Prince of Songkla University

The Faculty of Engineering

Midterm Examination Semester I   **Academic Year: 2009**
Date: Dec 21, 09   **Time:**   **09:30 -12:00**
Subject: 225-540 Human factors for System Design   **Room:**   **R.200**

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชานั้น และพักการเรียน **1** ภาคการศึกษา

DIRECTIONS

1. All materials are allowed for this opened book exam.

2. 5 questions are given on 7 pages and must be done.

3. Total score is 100.

4. Your answers could be in English or Thai.

5. Please check all questions before start working.

Good Luck

Asst.Prof. Angoon Sungkhapong

1. Apply " the system development processes" as discussed in class for " Teaching& Learning system in Department of Industrial Engineering, PSU". [Hint: 6 stages should be explained clearly and the diagram of system should be shown. (20 points)

2. According to Anthropometric data as shown in Table 1, please make some comments on the workstation as shown in Figure 1. Point out the acceptable design and mark on the bad design, and then propose the better design. Some parts could be redesigned or rearranged or removed if necessary. Specify the dimension and height of each important point for improved workstation. A recommended ergonomic chair should be provided. (20 points)
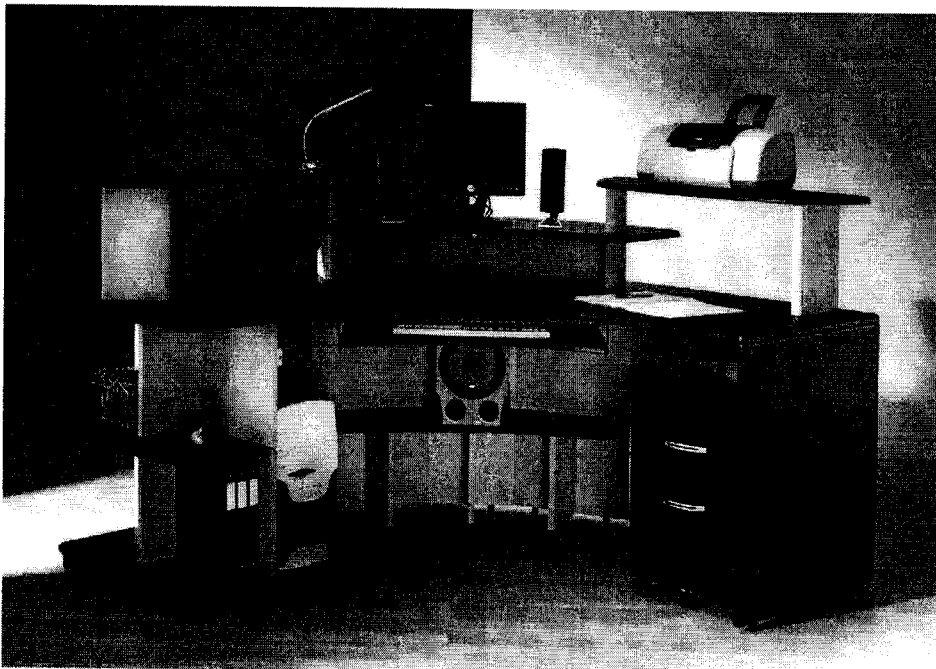

Figure 1: A workstation (for question #2)

Table 1: Anthropometric data (for question #2)

	Dimension[a]	Mean	S.D.	1st percentile	5th percentile	50th percentile	95th percentile	99th percentile
1	Weight (kg)	49.84	7.50	39.99	42.45	48.00	62.00	71.16
2	Stature	156.90	4.85	147.45	149.45	156.62	165.80	168.20
3	Acromion height	129.46	4.58	121.65	123.38	129.10	137.58	140.86
4	Bideltoid breadth	38.43	1.92	33.94	35.74	38.08	41.76	42.41
5	Biceps circumference, flexed	23.94	2.60	20.28	20.35	23.42	28.07	31.31
6	Buttock-popliteal length	45.38	2.14	41.37	42.67	44.77	49.16	50.41
7	Buttock-knee length	55.82	2.64	51.38	52.41	55.33	60.39	63.16
8	Calf circumference	30.15	3.22	25.80	26.38	29.62	35.61	39.08
9	Cervical height	127.57	12.33	83.98	121.77	128.85	136.46	139.87
10	Chest circumference at scye	78.34	5.01	70.44	71.52	76.80	86.83	90.36
11	Elbow to center of grip	32.45	1.60	29.85	30.32	32.30	34.62	37.43
12	Elbow-to-elbow breadth	37.84	3.51	32.85	33.60	36.97	44.35	47.13
13	Elbow-to-elbow length	42.72	1.86	39.83	40.24	42.85	45.29	48.45
14	Face breadth (bi-zygomatic)	12.30	0.65	10.58	11.24	12.27	13.39	13.58
15	Face length (sellion-menton)	11.98	0.65	10.73	10.95	11.87	13.14	13.42
16	Foot breadth	8.76	0.79	7.65	8.03	8.70	9.52	11.37
17	Foot length	22.58	1.14	20.37	20.98	22.47	24.51	25.22
18	Forearm circumference, flexed	20.18	1.62	17.58	17.91	20.18	23.36	24.59
19	Functional reach	69.83	3.15	62.75	64.74	69.97	74.78	75.25
20	Functional reach, extended	79.15	3.98	70.75	73.03	79.05	85.44	85.62
21	Hand breadth	7.25	0.32	6.66	6.78	7.27	7.67	7.97
22	Hand length	16.63	0.72	15.58	15.66	16.43	17.89	18.32
23	Head circumference	53.57	1.48	49.62	50.65	53.92	55.34	55.79
24	Head length	17.24	0.68	15.83	16.20	17.35	18.20	18.37
25	Hip circumference	80.14	5.51	71.41	73.08	79.40	90.92	92.95
26	Kneeling height	118.17	4.18	110.69	111.24	118.03	125.44	127.83
27	Neck circumference (base)	29.41	1.46	27.18	27.55	29.28	31.47	33.20
28	Overhead reach breadth	33.40	2.67	28.77	29.84	32.88	37.92	39.00
29	Overhead reach height	182.26	11.67	142.98	167.95	182.70	197.54	200.67
30	Popliteal height	39.04	2.30	34.56	36.05	38.72	41.72	46.75
31	Shoulder circumference	90.41	14.58	23.77	83.81	92.32	100.46	103.13
32	Shoulder-elbow length	32.97	1.30	30.11	30.74	33.03	35.07	35.40
33	Sitting height	83.07	3.76	72.23	77.54	83.18	88.17	89.54
34	Sitting thigh breadth	34.63	2.60	30.18	31.61	34.55	38.71	42.52
35	Upper thigh circumference	48.41	4.35	41.83	42.54	47.32	54.36	59.94
36	Waist circumference (natural)	66.79	6.68	55.42	59.32	64.80	79.50	85.23
37	Waist back length	39.73	2.63	34.83	35.44	39.45	44.46	45.95
38	Waist front length	33.62	1.98	30.50	30.72	33.60	37.14	37.59
39	Waist height	93.48	4.29	86.70	88.41	93.23	99.93	107.28

[a]Adopted from Intaranont et al. (1991); measured in centimeters.

3. Mr.Teer, a healthy 47-year-old operator, with his body weight of 65 kg, is working in the foundry laboratory. His task is concerning to take the molten- metal by a specific tool from the furnace and then pour it to the given mold as shown in Figure 2. The distance between the furnace and the mold is 0.003 km. This heavy work is carried out in ambient temperatures of   25-27 degree(celcious).   The duration time and frequency of his work are 3 hrs and 4 times/hr, respectively.   The total weight of the molten metal is 29.5 kg. How do you measure his workload?

How do you manage his working schedule for healthy occupation? [Hint: the energy consumption, work load and heart rate should be analyzed on given data and assume if necessary] (20 points)
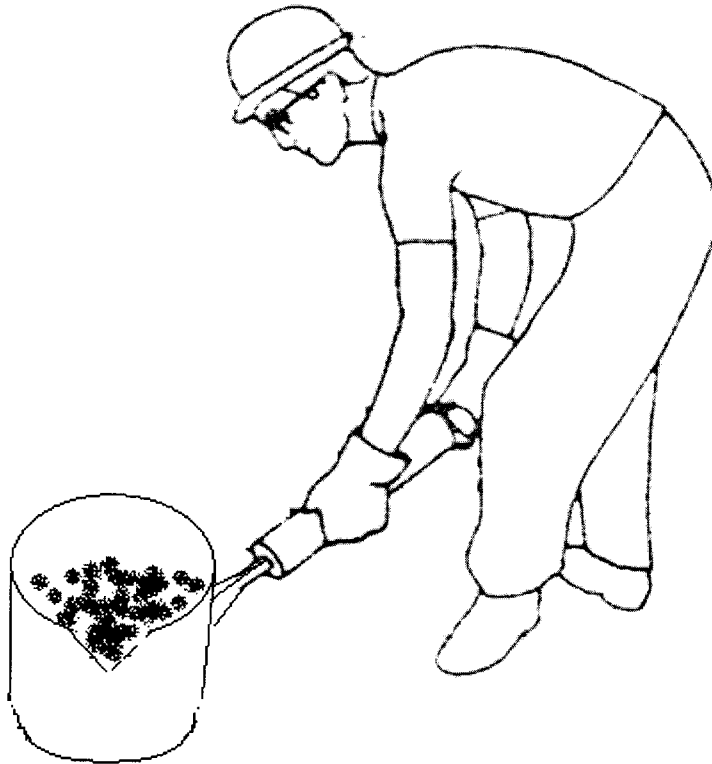
Figure 2: Working position of Mr.Teer. (for question # 3)

4. In a rubber wood manufacturing factory in Songkhla, the production process is shown in Figure 3. It is found that environmental problem is shown in many topics such as noise and dust (in sawing shop) , odor (in chemical compression process), and working position (in sawing shop and QC process). At present condition, the noise in sawing shop comes from the Band-saw machine (เครื่องเลื่อยสายพาน) as shown in Figure 4-5. If you are assigned to solve the noise problem in factory, how would you carry out for the solution? (20 points)

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                              ┌────────────────────────────┐  ⎫
                              │   receiving the lumbers     │  │
                              └────────────────────────────┘  │
                                          │                    │
                                          ▼                    │
Sawing method  ────▶          ┌────────────────────────────┐  ⎬  Sawing Shop
                              │ Changing the lumber size    │  │
                              │        (Sawing)             │  │
                              └────────────────────────────┘  │
                                          │                    │
                                          ▼                    │
                              ┌────────────────────────────┐  │
                              │ Screening (depend on size,  │  │
                              │          shape)             │  ⎭
                              └────────────────────────────┘
                                          │
                                          ▼
                              ┌────────────────────────────┐  ⎫
                              │   Putting on the cabbin     │  │
                              └────────────────────────────┘  │  Chemical
                                          │                    ⎬
                                          ▼                    │  Compression
                              ┌────────────────────────────┐  │
                              │ compression of chemical     │  │
                              │         liquid              │  ⎭
                              └────────────────────────────┘
                                          │
                                          ▼
                              ┌────────────────────────────┐  ⎫
                              │   Leaving in the oven       │  ⎬  Oven
                              └────────────────────────────┘  ⎭
                                          │
                                          ▼
Quality Control ────▶         ┌────────────────────────────┐  ⎫
                              │  Grading the dried-pieces   │  │
                              └────────────────────────────┘  │
                                          │                    │
                                          ▼                    │
                              ┌────────────────────────────┐  │
                              │          Packing            │  │
                              └────────────────────────────┘  │
                                          │                    │
                                          ▼                    │
                              ┌────────────────────────────┐  ⎬  Warehouse
                              │         Inventory           │  │
                              └────────────────────────────┘  │
                                          │                    │
                                          ▼                    │
                              ┌────────────────────────────┐  │
                              │    Loading to the truck     │  │
                              └────────────────────────────┘  │
                                          │                    │
                                          ▼                    │
                              ┌────────────────────────────┐  │
                              │         Delivery            │  ⎭
                              └────────────────────────────┘
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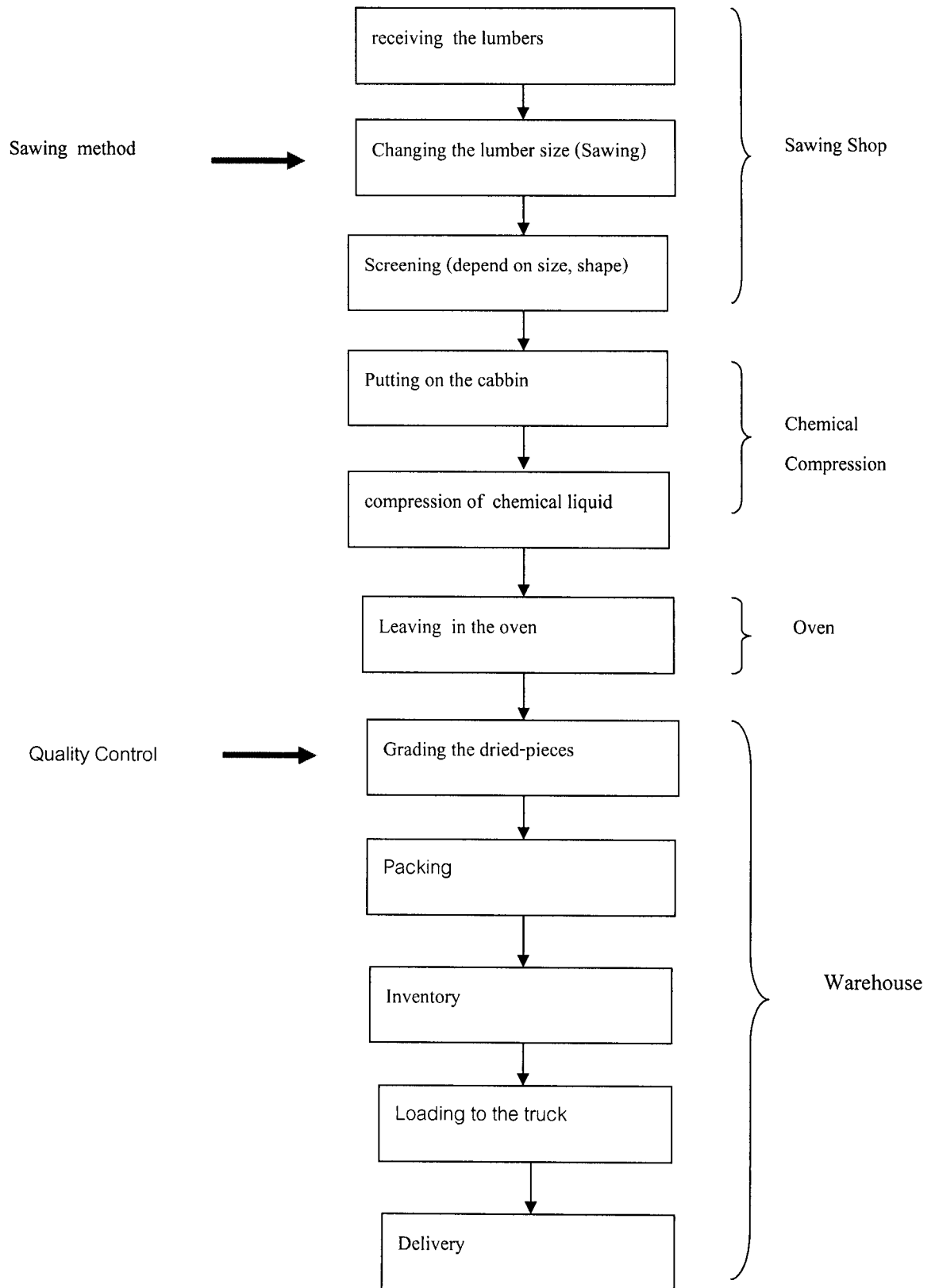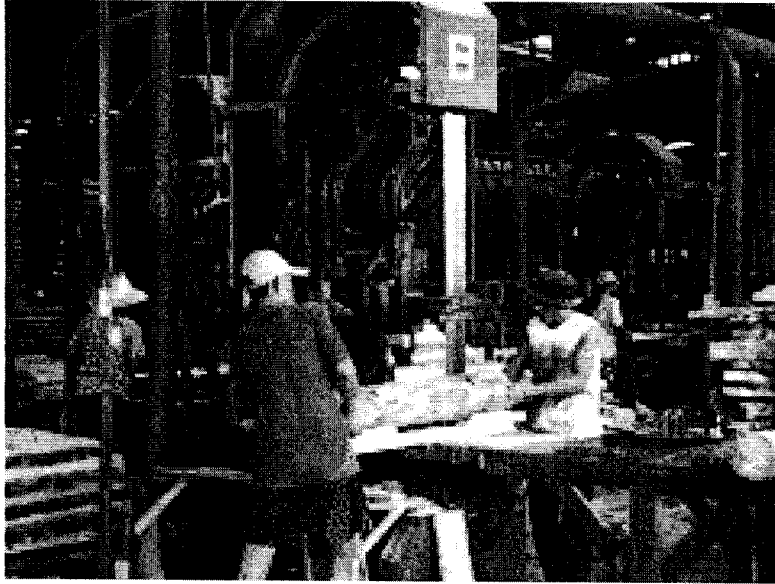
Figure 3: Production process of rubber wood manufacturing

Figure 4: The operators are working on Band-saw Machine. (for Question # 4)

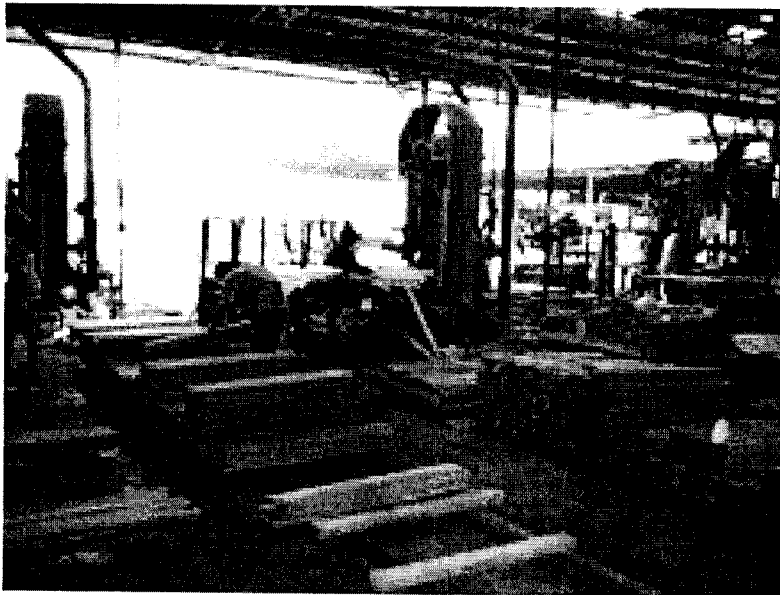

Figure 5: Band-saw Machine in sawing shop. (for Question # 4)

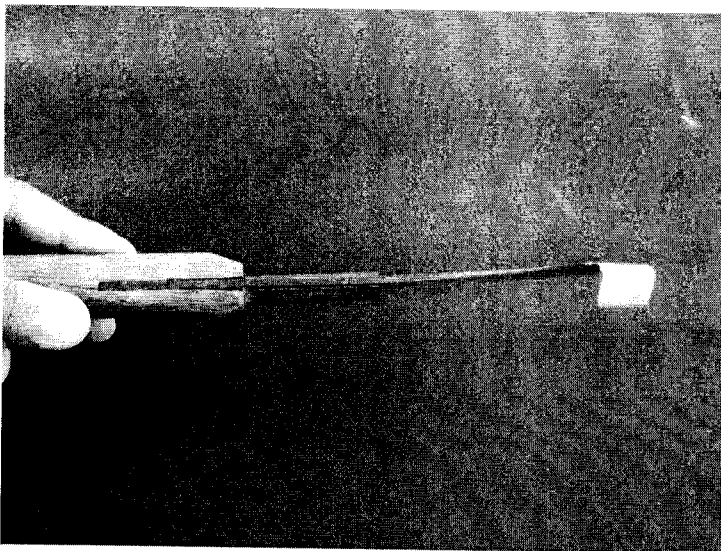Figure 6: Front view of rubber tapping knife. (for Question # 5)

Figure 7: Side view of rubber tapping knife. (for Question # 5)

5. Try to apply the ergonomic design concepts to improve the product [rubber tapping knife (มีดกรีดยาง)] which is shown in Figure 6-7. You should apply all aspects of design, such as, design for serviceability, design for safety, design for usability, environment , and etc. (20 points)

****************************THE END*****************************