ICA 13: Capacity Analysis

ISE 453: Design of PLS Systems **Fall 2018**

This ICA has five questions. Questions 1, 2, and 4 should be submitted.

$$t_e = \frac{t_0}{A}, \quad A = \frac{MTTF}{MTTF + MTTR}, \quad r_e = \frac{m}{t_e}, \quad m_{\min} = \lfloor r_a t_e + 1 \rfloor, \quad u = \frac{r_a}{r_e} = \frac{r_a t_e}{m}$$

$$r_{a,1} = \frac{r_{d,n}}{Y_n}, Y_i = \prod_{j=1}^{i} y_j, \quad r_a t_0 H \text{ (processing)}, r_a \left(t_e - t_0\right) H \text{ (repair)}, \left(m - r_a t_e\right) H \text{ (idle)}$$

1. Compute the capacity (i.e., service rate) for a workstation with 12 machines in parallel, each having a natural mean process time of two hours. The machines have a mean time to failure of 80 hours with a mean time to repair of four hours.

2. Given a desired output rate of 90 nondefective units per hour from a workstation, a yield fraction of 0.9, a natural process time of 2.16 minutes, where the standard deviation of the natural process time is 1.12 minutes, and machines that have a mean time to failure of 45 hours with a mean time to repair of 5 hours, what is the minimum number of machines that would be required at the workstation?

3. You are asked to design a workstation that will manufacture mirror doors for cabinets. You expect the annual demand for your doors to be around 150,000 units. Based on your time-motion studies, you estimate that each door requires, on average, three minutes of processing time on the clamp machine. The workstation will operate for eight hours per day, five days a week, fifty weeks per year. (Note: Unless otherwise stated, each of the questions below is an extension of the question immediately preceding it.)

   a) What is the minimum number of machines required at a workstation if only a single type of door were to be produced and the cost of holding the doors as finished goods inventory until they are ordered is insignificant?

   b) What would be the impact on the number the machines required if the machines fail after 25 hours of operation, on average, and require five hours to repair, on average?

   c) What would be the impact on the number of machines required if, on average, 20% of the raw material sent to the workstation is identified as being defective and must be scrapped prior to starting processing?

d) In words, what would be the impact of the scrap on the production cost of each door?

e) What would be the impact on the number of machines required if no raw material is defective and, on average, 20% of the doors scrapped only after they have finished processing?

f) What is the maximum number of doors that can be produced by the workstation each hour?

g) For how many machine-hours each year will the workstation be
   i. processing doors or being repaired?
   ii. just processing doors
   iii. being repaired
   iv. idle (i.e., not processing doors or being repaired)?

4. Given the desired output from a series of three fabrication operations of 125 nondefective finished parts, how many parts should be input to the first operation if the yield fractions of the operations are 0.85, 0.92, and 0.90, respectively?

5. Create two worksheets that duplicate Tables 4.1 (Line Yield slide) and 4.2 (Throughput Feasible Capacity Plan slide), respectively, in the notes. In order to check if your worksheet for Table 4.2 is working correctly, you should increase the throughput from 10 to 11 units per hour. The arrival rate at workstation 1 should increase to 15.4448 units/hr and the total number of machines in the line should increase from 14 to 17.