



## ERGONOMIC ASSESSMENT THROUGH RULA, REBA & MAN-TRA: A CASE STUDY

Prasanna Bagde  
Amar Gandam  
Rajesh J. Dhake

### Abstract

The paper presents a case study of ergonomic improvement in a tier 1 automobile company manufacturing clusters, fuel level sensors, oil pumps etc. Ergonomic assessment tools viz., RULA (Rapid upper limb assessment), REBA (Rapid entire body assessment), MAN-TRA (Manual task risk assessment) associated with the working posture are used to determine risks related with musculoskeletal disorders & work related injuries. Appropriate suggestions & improvements were effected in the form of workspace modification, provision of rotating fixture & work simplification. A comparison of work conditions before & after improvements shows considerable improvement in workers productivity.

**Keywords:** RULA: Rapid upper limb assessment, REBA: Rapid entire body assessment, Man-TRA: Manual task risk assessment, WMSD: Work related musculoskeletal disorders.

### 1. INTRODUCTION

The company manufactures oil pump & mechanical clusters averaging a monthly demand of 234000 units & 30000 units respectively. A large extent of work content is added in manual operations due to poor design of workplace leading to poor ergonomic conditions & even the risk of work related musculoskeletal disorders & work related injuries. A detailed assessment of work posture of loading pump body on cleaning fixture & packing of clusters in carton box was undertaken to make ergonomic improvements using ergonomic assessment tools like Man-TRA, REBA & RULA. The operators working on that specific workstation were facing the following problems:

- Back pain, Wrist pain
- Overall Exertion
- Overall fatigue to body
- Joints pain & other WMSD's.

### 2. LITERATURE REVIEW

Work-related musculoskeletal disorders (WMSDs) are a major concern in industry which can also compromise competitiveness due to costs related to worker compensation, labour turnover, absenteeism, poor quality and reduced productivity. The ramifications of WMSDs are large in terms of both health and costs.

Man-TRA—Man-TRA is a manual tasks risk assessment tool that was developed by the University of Queensland, Workplace Health and Safety Queensland and the Curtin University of Technology. User have to calculate data about the manual task. This data includes rating the physical risk factors for four body regions (neck/shoulder, arm/wrist/hand, back and lower limbs). The score for each risk factor is based on the task as a whole and for the person

performing the task. This data is used to determine action thresholds for repetition risk, exertion risk and cumulative risk. These action thresholds are presented in the results table. Further action is suggested if the thresholds are reached or exceeded. Refer figure 1 for assessment template for Man-TRA.

REBA - This ergonomic assessment tool uses a systematic process to evaluate whole body postural MSD and risks associated with job tasks. A single page worksheet is used to evaluate required or selected body posture, forceful exertions, type of movement or action, repetition, and coupling. Using the REBA worksheet, the evaluator will assign a score for each of the following body regions: wrists, forearms, elbows, shoulders, neck, trunk, back, legs and knees. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk. Refer figure 2 for assessment template for REBA.

RULA - The RULA Assessment Tool 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. Using the RULA worksheet, the evaluator will assign a score for each of the following body regions: upper arm, lower arm, wrist, neck, trunk, and legs. After the data for each region is collected and scored, tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk. Refer figure 3 for assessment template for RULA

Cumulative risk is the sum of unshaded cells.

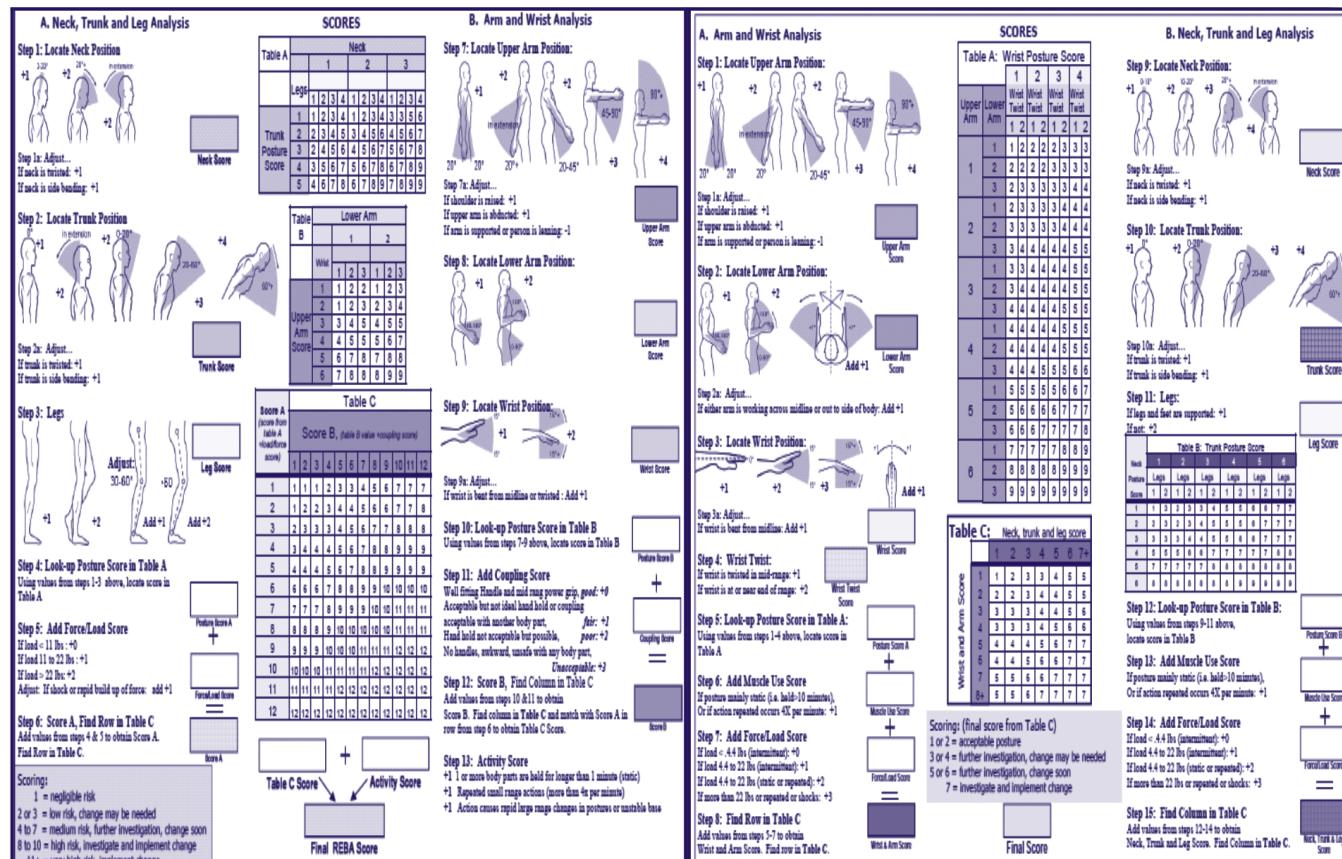
Codes				
Total time	2	3	4	5
0-2 hours/day	2-4 hours/day	4-6 hours/day	6-8 hours/day	> 8 hours/day
Duration of continuous performance				
1	2	3	4	5
< 10 minutes	10 min - 30 min	30 min - 1 hr	1 hr - 2 hr	> 2 hr
Cycle time				
1	2	3	4	5
> 5 minutes	1 - 5 minute	30 s - 1 min	10 s - 30 s	< 10 s
Force				
1	2	3	4	5
Minimal force		Moderate force		Maximal force
Speed				
1	2	3	4	5
Slow movements	Moderately paced	Little or no movement - static posture	Fast and smooth movements	Fast, jerky movements
Awkwardness				
1	2	3	4	5
All postures close to neutral	Moderate deviations from neutral in one direction only	Moderate deviations in more than one direction	Near end range of motion posture in one direction	Near end range of motion in more than one direction
Vibration (Whole body or Peripheral)				
1	2	3	4	5
None	Minimal	Moderate	Large amplitude	Severe amplitude

Scoring Keys for Repetition & Exertion					
Scoring key for Repetition					
Duration					
Cycle Time	1	2	3	4	5
1	1	1	2	3	4
2	1	2	3	4	4
3	2	3	4	4	5
4	2	3	4	5	5
5	3	4	5	5	5

Scoring key for Exertion					
Speed	1	2	3	4	5
1	1	1	2	3	4
2	1	2	3	4	4
3	2	3	4	4	5
4	2	3	4	5	5
5	3	4	5	5	5

Action may be indicated if, for any region, the Exertion risk factor is 5, the sum of exertion and awkwardness is 8 or greater, or the cumulative risk is 15 or greater

**Figure 1. Man-TRA Analysis Matrix**



**Figure 2. REBA Analysis Matrix**

**Figure 3. RULA Analysis Matrix**

### 3. METHODOLOGY

The following methodology was adapted for effecting improvements on the workstations

- Assessing present status of WMSD risk by different ergonomic assessment tools
- Solving the MSD risk problem through workplace & methods modification
- Implementation of proposed method & improvements.

#### 3.1. Ergonomic Assessment to Identify WMSD Risk

A detailed ergonomic assessment using Man-TRA, RULA &

REBA is done. The scores & risk associated are illustrated below for different ergonomic assessment techniques.

##### Work Area 1: "Packing Workstation"

On packing station of cluster manufacturing assembly line, operator of packing station required to put the cluster in polythene bag, then pack it in cardboard box & then put it in cartoon box placed on shop floor. The repetition frequency was 1000 units/shift. Severe bending of back & raising of shoulder was present while keeping cluster in cartoon box. Man-TRA & RULA assessment was conducted to this procedure.

**Table 1. Man-TRA Analysis Before Workplace Modification**

Body	Task Codes									Cumulative Risk
	Total Time	Duration	Cycle time	Repetition Risk	Force	Speed	Exertion Risk	Awkwardness	Vibration	
Lower Limb	4	4	4	3	2	2	2	2	1	12
Back	4	4	4	3	4	2	4	4	1	16
Neck/Shoulder	4	4	4	3	4	2	4	4	1	16
Arm/Wrist & Hand	4	4	4	3	2	2	2	2	1	12

**Table 2. Man-TRA Analysis After Workplace Modification**

Body	Task Codes									Cumulative Risk
	Total Time	Duration	Cycle time	Repetition Risk	Force	Speed	Exertion Risk	Awkwardness	Vibration	
Lower Limb	4	4	4	3	2	2	2	1	1	11
Back	4	4	4	3	2	2	2	2	1	12
Neck/Shoulder	4	4	4	3	2	2	2	2	1	12
Arm/Wrist & Hand	4	4	4	3	2	2	2	2	1	12

### RECOMMENDATION

After studying & analysing the initial state recommendations were made to reduce the WMSD risk at packing workstation by

increase in 50 cm height of carton box from ground to reduce bending & arm raising posture.

**Table 3. RULA Analysis Previous & Present Score**

No	Description	Previous Score	Previous Total Score	Current Score	Current Total Score
1	Locate upper arm position	3		3	
2	Locate lower arm position	2		2	
3	Locate wrist position	2		2	
4	Wrist twist	2		2	
5	Total Look up posture score from Table A	$3 + 2 + 2 + 2$	4	$3 + 2 + 2 + 2$	4
6	Muscle score	0		0	
7	Force score	0		0	
8	Total Wrist & arm score	$4 + 0 + 0$	4	$4 + 0 + 0$	4
9	Neck position score	3		3	
	Side Bending	1		0	
10	Trunk position score	4		3	
	Side Bending	1		0	
11	Leg position score	2		1	
12	Total Leg position score from Table B	$4 + 5 + 2$	7	$3 + 3 + 1$	4
13	Muscle score	0		0	
14	Force score	0		0	
15	Total Neck Trunk & Leg score from Table C	$7 + 0 + 0$	7	$4 + 0 + 0$	4
16	Total Final RULA score From Table C	$4 + 7$	6	$4 + 4$	4

**Before****After****Fig. 4 Improvements at Packing Workstation**

	Man-TRA			
	Lower Limb	Back	Neck & Shoulder	Arm/Wrist/Hand
Previous Score	12	16	16	12
Present Score	11	12	12	12

Table 4. Man-TRA Score

RULA	Arm & wrist analysis	Neck trunk & leg analysis	Table C grid	Final Score
Previous Score	4	4	7	6
Present Score	4	4	4	4

Table 5. RULA Score

**Work Area 2: “Cleaning Workstation”**

At cleaning workstation, it was observed that a single operator has to mount the pump body on cleaning fixture which consists of 30 casing on 1 stand; such 3 stands are used for cleaning 90 casings at a single cycle of operation in cleaning machine.

While cleaning machine is running, operator has to mount the pump body, pick the fixture, keep it on table & sit again to continue the process. The loaded fixture with pump body has a weight of 8 kilograms. This process is done about 150 a shift.

Table 6. Man-TRA Analysis Before Workplace Modification

Body	Task Codes									Cumulative Risk
	Total Time	Duration	Cycle time	Repetition Risk	Force	Speed	Exertion Risk	Awkwardness	Vibration	
Lower Limb	4	4	2	4	3	2	3	2	1	14
Back	4	4	2	4	3	2	3	3	1	15
Neck/Shoulder	4	4	2	4	2	2	2	2	1	13
Arm/ Wrist/ Hand	4	4	2	4	3	2	3	4	1	16

Table 7. Man-TRA Analysis After Workplace Modification

Body	Task Codes									Cumulative Risk
	Total Time	Duration	Cycle time	Repetition Risk	Force	Speed	Exertion Risk	Awkwardness	Vibration	
Lower Limb	4	4	2	4	1	2	1	1	1	11
Back	4	4	2	4	1	2	1	1	1	11
Neck/Shoulder	4	4	2	4	1	2	1	1	1	11
Arm/ Wrist/ Hand	4	4	2	4	2	2	2	2	1	13

**Table 8. REBA analysis Previous & Present Score**

No	Description	Previous Score	Previous Total Score	Current Score	Current Total score
1	Locate Neck position	2		2	
2	Locate Trunk position	4		2	
3	Leg position	4		1	
4	Look up posture score in Table A	2+4+2+2	8	5	3
5	Add force / load score	3		2	
6	Score A	8+2+1	11	7	5
7	Locate upper arm position	2		3	
8	Locate lower arm position	2		2	
9	Locate wrist position	1		1	
10	Look up posture in Table B	2+2+1	2	6	4
11	Add coupling score	2		2	
12	Score B	2+2	4	6	6
13	Score C	11+4	11	11	7
14	Activity Score + 1 If required	11+1	12		

**Recommendation**

After studying & analysing the initial state recommendations were made to reduce the WMSD risk at cleaning workstation by

providing new ergonomically designed rotary stand, which reduces arm/wrist/hand fatigue risk & also eliminates bending of operator.

**Before****After****Fig. 2 Improvements at Cleaning Workstation**

	Man-TRA			
	Lower Limb	Back	Neck & Shoulder	Arm/Wrist/Hand
Previous Score	14	15	13	16
Present Score	11	11	11	13

**Table 9. Man-TRA Score**

REBA	Neck trunk & leg analysis	Arm & wrist analysis	Table C grid	Activity analysis	Final score
Previous Score	11	4	11	1	12
Present Score	5	6	7	0	7

**Table 10. REBA Score**

#### 4. CONCLUSION

Ergonomics in tier 1 automobile industry is the most ignored aspect & hence more focus should be given for working posture of operator. The chances of developing work related musculoskeletal disorders are very high in operators. Ergonomic changes in current working conditions were made to reduce MSD by implementing small improvements. Use of rotating fixture & increased stand height from ground level has reduced the work related musculoskeletal disorders in operators substantially. Horizontal deployments of changes done on packing workstations at seven other assembly lines.

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#### AUTHORS

**Prasanna Bagde**, Department of Industrial & Production Engineering, Vishwakarma Institute of Technology, 666, Upper Indiranagar, Bibwewadi, Pune - 411 037 (MS)  
E-mail:prasannabagde91@gmail.com

**Amar Gandam**, Department of Industrial & Production Engineering, Vishwakarma Institute of Technology, 666, Upper Indiranagar, Bibwewadi, Pune - 411 037 (MS)

E-mail: amar\_gandam@yahoo.in,  
**Prof. Rajesh J. Dhake**, Professor, Department of Industrial & Production Engineering, Vishwakarma Institute of Technology, 666, Upper Indiranagar, Bibwewadi, Pune - 411 037 (MS)  
E-mail:rj\_dhake@yahoo.com