ME 355 Winter 2000

H.W. Set #1 Solutions

5.11 (a)

$$F = \sum P_i = \frac{22+31+47+8+58+21}{2000} = 0.12$$

$$T_p = T_c + FT_d = (1.10+0.15) + (0.125)(7.0)$$

$$= 2.125 \text{ min} = 0.03542 \text{ hours}$$

$$R_p = \frac{1}{T_p} = 28.2 \text{ hr}$$

(b)

$$E = \frac{T_c}{T_c + FT_d} = \frac{1.25}{2.125} = 58.8\%$$

$$D = \frac{FT_d}{T_c + FT_d} = \frac{0.875}{2.125} = 41.2\%$$

(c) No. of hours $= \frac{2000}{28.2} = 70.8$ hr

.12

(a)

$$\frac{2000}{1-F} = \frac{2000}{1-0.1} = 2,222 \text{ pieces}$$

(b)

$$2222 - 2000 = 222 \text{ pieces}$$

(c)

$$T_p = T_c + FT_d = (1.10+0.15) + (0.1)(7.0)$$

$$= 1.95 \text{ min} = 0.0325 \text{ hr}$$

$$R_p = \frac{1-F}{T_p} = \frac{1-0.1}{0.0325} = 27.69 \text{ pieces/hr}$$

$$\frac{2000}{27.69} = 72.2 \text{ hr}$$

5.13

(a) $T_c = 1.25 + \frac{6}{60} = 1.35$ min

$F = \frac{246}{1689} = 0.1456$

$T_d = \frac{42}{246} = 0.1707$ hr $= 10.24$ min

$E = \frac{T_c}{T_c + FT_d} = \frac{1.35}{1.35 + (0.1456)(10.24)} = 47.5\%$

$T_p = T_c + FT_d = 1.35 + (0.1456)(10.24) = 2.84$ min

$R_p = \frac{1}{2.84/60} = 21.11$ pieces/hr

(b) For stage 1:

$T_c = 1.35$ min

$F = \frac{96}{1689} = 0.0568$

$E = \frac{T_c}{T_c + FT_d} = \frac{1.35}{1.35 + (0.0569)(10.24 \times 0.75)}$

$= 75.5\%$

$T_p = T_c + FT_d = 1.787$ min $= 0.0298$ hr

$R_p = \frac{1}{T_p} = 33.56$ pieces/hr

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5.13 (b) Continue

For stage 2:

$$T_c = 0.90 + \frac{6}{60} = 1.0 \text{ min}$$

$$F = \frac{150}{246} = 0.0888$$

$$E = \frac{1.0}{1.0 + (0.0888)(10.24 \times 0.75)} = 59.5\%$$

$$T_p = 1.0 + 0.0888\,(10.24 \times 0.75) = 1.682 \text{ min}$$
$$= 0.02803 \text{ h}$$

$$R_p = \frac{1}{0.02803} = 35.68 \text{ pieces/h}$$

Assume infinite buffer capacity. The line efficiency and line production rate should be the lower values of the two stages, i.e.

line efficiency $= 59.5\%$

line production rate $= 33.56$ pieces/h

5.16

For the present operation, i.e. manual workstations and manual flow line, the unit cost is

$$C_{pc} = C_m + C_L T_p + C_t$$

where $C_L = n_a \underbrace{\cancel{C_{as}}}_{0} + n_o C_o + \underbrace{\cancel{C_{at}}}_{0} = n_o C_o$

$$T_p = T_c + \underbrace{\cancel{F T_d}}_{0} = T_c = 1.2 \text{ min}$$

Ignores the material and tooling costs, then

$$C_{pc} = (6 \times 0.20)(1.2) = 1.44/pc$$

Proposal 1: Mechanizing the flow line

$$C_L = n_o C_o + C_{at} = 6 \times 0.20 + 0.10 = 1.30$$

$$T_p = T_c = 1.0 \text{ min}$$

$$C_{pc} = (1.30)(1.0) = 1.30/pc$$

Proposal 2: Mechanizing and flow line and automating some of the workstations on the line

First, we should realize that in this proposal of automating workstations, all the workstations must be automated if this proposal is to be feasible at all because the cycle time of the line is not reduced if some of the workstations are still manually operated.

If all the workstations are automated,

$$C_L = n_a C_{as} + \cancel{n_o} C_o + C_{at} = 6 \times 0.25 + 0.1 = 1.6$$

$$\cancel{n_o} \to 0$$

$$T_p = T_c + F T_d = \frac{20}{60} + (0.01 + 0.02 + 0.03 + 0.04 + 0.05 + 0.06)(3.0)$$

$$= 0.963 \text{ min}$$

$$C_{pc} = C_L T_p = 1.6 \times 0.963 = 1.54/pc$$

The first proposal is acceptable because it reduces C_{pc} from \$1.44/pc to \$1.30/pc. However, the second proposal is not acceptable.

5.24

For the 20-station line,

$$E = \frac{T_c}{T_c + F T_d} = \frac{48/60}{\frac{48}{60} + F(3.0)} = 0.4$$

$$F = 0.4$$

Since $F = np = 20p$, the probability of station breakdown is $p = 0.02$

$$C_{pc} = \cancel{C_m} + C_L T_p + \cancel{C_t}$$

$$\cancel{C_m} \to 0, \quad \cancel{C_t} \to 0$$

$$= C_L T_p$$

$$T_p = \frac{T_c}{E} = \frac{0.8}{0.4} = 2 \text{ min}$$

$$C_L = C_{pc}/T_p = 4.0/2 = 2.0/\text{min}$$

For the 2-stage line, each stage having 10 stations,

$$E = E_0 + D_1' \, h(b) \, E_2$$

$$E_0 = \frac{T_c}{T_c + F_1 T_{d1} + F_2 T_{d2}} = \frac{0.8}{0.8 + (10 \times 0.02)(3) + (10 \times 0.02)(3)}$$

$$= 40\%$$

$$D_1' = \frac{F_1 T_{d1}}{T_c + F_1 T_{d1} + F_2 T_{d2}} = \frac{0.6}{2.0} = 0.3$$

$$E_2 = \frac{T_c}{T_c + F_2 T_{d2}} = \frac{0.8}{0.8 + 0.6} = 0.5714$$

To find $h(b)$, note that

$$b = B \frac{T_d}{T_c} + L$$

$$15 = B\left(\frac{3}{0.8}\right) + L$$

$$B = 4, \quad L = 0$$

thus $$h(b) = \frac{B}{B+1} + L \frac{T_c}{T_d} \frac{1}{(B+1)(B+2)}$$

$$= 0.8$$

$$E = 0.4 + 0.3 \times 0.8 \times 0.5714 = 0.537$$

$$T_p = \frac{T_c}{E} = \frac{0.8}{0.537} = 1.49$$

$C_{pc} = C_L T_p = 2 \times 1.49 = 2.98$ (if not considering the buffer cost)

For the storage buffer to pay for itself in one year without considering interest rate,

$4.0\,Q = 2.98\,Q + 14000$, $Q = 13725$ pieces