Prince of Songkla University
The Faculty of Engineering

Final Examination Semester I **Academic Year: 2005**

Date: Oct 11, 2005 **Time: 13:30 -16:30**

Subject: 226-443/226-454 Ergonomics **Room: A200**

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชานั้น และพักการเรียน 1 ภาคการศึกษา

DIRECTIONS

1. Only short note on an A4 piece (both sides), dictionary and calculator are allowed.
2. 6 questions are given on 8 pages, but only 5 questions must be done.
3. Total score is 100.
4. RULA worksheet is attached as page #8.
5. Please check all questions/ pages before start working.

Good Luck

Asst.Prof.Dr. Angoon Sungkhapong

1. You are assigned to design a VDT (visual display terminal) workstation, what would you like to propose about A) VDT operator's posture, B) necessary equipment, and C) work environment? Clear explanation to support your answer is required. (15 points)

2. An ergonomist described the ergonomic design challenges associated with a trencher (as shown in Figure 1). The machine moves forward, and the operator sits in a position to look in that direction, but the trenching tool is attached to the rear of the machine---see Figure 1. To observe the trenching operation, the operator must rotate trunk and neck nearly 180 degrees---see Figure 3. While all the regular controls to move the vehicle are located, as is common, in front of the operator, the controls for operating the trenching attachment are located to the side---see Figure 2.

   A) Apply RULA to evaluate the operator's posture. [Hint: separate left and right hand and explain clearly for score obtained in each step] (15 points)

   B) What would you like to propose for working improvement? (10 points)

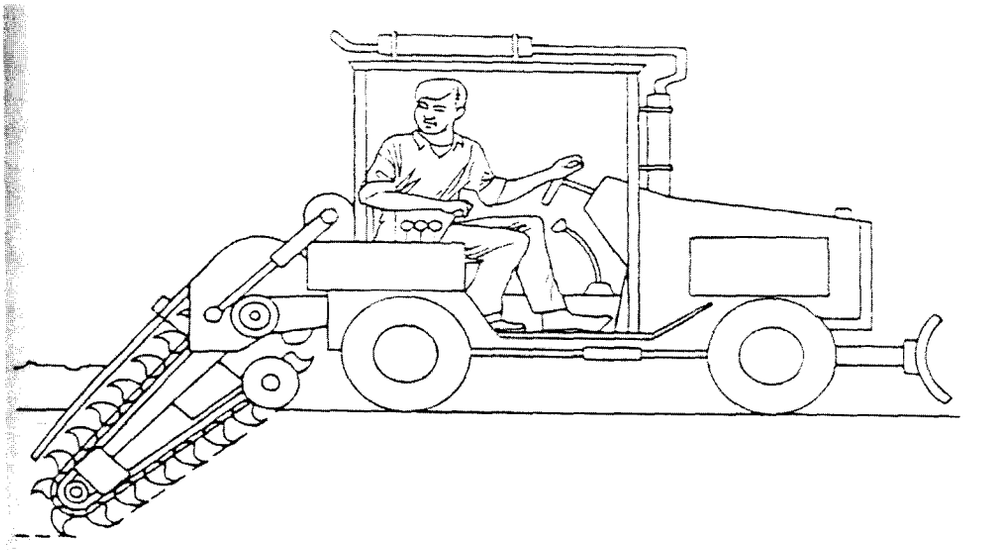

Figure 1: A trencher and working area.

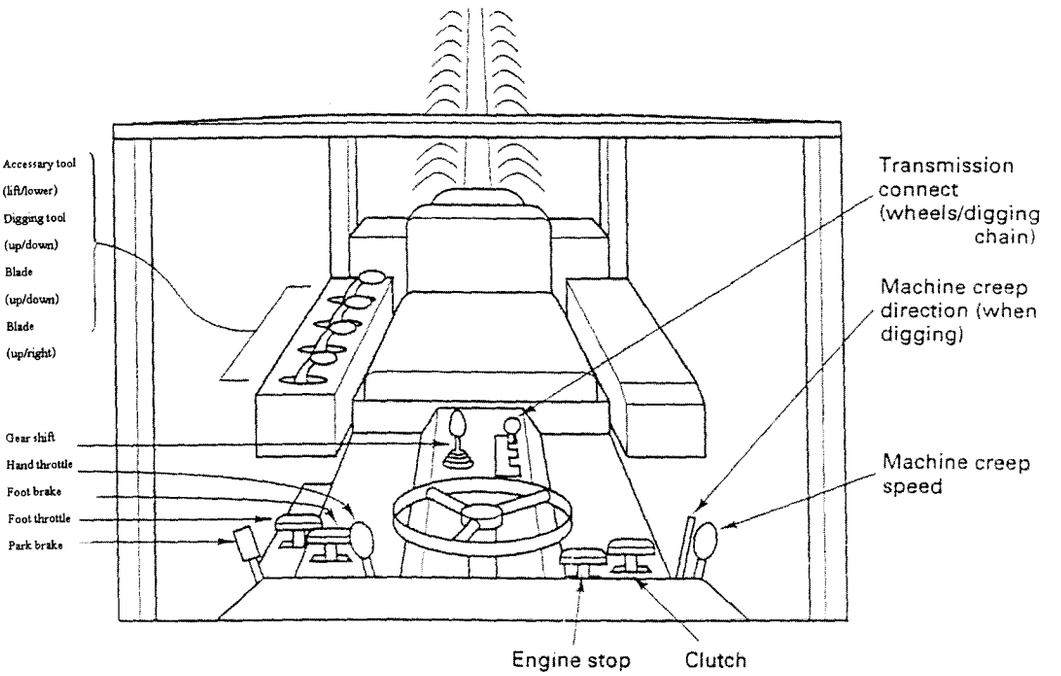

Figure 2: Frontal view of the trencher cab.

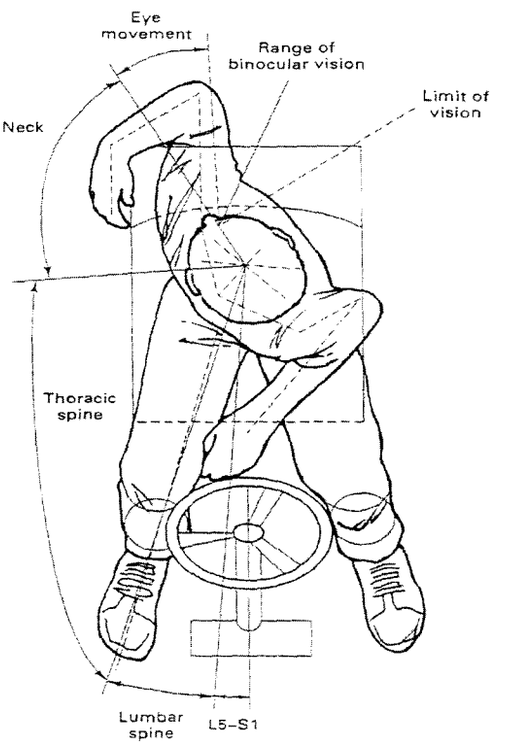

Figure 3: Contorted body posture of the trencher operator looking at the trenching equipment.

3. A 160 lb. man is carrying a 100 lb. material-box in his left hand while standing on his right foot. The center of mass of the box is 10 inches from his center of mass. The direction of the resultant of the hip abductor muscle group acting at the greater trochanter made an angle of 75 degrees with the horizontal. The other dimensions required have been obtained from measurements of x-ray films (shown in Figure 4).

   A) Find the muscle force, the reaction force on the head of the supporting femur and its direction. (15 points)

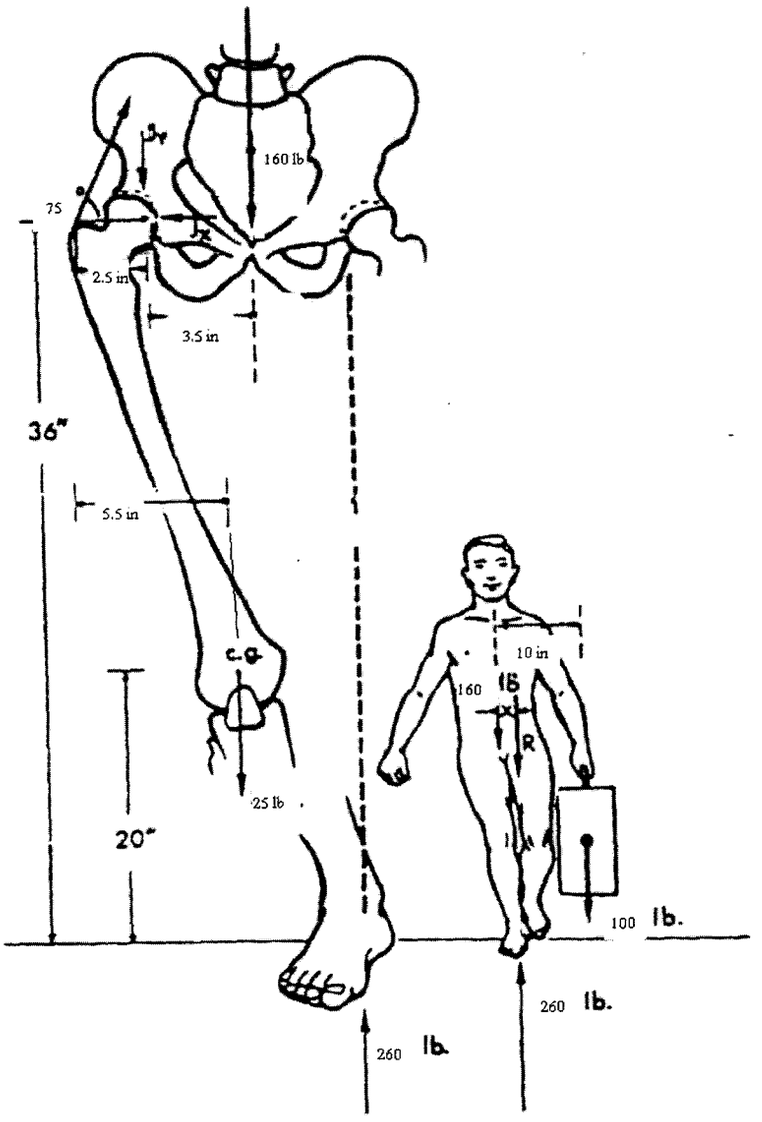

Figure 4: The posture of a man with 100 lb. box in one hand. The dimensions were obtained from measurements of x-ray films.

If he moves half of materials to another box, then now he is carrying 50 lb. in each hand (total weight is 100 lb. in both hands). Again, the other dimensions required have been obtained from measurements of x-ray films (as shown in Figure 5).

B) Find the muscle force, the reaction force on the head of the supporting femur and its direction. (15 points)

C) What is your recommendation on manual handling for occupational safety? (10 points)

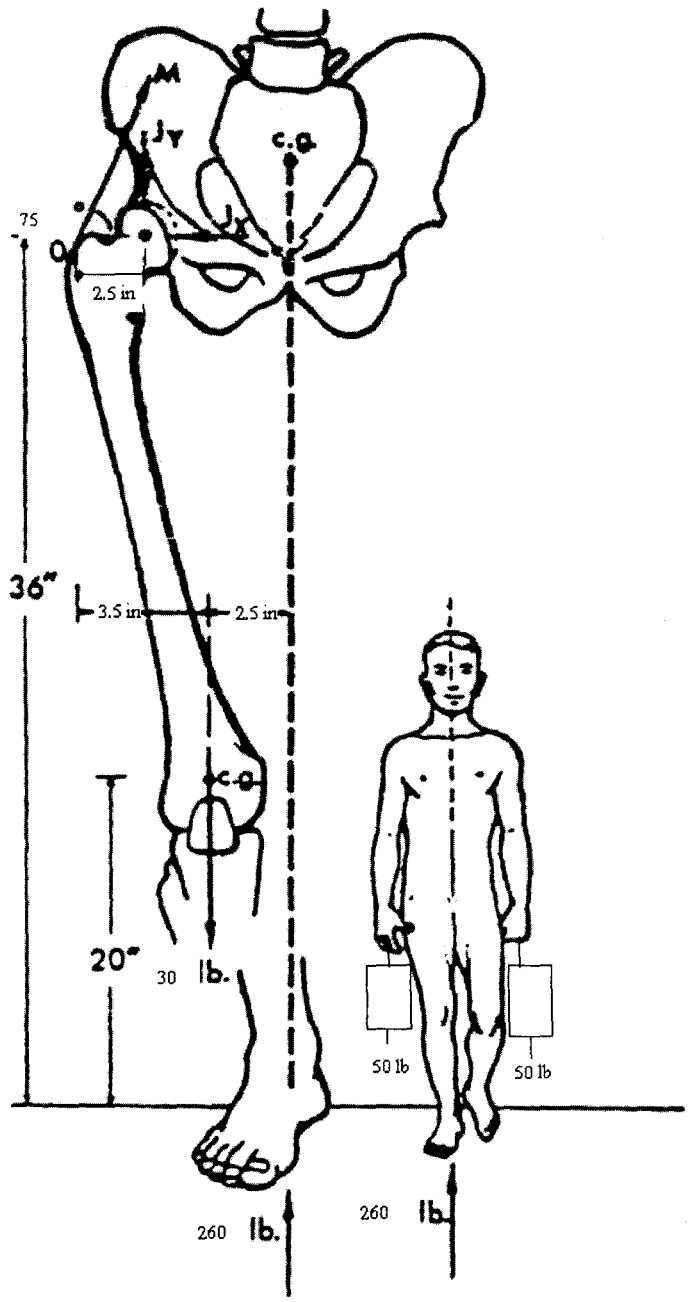

Figure 5: The posture of a man with 50 lb. box in each hand. The dimensions were obtained from measurements of x-ray films.

work efficiency? What is the appropriate time to take the listening check? (10 points)

6. What are the main causes of ergonomic problems of wearing high heel shoes? Explain by using biomechanic concept. (10 points)

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Question 4-6 are related to your term papers. You have the right to pick ***only 2 items (from 3 items)*** and do the best. (total score for 2 items: 20 points)

4. What are the essential ergonomic problems of the operator at a Laminar Airflow Cabinet? How do they apply ergonomic concept for the appropriate design of the Laminar Airflow Cabinet? (10 points)
5. How does noise affect to physical health, occupational safety and work efficiency? What is the appropriate time to take the listening check? (10 points)
6. What are the main causes of ergonomic problems of wearing high heel shoes? Explain by using biomechanic concept. (10 points)

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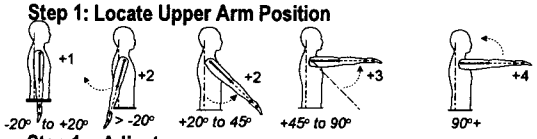
Next page is the RULA worksheet.

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

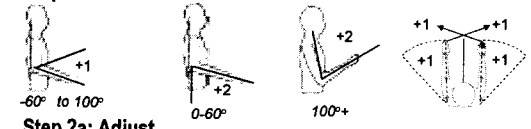
Step 1: Locate Upper Arm Position



Step 1a: Adjust...

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

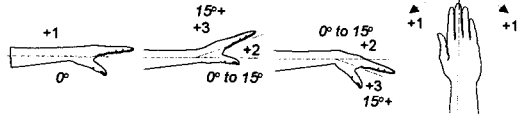
Step 2: Locate LowerArm Position



Step 2a: Adjust...

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

Step 3: Locate Wrist Position



Step 3a: Adjust...

If wrist is bent from the midline: +1

Step 4: Wrist Twist

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

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

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

Step 8: Find Row in Table C

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

SCORES

Final Upper Arm Score = ☐

Final Lower Arm Score = ☐

Final Wrist Score = ☐

Wrist Twist Score = ☐

Posture Score A = ☐ +

Muscle Use Score = ☐ +

Force/load Score = ☐ =

Final Wrist & Arm Score = ☐

Table A

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

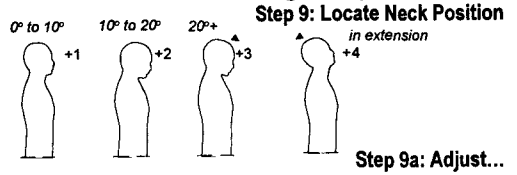
Table C

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

Final Score=

B. Neck, Trunk & Leg Analysis

Step 9: Locate Neck Position

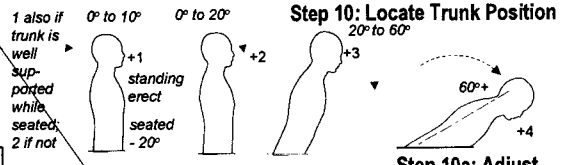


=Final Neck Score ☐

Step 9a: Adjust...

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

Step 10: Locate Trunk Position



= Final Trunk Score ☐

Step 10a: Adjust...

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

Step 11: Legs

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

= Final LegScore ☐

Table B

Trunk Posture Score

Neck	1 Legs 1	1 Legs 2	2 Legs 1	2 Legs 2	3 Legs 1	3 Legs 2	4 Legs 1	4 Legs 2	5 Legs 1	5 Legs 2	6 Legs 1	6 Legs 2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

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 ☐ +

Step 13: Add Muscle Use Score

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

= Muscle Use Score ☐ +

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 ☐ =

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 ☐

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.