MIT 2.810 Manufacturing Processes and Systems

Fall 2013

Homework 10 – Transfer lines: evaluation and optimization

November 13, 2013

Problem 1

Consider a transfer line as shown in figure 1 below.

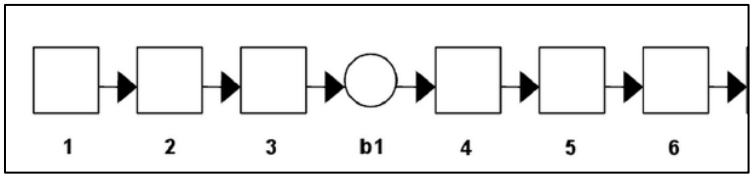

Figure 1: Transfer line layout

The machine parameters are as given in table 1 below.

	M1	**M2**	**M3**	**M4**	**M5**	**M6**
MTTF (hours)	30	40	20	20	10	50
MTTR (hours)	1	1	1	1	1	1
Processing time (hours)	1	1	1	1	1	1

Table 1: Machine parameters

The buffer has **infinite** storage capacity.

a. **Line evaluation**
   Estimate the production capacity of this system. Assume that the profit per part is $10 and that you sell every part you make. Maintenance costs (not included in the profit calculation) are $1 per hour. Calculate the net profit for this system.

b. **Line improvement: Part I**
   Identify the bottleneck machine for this line. Suppose that you have a budget of $40,000 to improve the line. Each $10,000 increases the MTTF of a machine by 10 hours. How would you allocate this budget so that you can achieve a production rate of 0.91?

c. **Line improvement: Part II**
   Each 0.005 units decrement in the failure rate of a machine increases the maintenance costs by 3%. Recall that the failure rate, p = 1/MTTF. For example, if you reduce the p-value for machine M2 from (1/40 = 0.025) by 0.005 to 0.02, the maintenance costs would

become 1.03 ($/hour). If you could improve only **one** machine, which machine would you apply this improvement to? Set up the equation for the profit of such a system, in terms of the number of decrements, n. What are the upper and lower limits on the value of n? Set up an optimization problem to find the value of n which maximizes profit.

Extra credit: Plot the profit function, and find (manually or using software) the optimum value of n, the resulting failure probability rate for the chosen machine, and the maximum profit.

d. Finite Buffers and Inventory costs

As the market matures, we are looking to cut our production costs. Inventory costs which were so far not considered in our profit calculations are now considered important. Inventory cost per part per hour is $0.01. You have estimated the production rates and average inventory in the system for various sizes of buffers. These are given in table 2 below.

Buffer size	Production rate	Average inventory
1	0.7866	0.611
5	0.8006	3.077
10	0.8127	6.218
20	0.8274	12.74
50	0.8449	34.345
100	0.8522	76
200	0.8545	170
400	0.8547	370

Table 2: Production rate and average inventory for different buffer sizes

1. Considering the inventory costs, find the buffer size (out of the options in the table) which maximizes your profit.
2. What answer would you get for the optimum buffer size using Gershwin's Approximation?