



Attaining a Safer Work Environment  
for Manufacturing Plants

# Ergonomics Intervention in Industries

**Assoc. Prof. Wattana Jalayondeja**  
**Ergonomic Society of Thailand**  
**Mahidol University**



**Mahidol University**  
*Wisdom of the Land*

# Ergonomic Society of Thailand (EST)



- Ergonomics Best Practice Award (EBPA)



# Ergonomic Interventions (examples)

- **Glass bottle industry**
- **Car industry**
  - **Pallet for cylinder head core (Autopart)**
  - **Assembly line**

# Glass bottle industry -arrangement



# Placing bottles into a tray by manual



1. Bottles flowing through conveyer



2. Picking up bottles by hands



3. Placing bottles from inside-out



# Glass bottles arrangement by manual

- 60 minutes/1 tray : 5 manpower/shift
- Cannot stop because of the continuation of the arrangement line
- Hydraulic Tray




Process	Contain	Arrangement	Rotating	Covering tray
Before	45	10	3	2





# Problems

Production line: **RB33** Using manual handling have to work with fast pace according to the speed conveyors

Process	Postures	Frequency	Work duration	WMSD
	finger flexion (awkward postures)	20 times/min	7 hr/day (3 consecutive days/1 day rest)	Finger pain (trigger fingers?)
	180° trunk rotation	20 times/min	7 hr/day (3 consecutive days/1 day rest)	Low back pain
	Reaching, trunk flexion	0.5 times/min	7 hr/day (3 consecutive days/1 day rest)	Shoulder, upper and lower back pain

# REBA Employee Assessment Worksheet

based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

## A. Neck, Trunk and Leg Analysis

### Step 1: Locate Neck Position



Step 1a: Adjust...  
If neck is twisted: +1  
If neck is side bending: +1

4  
Neck Score

### Step 2: Locate Trunk Position



Step 2a: Adjust...  
If trunk is twisted: +1  
If trunk is side bending: +1

4  
Trunk Score

### Step 3: Legs



Step 4: Look-up Posture Score in Table A  
Using values from steps 1-3 above, locate score in Table A.

9  
Posture Score A

### Step 5: Add Force/Load Score

If load < 11 lbs: +0  
If load 11 to 22 lbs: +1  
If load > 22 lbs: +2  
Adjust: If shock or rapid build up of force: add +1

0  
Force/load Score

### Step 6: Score A, Find Row in Table C

Add values from steps 4 & 5 to obtain Score A.  
Find Row in Table C.

9  
Score A

### Scoring:

- 1 = negligible risk
- 2 or 3 = low risk, change may be needed
- 4 to 7 = medium risk, further investigation, change soon
- 8 to 10 = high risk, investigate and implement change
- 11+ = very high risk, implement change

## SCORES

Table A		Neck											
		1				2				3			
Trunk Posture Score	Legs	1	2	3	4	1	2	3	4	1	2	3	4
	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table B		Lower Arm					
		1			2		
Upper Arm Score	Wrist	1	2	3	1	2	3
	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
6	7	8	8	8	9	9	

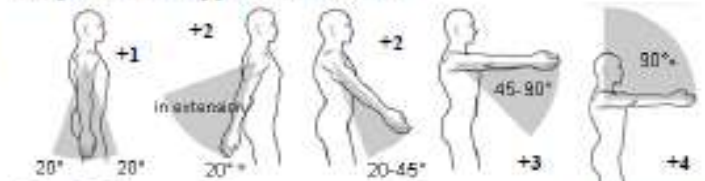
Score A (score from table A +load/force score)	Table C											
	Score B, (table B value +coupling score)											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

10 + 1  
Table C Score + Activity Score

11  
Final REBA Score

## B. Arm and Wrist Analysis

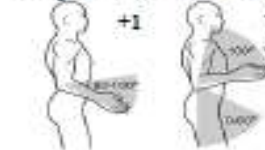
### Step 7: Locate Upper Arm Position:



Step 7a: Adjust...  
If shoulder is raised: +1  
If upper arm is abducted: +1  
If arm is supported or person is leaning: -1

3  
Upper Arm Score

### Step 8: Locate Lower Arm Position:



1  
Lower Arm Score

### Step 9: Locate Wrist Position:



2  
Wrist Score

Step 9a: Adjust...  
If wrist is bent from midline or twisted: Add +1

### Step 10: Look-up Posture Score in Table B

Using values from steps 7-9 above, locate score in Table B

5  
Posture Score B

### Step 11: Add Coupling Score

Well fitting Handle and mid range power grip: *good*: +0  
Acceptable but not ideal hand hold or coupling acceptable with another body part: *fair*: +1  
Hand hold not acceptable but possible: *poor*: +2  
No handles, awkward, unsafe with any body part: *Unacceptable*: +3

+  
1  
Coupling Score

### Step 12: Score B, Find Column in Table C

Add values from steps 10 & 11 to obtain Score B. Find column in Table C and match with Score A in row from step 6 to obtain Table C Score.

6  
Score B

### Step 13: Activity Score

+1 1 or more body parts are held for longer than 1 minute (static)  
+1 Repeated small range actions (more than 4x per minute)  
+1 Action causes rapid large range changes in postures or unstable base

Very high risk



# Goal and Target Points

	Preferred Level	Current Level
Goal	Low ergonomic risks	High ergonomics risks

Theme	Survey	standard	current	Gap	Targets	Topics		Results	Usage
						Possibility	\$\$		
เพิ่มประสิทธิภาพในการบรรจุขวดที่ราง 33	workers	amount of bottles	Not equal	Skill	Training	0	0	0	No
	Packing	decrease ergo risk	high risk	Long time	Improve packing methods	3	3	6	Yes
	Tray	easy to handle	Jam sometimes	Handle easily	Improvement of tray	3	1	4	Yes
	Frame	stable	Rotate away frequently	Not standard	Frame improvement	1	2	3	No
	Divider and pushing bar	easy to handle (no reaching)	arrange in rows	time consuming	Divider bar	3	2	5	Yes

# Design to decrease trunk rotation

**Old version**



***New version***



**\* Changing size length and depth**

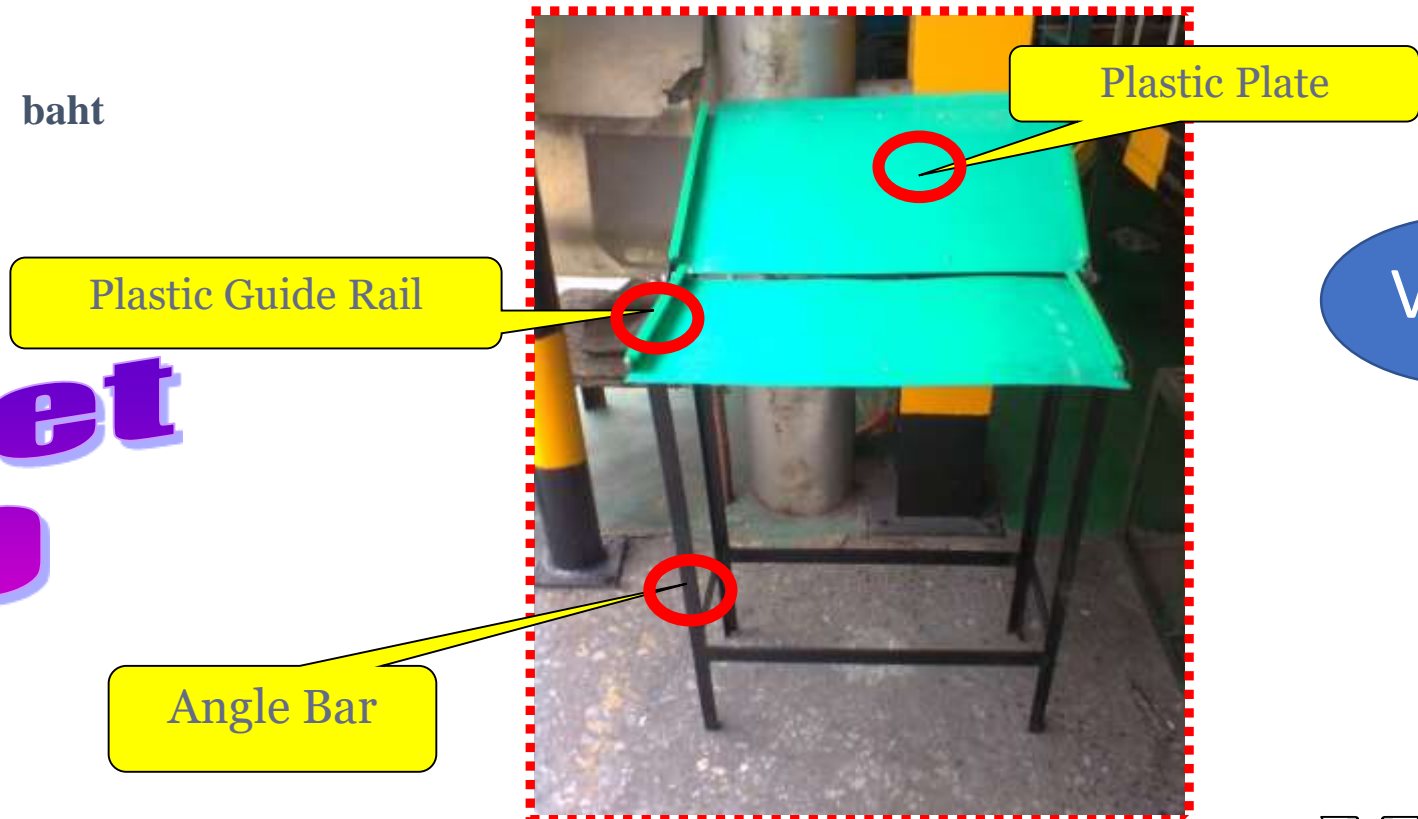
**\*\* Test for weight resistance**

**\*\*\* Change to stronger material and structure**

# Budget for station improvement

1. Guide Rail = **540** baht
2. Angle bar = **570** baht
3. Plastic Plate = **500** baht
4. Work force 4 days = **1,800** baht

**budget**  
**\$100**



VDO2

# Scenario 4 Divider Design



Old version



New



# Comparison btw Old and new

Before



After



VDO3

- Bottles can be easily arranged



# CHECKED RESULTS

## Minute differences

Process	contain	Arrangement	Rotating	Cover tray
Old	45	10	3	2
New	37	0	3	0
Differences	8	10	0	2

❖ Time saver = 20 min



# RULA Employee Assessment Worksheet

Complete this worksheet following the step-by-step procedure below. Keep a copy in the employee's personnel folder for future reference.

### A. Arm & Wrist Analysis

**Step 1: Locate Upper Arm Position**

**Step 1a: Adjust...**

If shoulder is raised: +1;  
If upper arm is abducted: +1;  
If arm is supported or person is leaning: -1

**Final Upper Arm Score = 2**

**Step 2: Locate Lower Arm Position**

**Step 2a: Adjust...**

If arm is working across midline of the body: +1;  
If arm out to side of body: +1

**Final Lower Arm Score = 1**

**Step 3: Locate Wrist Position**

**Step 3a: Adjust...**

If wrist is bent from the midline: +1

**Final Wrist Score = 2**

**Step 4: Wrist Twist**

If wrist is twisted mainly in mid-range = 1;  
If twist at or near end of twisting range = 2

**Wrist Twist Score = 2**

**Step 5: Look-up Posture Score in Table A**

Use values from steps 1,2,3 & 4 to locate Posture Score in table A

**Posture Score A = 2**

**Step 6: Add Muscle Use Score**

If posture mainly static (i.e. held for longer than 1 minute) or;  
If action repeatedly occurs 4 times per minute or more: +1

**Muscle Use Score = 2**

**Step 7: Add Force/load Score**

If load less than 2 kg (intermittent): +0;  
If 2 kg to 10 kg (intermittent): +1;  
If 2 kg to 10 kg (static or repeated): +2;  
If more than 10 kg load or repeated or shocks: +3

**Force/load Score = 0**

**Step 8: Find Row in Table C**

The completed score from the Arm/wrist analysis is used to find the row on Table C

**Final Wrist & Arm Score = 4**

## SCORES

**Table A**

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

**Table B**

Neck	1		2		3		4		5		6	
	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	4	4	5	5	6	6	7	7	7
3	3	3	4	4	5	5	6	6	7	7	7	7
4	5	5	5	6	6	7	7	7	7	8	8	8
5	7	7	7	7	8	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	8	8	8	8	8

**Table C**

1	2		3		4		5		6		7	
	1	2	1	2	1	2	1	2	1	2	1	2
1	1	2	3	3	4	5	5	6	6	7	7	7
2	2	2	3	4	4	5	5	6	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	3	3	3	4	4	5	5	6	6	7	7	7
5	4	4	4	5	5	6	6	7	7	7	7	7
6	4	4	5	6	6	7	7	7	7	7	7	7
7	5	5	5	6	6	7	7	7	7	7	7	7
8	5	5	5	6	6	7	7	7	7	7	7	7

### B. Neck, Trunk & Leg Analysis

**Step 9: Locate Neck Position**

**Step 9a: Adjust...**

If neck is twisted: +1; If neck is side-bending: +1

**Final Neck Score = 3**

**Step 10: Locate Trunk Position**

**Step 10a: Adjust...**

If trunk is twisted: +1; If trunk is side-bending: +1

**Final Trunk Score = 2**

**Step 11: Legs**

If legs & feet supported and balanced: +1;  
If not: +2

**Final Leg Score = 1**

**Trunk Posture Score**

Neck	1		2		3		4		5		6	
	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	4	4	5	5	6	6	7	7	7
3	3	3	4	4	5	5	6	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	8	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	8	8	8	8	8

**Step 12: Look-up Posture Score in Table B**

Use values from steps 8,9,& 10 to locate Posture Score in Table B

**Posture B Score = 3**

**Step 13: Add Muscle Use Score**

If posture mainly static or;  
If action 4/minute or more: +1

**Muscle Use Score = 1**

**Step 14: Add Force/load Score**

If load less than 2 kg (intermittent): +0;  
If 2 kg to 10 kg (intermittent): +1;  
If 2 kg to 10 kg (static or repeated): +2;  
If more than 10 kg load or repeated or shocks: +3

**Force/load Score = 0**

**Step 15: Find Column in Table C**

The completed score from the Neck/Trunk & Leg analysis is used to find the column on Chart C

**Final Neck, Trunk & Leg Score = 4**

**Final Score = 4**

Subject: \_\_\_\_\_ Date: / / \_\_\_\_\_

Company: \_\_\_\_\_ Department: \_\_\_\_\_ Scorer: \_\_\_\_\_

**FINAL SCORE: 1 or 2 = Acceptable; 3 or 4 investigate further; 5 or 6 investigate further and change soon; 7 investigate and change immediately**

Source: McAtamney, L. & Corlett, E.N. (1993) RULA: a survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics* 24(2) 91-99.  
© Professor Alan Hedge, Cornell University, Ithaca, NY, 2001

# RESULTS

## Direct

- Pain decrease in fingers, shoulder, upper and lower back
- Decrease working time (20 min)



## Indirect

- More rest time 20 min/tray
- Decrease work force by 1 manpower/day

Thank you

