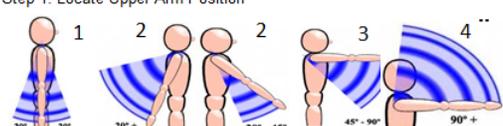
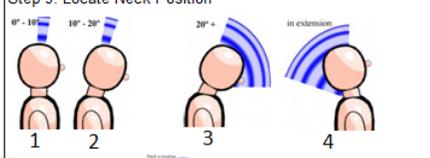
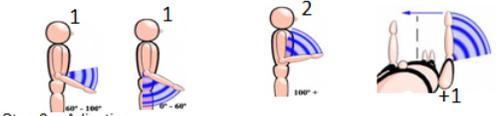
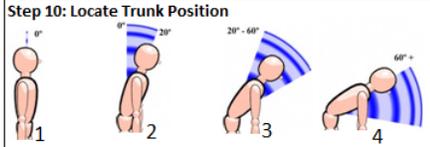
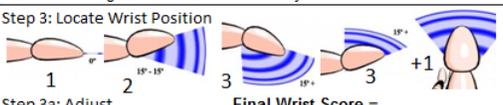
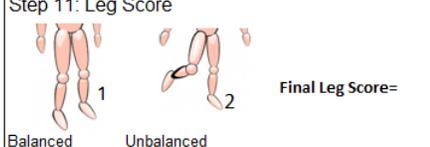
	Scores	Observation	Scores
<b>Arm &amp; Wrist Analysis</b>			
<b>Step 1: Locate Upper Arm Position</b>  <p>Step 1a: Adjusting                      If Shoulder is raised +1                      If upper arm is abducted: +1                      If arm is supported or person is leaning: +1</p> <p style="text-align: right;"><b>Final Upper Arm Score =</b></p>	RIGHT LEFT I <input type="text"/> <input type="text"/>	<b>Step 9: Locate Neck Position</b>  <p>Final Neck Score=                      Bend +1 or Twist +1 with neck position score</p>	IX <input type="text"/>
<b>Step 2: Locate Lower Arm Position</b>  <p>Step 2a: Adjusting                      If arm outside of body +1                      If arm is working across midline of the body: +1</p> <p style="text-align: right;"><b>Final Upper Arm Score =</b></p>	II <input type="text"/> <input type="text"/>	<b>Step 10: Locate Trunk Position</b>  <p>Step 10 a: Adjust:                      If Trunk is twisted +1; if Trunk is side-bending: +1</p> <p style="text-align: right;"><b>Final Trunk Score=</b></p>	X <input type="text"/>
<b>Step 3: Locate Wrist Position</b>  <p>Step 3a: Adjust                      If wrist is bent from the midline: +1</p> <p style="text-align: right;"><b>Final Wrist Score =</b></p>	III <input type="text"/> <input type="text"/>	<b>Step 11: Leg Score</b>  <p style="text-align: right;"><b>Final Leg Score=</b></p>	XI <input type="text"/>
<b>Step 4: Wrist Twist</b>  <p style="text-align: right;"><b>Final Wrist Score =</b></p>	IV <input type="text"/> <input type="text"/>	<b>STEP 12: Look-up Posturer score in TABLE B</b> Use Values IX, X, XI	XII <input type="text"/>
<b>STEP 5: Look up Posture score in TABLE A</b> Use values I, II, III & IV	V <input type="text"/> <input type="text"/>	<b>STEP 13: Add Muscle Use Score</b> Static (i.e held longer than 1 min) or; Repeated 4 times in a minute = +1	XIII <input type="text"/>
<b>Table A Score</b> Choose the maximum score as arm score	VI <input type="text"/>	<b>STEP 14: Add force / load score</b> If load <2kg =0; If load 2 to 10kg=+1; If load 2 to 10 kg (static or Repeated)=+2;	XIV <input type="text"/>
<b>STEP 6: Add Muscle use score</b> Static (i.e held longer than 1 min) or; Repeated 4 times in a minute = +1	VII <input type="text"/>	<b>STEP 15: Find column in TABLE C</b> Neck, Trunk and Leg score	XV <input type="text"/>
<b>STEP 7: Add force / load score</b> If load <2kg =0; If load 2 to 10kg=+1; If load 2 to 10 kg (static or Repeated)=+2;	VIII <input type="text"/>	<b>Final RULA score</b>	<input type="text"/>
<b>STEP 8: Find row in TABLE C</b> <b>FINAL WRIST &amp; ARM SCORE</b>	<input type="text"/>	Overall Suggestions	<input type="text"/>

Fig: 2 RULA Assessment Sheet

**RULA ASSESSMENT SHEET**

Module: \_\_\_\_\_ Date: \_\_\_\_\_ Operation: \_\_\_\_\_  
 Station: \_\_\_\_\_ Operator: \_\_\_\_\_

**Am & Wrist Analysis**

Step 1: Locate Upper Arm Position  
 Final Upper Arm Score =  
 If Shoulder is raised +1  
 If upper arm is abducted: +1  
 If arm is supported or person is leaning: +1

Step 2: Locate Lower Arm Position  
 Final Upper Arm Score =  
 If arm outside of body +1  
 If arm is working across midline of the body: +1

Step 3: Locate Wrist Position  
 Final Wrist Score =  
 If wrist is bent from the midline: +1

Step 4: Wrist Twist  
 Final Wrist Score =

**STEP 5: Look up Posture score in TABLE A**  
 Use values I, II, III & IV

**Table A**

Upper Arm	Lower Arm	Wrist									
		IV		1		2		3		4	
1	1	1	2	2	2	2	2	3	3	3	3
1	2	2	2	2	2	2	2	3	3	3	3
1	3	2	3	3	3	3	3	3	4	4	4
1	4	1	2	3	3	3	3	3	4	4	4
2	1	2	3	3	3	3	3	3	4	4	4
2	2	2	3	3	3	3	3	3	4	4	4
2	3	3	3	3	3	3	3	4	4	4	4
2	4	3	3	4	4	4	4	4	4	5	5
3	1	3	3	3	4	4	4	4	4	5	5
3	2	3	3	4	4	4	4	4	4	5	5
3	3	3	4	4	4	4	4	4	4	5	5
3	4	3	4	4	4	4	4	4	4	5	5
4	1	4	4	4	4	4	4	4	4	5	5
4	2	4	4	4	4	4	4	4	4	5	5
4	3	4	4	4	4	4	4	4	4	5	5
4	4	4	4	4	4	4	4	4	4	5	5
5	1	5	5	5	5	5	5	5	5	6	6
5	2	5	5	5	5	5	5	5	5	6	6
5	3	5	5	5	5	5	5	5	5	6	6
5	4	5	5	5	5	5	5	5	5	6	6
6	1	7	7	7	7	7	7	7	7	7	7
6	2	8	8	8	8	8	8	8	8	8	8
6	3	8	8	8	8	8	8	8	8	8	8
6	4	9	9	9	9	9	9	9	9	9	9

Upper arm : I = 2  
 Lower arm : II = 2  
 Wrist : III = 2  
 Wrist Twist : IV = 1  
**Table A score = 3**

**Table B**

IX	Trunk Posture Score											
	X		2		4		6		8		10	
Neck	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	3	3	4	4	5	5	6	6	7	7
3	3	3	3	3	4	4	5	5	6	6	7	7
4	4	5	5	5	6	6	7	7	7	7	8	8
5	5	7	7	7	7	7	8	8	8	8	8	8
6	6	8	8	8	8	8	8	8	8	8	9	9

Neck : IX = 3, Trunk : X = 3 & Leg : XI = 2  
**Table B score = 5**

**Table C**

VIII	Final Score						
	XV						
1	1	2	3	4	5	6	7+
2	1	2	3	3	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	4	5	6
5	4	4	4	4	5	6	7
6	4	4	4	5	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Table A score : VIII=3, Table B score : XV = 5  
**Final RULA Score=4**

**STEP 6: Add Muscle use score**  
 Static (i.e. held longer than 1 min) or:  
 Repeated 4 times in a minute = +1

**STEP 7: Add force / load score**  
 If load < 2kg = 0; If load 2 to 10kg = 1;  
 If load 2 to 10 kg (static or Repeated) = 2;

**STEP 8: Find row in TABLE C**  
**FINAL WRIST & ARM SCORE**

**STEP 9: Locate Neck Position**  
 Final Neck Score =  
 If neck is twisted +1, if neck is side-bending +1

**STEP 10: Locate Trunk Position**  
 Final Trunk Score =  
 If trunk is twisted +1, if trunk is side-bending +1

**STEP 11: Leg Score**  
 Final Leg Score =  
 Balanced Unbalanced

**STEP 12: Look-up Posture score in TABLE B**  
 Use Values IX, X, XI

**STEP 13: Add Muscle Use Score**  
 Static (i.e. held longer than 1 min) or:  
 Repeated 4 times in a minute = +1

**STEP 14: Add force / load score**  
 If load < 2kg = 0; If load 2 to 10kg = 1;  
 If load 2 to 10 kg (static or Repeated) = 2;

**STEP 15: Find column in TABLE C**  
 Neck, Trunk and Leg score

**Final RULA score**

Overall Suggestions

Fig: 3 RULA Methodologies

**RULA Assessment methodology**

**RULA ASSESSMENT SHEET**

Module: \_\_\_\_\_ Date: \_\_\_\_\_ Operation: \_\_\_\_\_  
 Station: \_\_\_\_\_ Operator: \_\_\_\_\_

**Table B**

IX	Trunk Posture Score											
	X		2		4		6		8		10	
Neck	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	3	3	4	4	5	5	6	6	7	7
3	3	3	3	3	4	4	5	5	6	6	7	7
4	4	5	5	5	6	6	7	7	7	7	8	8
5	5	7	7	7	7	7	8	8	8	8	8	8
6	6	8	8	8	8	8	8	8	8	8	9	9

Neck : IX = 3, Trunk : X = 3 & Leg : XI = 2  
**Table B score = 5**

**Table C**

VIII	Final Score						
	XV						
1	1	2	3	4	5	6	7+
2	1	2	3	3	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	4	5	6
5	4	4	4	4	5	6	7
6	4	4	4	5	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Table A score : VIII=3, Table B score : XV = 5  
**Final RULA Score=4**

**STEP 9: Locate Neck Position**  
 Final Neck Score =  
 If neck is twisted +1, if neck is side-bending +1

**STEP 10: Locate Trunk Position**  
 Final Trunk Score =  
 If trunk is twisted +1, if trunk is side-bending +1

**STEP 11: Leg Score**  
 Final Leg Score =  
 Balanced Unbalanced

**STEP 12: Look-up Posture score in TABLE B**  
 Use Values IX, X, XI

**STEP 13: Add Muscle Use Score**  
 Static (i.e. held longer than 1 min) or:  
 Repeated 4 times in a minute = +1

**STEP 14: Add force / load score**  
 If load < 2kg = 0; If load 2 to 10kg = 1;  
 If load 2 to 10 kg (static or Repeated) = 2;

**STEP 15: Find column in TABLE C**  
 Neck, Trunk and Leg score

**Final RULA score**

Overall Suggestions

RML-ERGONOMIC ASSESSMENT

Fig: 4 RULA Assessment Chart

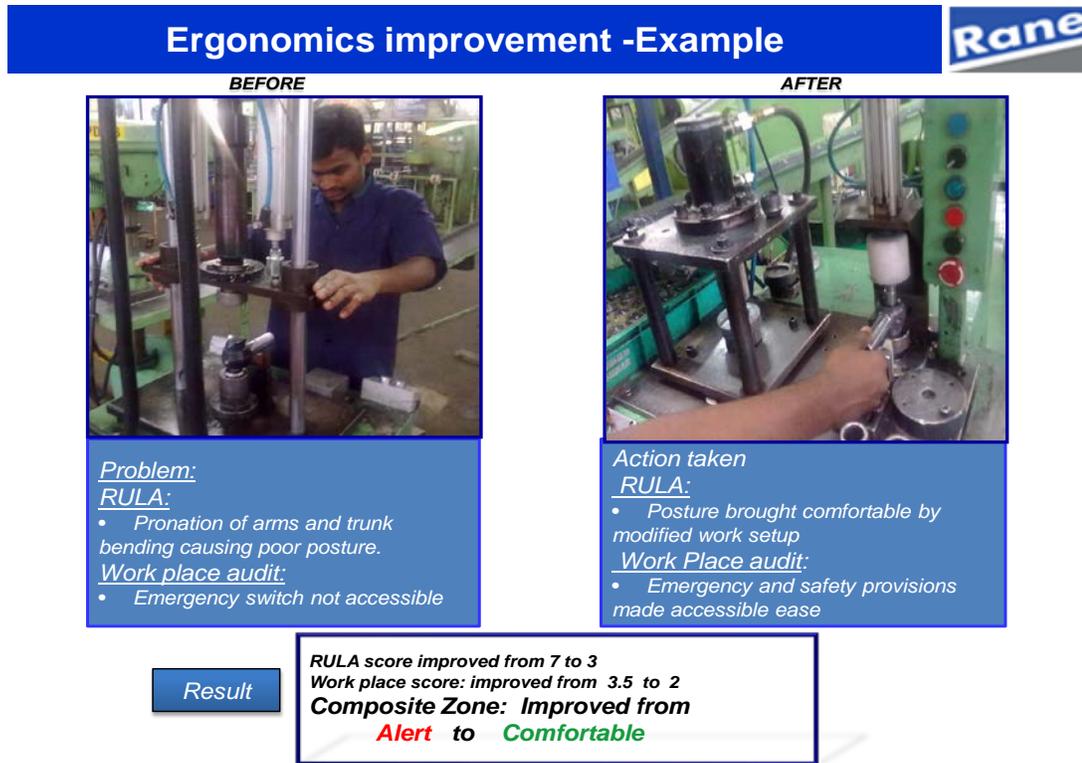
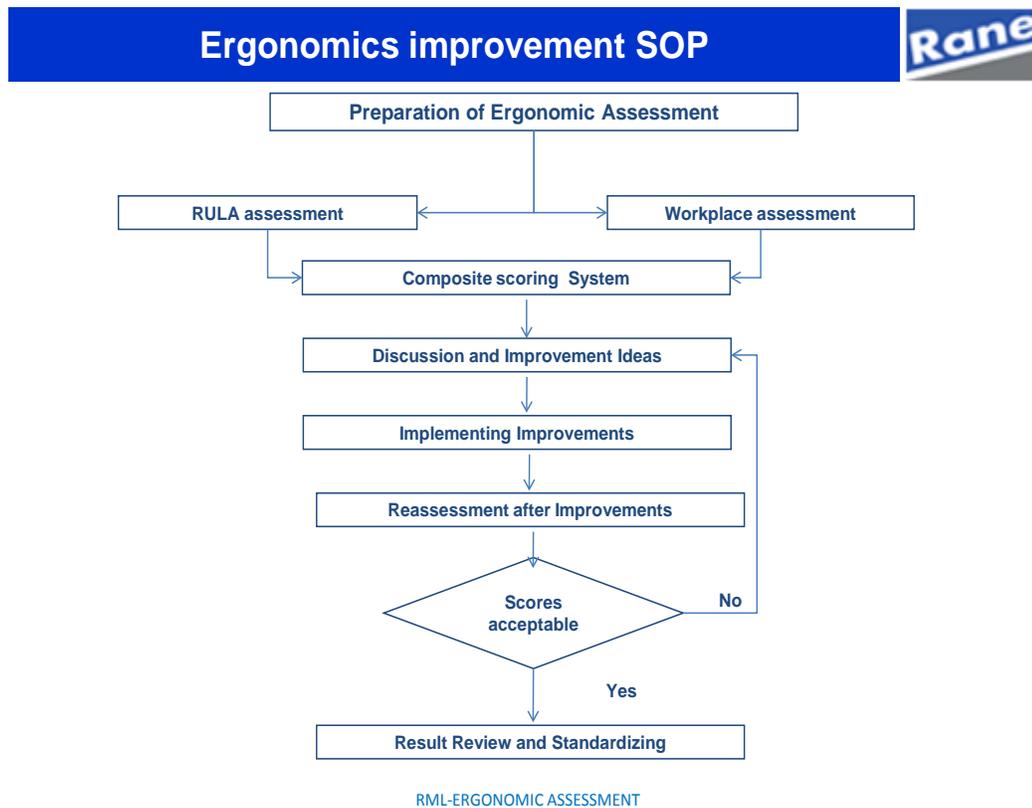


Fig: 5 Operators Working



Flow Chart 1: Method of Working

### Ergonomics Analysis:

When operator are interview for getting information regarding awkward postures and complex activities, various illness are informed by these workers including neck pain, back, shoulder pain etc. Lead to reduced efficiency of workers and in server cases long duration pains. Motion study revels reasons of this illness. Analysis of these factors is done by motion film and root causes of these are found out.

### *Employee Productivity:*

Many industries are looking for new ways to make their overall output more cost effective. Since operator costs are a major component of most contact centre expenses, improving agent productivity has become a battle crying of management. Improving productivity can be accomplished by changing process, and increasing employee job satisfaction. Few people would disagree with the happy employees who have the right to perform their work with the highest productivity. Improving operator performance is central to the improvement of overall working performance.

### *Employee Satisfaction:*

Major Sector is far more cost effective for operator to retain a good agent than to recruit a replacement. Workers satisfaction and morale at good steps for reaching goal. Most industries are providing ergonomically optimized workstations that reduce the high levels of discomfort and tension that often cause agents to move away from their workstation.

## III. CONCLUSIONS

This work was conducted on an automobile spare parts manufacturing industry of steering gear box. The shop was facing problem of less efficiency of workers due to poor ergonomics and in some severe cases hazardous health issues are found. Here attempt has been made to identify fatigue causing factors which leads to reduced efficiency of workers hence less productivity of workstation. To study and analyses factors causing less efficiency, motion study technique is used. The other source of data is interview with workers, mangers, archived documents etc. Ergonomically improved workplace layout helps in reduced stress on workers, elimination of repetitive tasks, cycle time reduction and hence increased productivity.

## REFERENCES

- [1] Mc Atamney, L., Corlett, and E.N., Rula: A Survey method for the investigation of work related per limb disorders, Applied Ergonomics, Vol.24 (2), pp.91-99, 1993.
- [2] Bimal Das, Julia wimpee, Bijon Das, Ergonomics evaluation and redesign of a hospital meal cart” Applied Ergonomics Vol.No.33 pp.309-318, 2002.
- [3] Chaffin, D.B., Anderson G.B.J., 1999. Occupational biomechanics, 3<sup>rd</sup> ed Newyork: John Wiley and Sons.pp.355-392.
- [4] Anil Mittal, Shrawan Kumar, Human muscle strength definition, measurement and usage. Part guidelines for the practioners, International journal of Industrial Ergonomics22 (1998)101-121.
- [5] Holley A. Sweeney, M.A., Applying Ergonomics principle in the workplace: How the Alexander Technique can help.
- [6] CEN (2002). CEN, EN 1005-3. Safety of Machinery-Human Physical Performance- Part 3: Recommended Force Limits for Machinery Operation (2002).