Problems

(20) 1. Consider the technical papers and PPT presentations in class to arrive at the T/F answer for the following:

a. The Opitz classification number for this part is 15120.  T___ F_X_

b. A Flexible Manufacturing System consists of 3 or more workstations connected by common part handling system and distributed computer system.  T___ F_X__

c. To minimize WIP inventories, batch size and setup time must be minimized. T_X__ F___

d. In the paper on dynamic scheduling the machine utilization numbers were low. T_X__ F___

e. A paper considered the impact of interruptions on schedule execution. It concluded that bottleneck stations downstream of the interruption provide the worst disruption. T___ F_X__

f. In an FMS analysis, a server is the central computer that downloads the process. T___ F_X__

g. In FMS bottleneck analysis, \( f_{ijk} \) (operation frequency) can never be greater than 1. T___ F_X__

h. The bottleneck model can be used to calculate the number of server at each station to achieve a certain production rate. T_X__ F___

i. A perfect just-in-time system with no delays between stations will always have WIP. T_X__ F___

j. A Kanban system is a pull system of inventory control. T_X__ F___

(40) 2. You worked problem 16.4 as a class HW assignment. You are now to increase the utilization of the two non-bottleneck machining stations in the FMS by introducing a new part (part E) into the part mix. Part E is to be produced at 2 units/hr. What would be the ideal process routing (sequence and process times) for part E that would increase the utilization of the two non-bottleneck machining stations to 100% each? The respective production rates of parts A, B, C, and D will remain the same as in problem 16.4. Disregard the utilizations of the load/unload stations and the part handling system.

Solution to (16.4):

\[
\begin{align*}
WL_1 &= (4+3)(0.2)(1.0) + (4+3)(0.2)(1.0) + (4+3)(0.25)(1.0) + (4+3)(0.35)(1.0) = 7.0 \text{ min.} \\
WL_2 &= 15(0.2)(1.0) + 16(0.2)(1.0) + 10(0.25)(1.0) = 8.7 \text{ min.} \\
WL_3 &= 14(0.2)(1.0) + 11(0.2)(1.0) + 18(0.35)(1.0) = 11.3 \text{ min.} \\
WL_4 &= 13(0.2)(1.0) + (12+17)(0.2)(1.0) + 9(0.25)(1.0) + 8(0.35)(1.0) = 13.45 \text{ min.} \\
n_i &= 4(0.2) + 5(0.2) + 3(0.25) + 3(0.35) = 3.6, \ WL_5 = 3.6(3.5) = 12.6 \text{ min.}
\end{align*}
\]

<table>
<thead>
<tr>
<th>Station</th>
<th>WL/s_i ratio</th>
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<tbody>
<tr>
<td>1 (load/unload)</td>
<td>7.0/2 = 3.5 min</td>
</tr>
<tr>
<td>2 (drill)</td>
<td>8.7/2 = 4.35 min</td>
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</table>
3 (H. mill) \[ \frac{11.3}{3} = 3.76 \text{ min.} \]
4 (V. mill) \[ \frac{13.45}{2} = 6.725 \]
5 (material handling) \[ \frac{12.6}{3} = 4.2 \text{ min.} \]

(a) Bottleneck = station 4: \( R_p^* = \frac{2}{13.45} = 0.1487 \text{ pc/min} = 8.92 \text{ pc/hr} \)

(b) \[ U_1 = \frac{(7.0/2)(0. 1487)}{2} = 0.52 = 52\% \]
\[ U_2 = \frac{(8.7/2)(0. 1487)}{2} = 0.647 = 64.7\% \]
\[ U_3 = \frac{(11.3/3)(0. 1487)}{2} = 0.56 = 56\% \]
\[ U_4 = \frac{(13.45/2)(0. 1487)}{2} = 1.00 = 100\% \]
\[ U_5 = \frac{(12.6/3)(0. 1487)}{2} = 0.624 = 62.4\% \]

(c) \[ U_s = \frac{2(0.52) + 2(0.647) + 3(0.56) + 2(1.0)}{9} = 0.666 = 66.6\% \]

**Solution to exam problem:**

Likely process routing for part E would be \( 1 \rightarrow 2 \rightarrow 3 \rightarrow 1 \)

**Consider station 2:**

Let \( U_2 = 90\% \) so that \( U_2 = \frac{WL_2 (0. 1487)}{2} = 0.9 \)

Current \( WL_2 = 8.7 \text{ min.} \); thus, \( \Delta WL_2 = 12.10 - 8.7 = 3.4 \text{ min.} \)

\( R_{pE} = 2 \text{ pc/hr, so total } R_{p*} = 8.92 + 2 = 10.92 \text{ pc/hr.} \)

\( p_E = 2/10.92 = 0.183 \) (part mix for E)

\( \Delta WL_2(E) = 3.4 \text{ min.} = t_{12E2}(1.0)(0.183) \)

Ideal process time \( t_{12E2} = 3.4/0.183 = 18.59 \text{ min.} \) (time to process E at station 2 – H Mill)

**Consider station 3:**

Let \( U_3 = 90\% \) so that \( U_3 = \frac{WL_3 (0. 1487)}{3} = 0.9 \)

Current \( WL_3 = 11.3 \text{ min.} \); thus, \( \Delta WL_3(E) = 18.157 - 11.3 = 6.857 \text{ min.} \)

From the computation above, \( p_E = 0.183 \)

6.857 min. = \( t_{3E3}(1.0)(0.183) \)

Ideal process time \( t_{3E3} = 4.69/0.1579 = 37.47 \text{ min.} \)

**New part mix fractions:**

\[ p_A = \frac{(8.92/10.92)(0.2)}{2} = 0.163 \]
\[ p_B = \frac{(8.92/10.92)(0.2)}{2} = 0.163 \]
\[ p_C = \frac{(8.92/10.92)(0.25)}{2} = 0.264 \]
\[ p_D = \frac{(8.927/10.92)(0.35)}{2} = 0.285 \]
\[ p_E = 0.1579 \] as calculated above.

**Grading:**

1. 1 to 2 to 3 to 1 acceptable \hspace{1cm} 10 pts
   1 to 3 to 2 to 1 also acceptable
2. Compute new workloads \hspace{1cm} 5 pts
3. Compute new E part mix \hspace{1cm} 5 pts
4. Compute E processing time at St 2 \hspace{1cm} 10 pts
5. Compute E processing time at St 3 \hspace{1cm} 10 pts
A variety of assembled products are made in batches on a batch model assembly line. Every time a different product is produced, the line must be changed over, which causes lost production time. The assembled product of interest here has an annual demand of 12,000 units. The changeover time to set up the line for this product is 6.0 hr. The company figures that the hourly rate for lost production time on the line due to changeovers is $200/hr. Annual holding cost for the product is $7.00/product. The product is currently made in batches of 1000 units for shipment each month to the wholesale distributor. (a) Determine the total annual inventory cost for this product in batch sizes of 1000 units. (b) Determine the economic batch quantity for this product. (c) How often would shipments be made using this EOQ? (d) How much would the company save in annual inventory costs if it produced batches equal to the EOQ rather than 1000 units?

**Solution:**

a) At \( Q = 1000 \), TIC (total inventory costs) = \( (7)(1000)/2 + (200)(6)(12,000)/1000 = $17,900 \)/yr

b) EOQ (economic order quantity) = \( \sqrt{2(12,000)(200)(6)/7} = 2028 \) pieces

c) Using this EOQ, the number of batches per year = 12,000/2028 = 5.92, and the cycle time per batch = 2.028 months (shipped every 2.028 months)

d) At EOQ = 2028, TIC = \( (7)(2028)/2 + (200)(6)(12,000)/2028 = $14,198.59 \)/yr

Savings = $17,900 - $14,199 = $3701

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<tr>
<td>2. Compute EOQ</td>
<td>10 pts</td>
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<tr>
<td>3. Compute new batch size</td>
<td>5 pts</td>
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<tr>
<td>4. Compute batch delivery time</td>
<td>5 pts</td>
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<tr>
<td>5. Compute savings</td>
<td>5 pts</td>
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