

17.4

$$(a) R_p = \frac{D_a}{50 \text{ SH}} = \frac{200,000 \text{ units} \cancel{\text{yr}}}{50 \cancel{\text{wks}} \cdot 5 \cancel{\text{days}} \cdot 2 \cancel{\text{shifts}} \cdot \cancel{\text{hr}}} = 50 \text{ units/hr}$$

$$(b) T_c = \frac{60 E}{R_p} = \frac{60 \times 0.95 \cancel{\text{min}}}{50 \text{ units/hr}} = 1.14 \text{ min/unit}$$

$$(c) W^* \geq \frac{T_{wc}}{T_c} = \frac{35}{1.14} = 30.7 \rightarrow 31 \text{ workers}$$

$$(d) T_s = T_c - T_r = 1.14 - \frac{6}{60} = 1.04$$

$$E_r = \frac{1.04}{1.14} = \frac{E_s}{T_c} = 0.9123$$

$$W \geq \frac{T_{wc}}{E_b T_s} = \frac{35}{0.93 \cdot 1.04}$$

$$= 36.18 \rightarrow 37 \text{ workers}$$

List of elements by precedence columns

element	Te	column
1	0.4	I
2	0.7	II
3	0.5	II
4	0.8	III
5	1.0	III
6	0.2	III
7	0.3	VI
9	0.3	VI
8	0.9	V
10	0.5	VI

Allocation of elements to stations

station	element	Te	ΣTe
1	1	0.4	
	2	0.7	1.1
2	3	0.5	
	4	0.8	1.3
3	5	1.0	
	6	0.2	1.2
4	7	0.3	
	9	0.3	0.6
5	8	0.9	
6	10	0.5	0.5

Total = 5.6 min

HWS-5

(c). Use cycle time of 1.3 min instead of 1.333 min

$$d = \frac{w T_s - T_{wc}}{w T_s} = \frac{6 \times 1.3 - 5.6}{6 \times 1.3} = 28.2\%$$

$$(d) \quad f_p = \frac{1}{T_c} = \frac{1}{1.3} = 0.769 \text{ product/min}$$

$$\bar{s} = \frac{V_c}{f_p} = \frac{1.25 \text{ m/min}}{0.769 \text{ product/min}} = 1.625 \text{ m/product}$$

$$(e) \quad T_t = 1.5 T_c = 1.5 \times 1.3 = 1.95 \text{ min}$$

$$L_s = T_t V_c = 1.95 \text{ min} \times 1.25 \text{ m/min} = 2.44 \text{ m}$$

17.21

(a) same. $W = 5$ workers

Elements by ranked positional weights

Elements ΣT_e RPW

$$1 \quad 3.4 + 0.4 + 0.7 + 0.8 + 0.3 = 5.6$$

$$2 \quad 2.5 + 0.7 + 1.0 + 0.3 = 4.5$$

$$3 \quad 1.9 + 1.0 + 0.5 = 3.4$$

$$4 \quad 0.5 + 0.8 + 0.3 + 0.8 = 2.5$$

$$5 \quad 1.7 + 1.0 = 2.7$$

$$6 \quad 1.7 + 0.2 = 1.9$$

$$7 \quad 0.5 + 0.3 = 0.8$$

$$8 \quad 0.5 + 0.9 = 1.4$$

$$9 \quad 1.4 + 0.3 = 1.7$$

$$10 \quad 0.5$$

elements	T_e	RPW
1	0.4	5.6
2	0.7	4.5
3	0.5	3.4
5	1.0	2.7
4	0.8	2.5
6	0.2	1.9
9	0.3	1.7
8	0.9	1.4
7	0.3	0.8
10	0.5	0.5

17.7

$$R_p = 48 \text{ units/hr}$$

(a)

$$T_c = \frac{60 \times 0.96}{R_p} = \frac{60 E}{R_p} = \frac{60 \times 0.96}{48} = 1.2 \text{ min/ft}$$

$$T_s = T_c - T_r = 1.2 - \frac{3}{60} = 1 - 0.05 = 1.15$$

$$d = 0.07 \quad E_b = 1 - d = 0.93$$

$$M = 1, \quad n = w \geq \frac{T_w c}{E_b T_s} = \frac{20}{0.93 \times 1.15} = 18.7$$

→ 19 workers

$$(b) \text{ Use } T_t = 1.5 T_c = 1.5 \times 1.2 = 1.8 \text{ min/section}$$

$$T_t = \frac{L_s}{N_c} \quad N_c = \frac{L_s}{T_t} = \frac{5 \text{ ft/section}}{1.8 \text{ min/section}} = 2.778 \text{ ft/min}$$

$$T_c = \frac{S_p}{N_c} \quad S_p = T_c N_c = 1.2 \text{ min/pc} \times 2.778 \text{ ft/min} = 3.33 \text{ ft/pc}$$

17.20

(a) $R_p = 300 \text{ pc/day}$

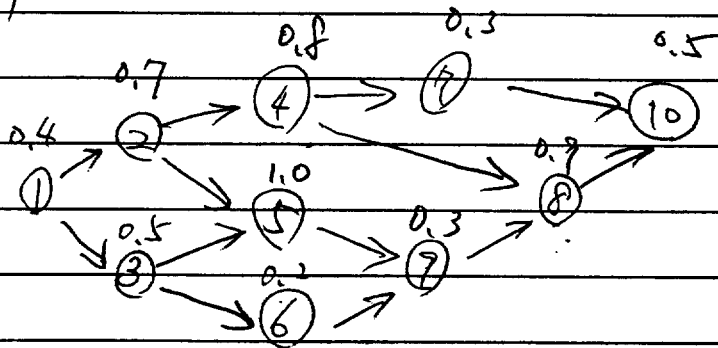
$$T_c = \frac{400 \text{ min/day}}{300 \text{ product/day}} = 1.333 \text{ min/product}$$

assuming $T_r = 0$

$$T_{wc} = \sum_{k=1}^{10} T_{ek} = 0.4 + 0.7 + \dots + 0.5 = 5.6 \text{ min.}$$

$$W \geq \frac{T_{wc}}{T_c} = \frac{5.6}{1.333} = 4.2 \rightarrow W = 5 \text{ workers}$$

(b)



I II III IV V VI

HW 5-7

Station	element	T_e	ΣT_e
1	1	0.4	
	2	0.7	1.1
2	3	0.5	
	4	0.8	1.3
3	5	1.0	
	6	0.2	1.2
4	9	0.3	
	8	0.9	1.2
5	7	0.3	
	10	0.5	0.8

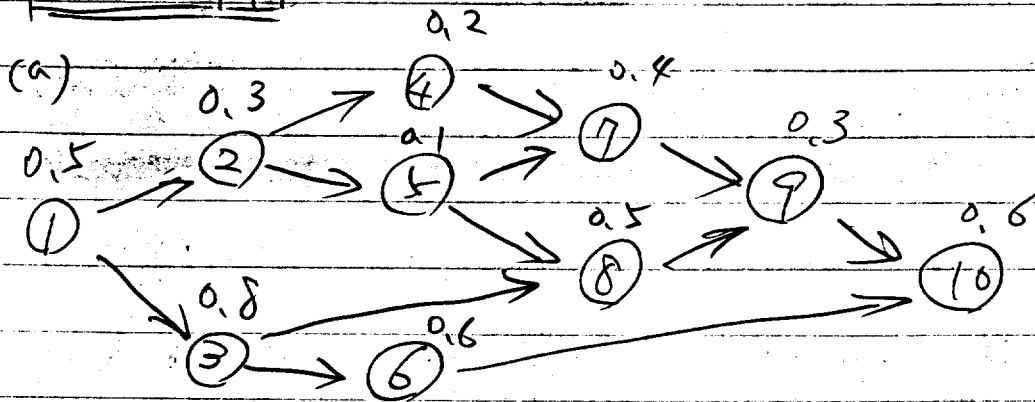
5.6 min total

(c) Use cycle time of 1.3 min instead of 1.333 min

$$d = \frac{5 \times 1.3 - 5.6}{5 \times 1.3} = 13.8\%$$

(d) Same $S_p = 1.625$ m/product

(e) same $L_s = 2.44$ m.

problem 17.17

$$(b) T_{wc} = \sum T_{ej} = 0.5 + 0.3 + 0.8 + 0.2 + \dots + 0.6 = 4.3$$

$$T_g = 1.0 = T_c - T_r = 1.1 - 0.1$$

$$n \geq \frac{T_{wc}}{T_c} = 4.3 \quad n = 5 \text{ stations}$$

$$(c) \quad d = \frac{n \times T_c - T_{wc}}{n \times T_c} = \frac{5 \times 1 - 4.3}{5 \times 1} = \frac{0.7}{5} = 0.14 = 14\%$$

LWT-9

element	Te	predecessors
3	0.8	1
6	0.6	3
10	0.6	6, 9
1	0.5	-
8	0.5	3, 5
7	0.4	4, 5
2	0.3	1
9	0.3	7, 8
4	0.2	2
5	0.1	2

Station	element	Te	ΣTe
1	1	0.5	
	2	0.3	
	4	0.2	1.0
2	3	0.8	
	5	0.1	0.9
3	6	0.6	
	7	0.4	1.0
4	8	0.5	
	9	0.3	0.8
5	10	0.6	0.6

4.3 min.

problem 19.13

$$n = 1 \quad R_p = 400 \text{ ass/hr} \quad T_d = 2.5 \text{ min}$$

$$F = \frac{1}{50} = 0.02 \quad \theta = 0.2 = \frac{1}{5}$$

$$T_p = \frac{1}{R_p} = \frac{60 \text{ min/hr}}{400 \text{ ass/hr}} = 0.15 \text{ min/ass}$$

$$T_c = T_p - F T_d = 0.15 - 0.02(2.5) = 0.1 \text{ min}$$

$$f \theta \geq R_c = \frac{1}{0.1} = 10 \text{ pc/min}$$

$$f \cdot 0.2 \geq 10 \text{ pc/min}$$

$$f \geq 50 \text{ comp/min}$$

problem 19.4

$$n = 6 \quad T_c = \overset{\downarrow \text{max}}{6} + 2 = 8 \text{ sec} = 0.1333 \text{ min}$$

$$T_d = 1.5 \text{ min}$$

$$T_p = T_c + \sum m_i f_i T_d$$

$$= 0.1333 + (0.6 \times 0.015 + 0.01 \times 0.8 + 0.02 \times 1.0 + 0.01 \times 0.5) \times 1.5$$

$$= 0.1333 + 0.042 \times 1.5 = 0.19635 \frac{\text{min}}{\text{ass}}$$

$$(a) R_p = \frac{60}{0.19633} = 305.6 \text{ assembly/hr}$$

$$(b) P_{ap} = \overset{-0.015}{(1 + 0.015 \times 0.6)} \overset{-0.01}{(1 + 0.01 \times 0.8)} \\ (1 + 0.03 \times 1.0) (1 + 0.01 \times 0.5) \\ = 0.994 \times 0.998 \times 1.0 \times 0.995 \\ = 0.98705$$

$$(c) E = \frac{0.1333}{0.19633} = \frac{T_c}{T_p} = 67.9\%$$

problem 7.9

$$n = 8, \quad T_c = 10 \text{ sec} = 0.1667 \text{ min.}$$

$$f = 0.01, \quad T_d = 3 \text{ min}$$

$$m = 0.6$$

$$C_L = \$90/h, \quad C_m = \$0.6/\text{unit.}$$

$$a) \quad P_{ab} = (1 - f + f m)^8 = (0.996)^8 = 0.9684$$

$$b) \quad T_p = T_c + n f m T_d$$

$$= 0.1667 + 8 \times 0.01 \times 0.6 \times 3 = 0.31066 \text{ min.}$$

$$R_p = \frac{1}{T_p} = \frac{60}{0.31066} = 193.1 \text{ unit/hr}$$

$$R_{ap} = \frac{(1 - 0.01 + 0.01 \times 0.6)^8}{T_p} = \frac{(1 - f + f m)^8}{T_p}$$

$$= \frac{(0.996)^8}{T_p} = 0.9684 \times 193.1$$

$$= 187.01 \text{ good units/hr}$$

$$c) \quad P_{fp} = 1 - 0.9684 = 0.0316 = 3.16\%$$

$$d) \quad C_{pc} = \frac{C_m + C_L T_p + \cancel{C_r}}{(1 - f + m f)^n} \quad \begin{matrix} \nearrow \text{ignore} \\ \end{matrix}$$

$$= \frac{[0.6 + 90 \times 0.31066]}{0.9684}$$

$$= \frac{1.066}{0.9684} = \$1.1007/\text{unit}$$

dial index : floor ?

HWS-13

problem 19.15

$$n = 6, \quad T_d = 2 \text{ min.}$$

$$T_c = 7 + 2 = 9 \text{ sec.} = 0.15 \text{ min.}$$

$$R_c = \frac{1}{T_c} = 6.667 \text{ cycles/min.}$$

$$(a) \quad \Sigma m_j = 1 \times 0.01 + 0.6 \times 0.05 + 1 \times 0.02 + 0.7 \times 0.01 = 0.04$$

$$T_p = 0.15 + 0.04(2) = 0.23 \text{ min.}$$

$$R_p = \frac{6.0}{0.23} = 260.9 \text{ ass/hr.}$$

$$(b) \quad R_{ap} = (1 - 0.01 + 1 \times 0.01) \cdot (1 - 0.05 + 0.6 \times 0.05) \\ (1 - 0.02 + 1 \times 0.02) (1 - 0.01 + 0.7 \times 0.01) \\ = 1 \times 0.998 \times 1 \times 0.997 = 0.995$$

$$R_{ap} = 260.9 \times 0.995 = 259.6 \text{ good ass/hr.}$$

$$(c) \quad \text{Station 2: } f_0 = 32(0.25) = 8 \text{ PC/min} \\ 3: f_0 = 20 \times 0.5 = 10 \text{ PC/min} \\ 4: f_0 = 20 \times 0.2 = 4 \text{ PC/min} \\ 5: f_0 = 15 \times 1.0 = 15 \text{ PC/min}$$

problem: machine cycle time $R_c = 6.667 \text{ cycles/min}$
 $> f_{04} = 4 \text{ PC/min.}$

$$\text{If } R_c = 4 \text{ PC/min} \Rightarrow -$$

HWS-44

$$(d) \quad T_c = \frac{1}{4} \text{ min/PC} = 0.25 \text{ min}$$

$$T_p = 0.25 + \underset{\substack{\uparrow \\ \text{avg}}}{0.04(2)} = 0.33 \text{ min.}$$

$$R_p = \frac{60}{T_p} = \frac{60}{0.33} = 181.8 \text{ ass/hr.}$$

$$R_{ap} = 181.8 (0.995) = 180.9 \text{ good ass/hr.}$$