MGT 40750 – Quantitative Decision Modeling Spring 2017

**Solution with Comments to Assignment 1: Process Simulation**

There are five questions (15 total points) in this assignment. Solve these questions in SimQuick and fill in the solution template provided below.

Note that: Every time you run simulations in SimQuick, your output would be different. Therefore your numbers may look slightly different from the numbers here.

**Question 1: Exercise 1 on page 33 in the SimQuick book.**

1. Report the overall mean cycle times in Line in the following table:

|  |  |  |  |
| --- | --- | --- | --- |
| # of Tellers = | 1 | 2 | 3 |
| Overall mean cycle time in Line = | 17.35 | 1.58 | 0.29 |

What’s the impact of adding tellers on the waiting times of customers?

Waiting times decrease.

1. Report the overall mean cycle times in Line in the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Time between arrivals = | 2 | 1.8 | 1.6 | 1.4 | 1.2 |
| Overall mean cycle time in Line = | 0.72 | 0.94 | 1.52 | 2.27 | 3.85 |

Comments:

* Some students’ numbers are off because they forgot to change the working time back to Nor(2.4,.5). 🡪 “The question asks you to use the original working time, i.e., Nor(2.4,.5)”

What’s the impact of the potential promotions in an effort to increase the number of customers on the waiting times of customers?

Waiting times increase.

**Question 2: Exercise 3 on page 34 in the SimQuick book.**

When setting up your model, note that: Because there are only 10 phone lines, the number of CS people plus the capacity of Line must be 10.

Report the overall mean cycle times in Line and the overall mean service levels in the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # of CS people = | 1 | 2 | 3 | 4 | 5 |
| Overall mean cycle time in Line = | 79.49 | 25.50 | 5.00 | 1.03 | 0.33 |
| Overall mean service level = | 0.46 | 0.86 | 0.99 | 1.00 | 1.00 |

How many CS people would you recommend for the day shift? (The minimum number of CS people that satisfied both the waiting time requirement and the service level requirement.)

4 .

Comments:

* Some students forget to answer this question. 🡪 “I’m not taking any point off this time. But make sure to answer all questions next time.”

For the setting with your recommended number of CS people, record your SimQuick configurations below:

**Entrances:**



**Buffers:**



Comments:

* Some students forget Nor(2,.5) for initial # objects. “Need to read the question more carefully.”
* Some students set the capacity of Line to 10. 🡪 “There are only 10 phone lines in total. So if you allocate 4 of them to 4 CS people, then the capacity of Line should be 10 – 4 = 6.”

**Work Stations:**





Comments:

* Some people miss certain cells in the SimQuick setup. 🡪 “Need to specify all necessary cells.”

**Question 3: Exercise 7 on page 42 in the SimQuick book.**

1. **Create a complete process flow map using SimQuick elements:**

Entrance

Door

Buffer

Desk Line

Work Station

Desk

Buffer

X-ray Line

Buffer

Ambulatory Line

Buffer

Hospital

Buffer

Lab Line

Work Station

Ambulatory

Work Station

X-ray

Work Station

Lab

Decision Point

X-ray DP

Buffer

Release

Decision Point

Lab DP

Decision Point

Desk DP

Comments:

* You need to specify the unique names for each element. Many decision points and buffers are missing.
* Some students drew two Work Stations for Lab. 🡪 That’s fine. No need to take off any point because a later question asks to double the capacity.

Report the overall mean fraction time working (utilization) for each Work Station in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Work Station: | Desk | Ambulatory | X-ray | Lab |
| Overall mean fraction time working = | .19 | .28 | .19 | .74 |

Report the overall mean cycle time for each Buffer in front of a Work Station in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Buffer: | Desk Line | Ambulatory Line | X-ray Line | Lab Line |
| Overall mean cycle time = | .36 | 2.63 | 1.57 | 42.57 |

Which Work Station is a bottleneck based on the above results? Lab .

1. **Double the capacity of the bottleneck by adding an identical Work Station next to the existing one.**

Report the new overall mean fraction time working (utilization) for each Work Station in the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Work Station: | Desk | Ambulatory | X-ray | Lab | The added Work Station |
| Overall mean fraction time working = | .20 | .28 | .19 | .54 | .36 |

Report the new overall mean cycle time for each Buffer in front of a Work Station in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Buffer: | Desk Line | Ambulatory Line | X-ray Line | Lab Line |
| Overall mean cycle time = | .37 | 2.64 | 1.11 | 4.45 |

How has the bottleneck been affected?

The performance of the Lab on both statistics has been greatly improved.

1. **Suppose the time between arrivals drops to 10 minutes.**

Report the new overall mean fraction time working (utilization) for each Work Station in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Work Station: | Desk | Ambulatory | X-ray | Lab |
| Overall mean fraction time working = | .31 | .45 | .30 | .91 |

Report the new overall mean cycle time for each Buffer in front of a Work Station in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Buffer: | Desk Line | Ambulatory Line | X-ray Line | Lab Line |
| Overall mean cycle time = | .68 | 5.23 | 2.46 | 129.61 |

How has the bottleneck been affected?

The performance of the Lab on both statistics is much worse.

**Question 4: Exercise 13 on page 59 in the SimQuick book.**

1. Report the overall mean service level for Purchase Requests in the following table:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Capacity of Storage = | 70 | 74 | 78 | 82 | 86 | 90 | 94 |
| Overall mean service level for Purchase Requests = | .87 | .91 | .95 | .97 | .98 | .99 | 1.00 |

Report the overall mean cycle time of simulated loaves in Storage in the following table:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Capacity of Storage = | 70 | 74 | 78 | 82 | 86 | 90 | 94 |
| Overall mean cycle time in Storage = | 10.74 | 11.46 | 12.47 | 13.17 | 14.16 | 15.02 | 16.33 |

What level of inventory do you recommend to achieve a service level of .99?

90 .

Comments:

* You should use service level for exit NOT entrance for this question.
* Since this question follows the order-up-to policy, inventory = capacity of storage.

1. Suppose the bakery make deliveries every day instead of every other day.

Report the new overall mean service level for Purchase Requests in the following table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Capacity of Storage = | 34 | 38 | 42 | 46 | 50 | 54 |
| Overall mean service level for Purchase Requests = | .84 | .92 | .96 | .99 | 1.00 | 1.00 |

Report the new overall mean cycle time of simulated loaves in Storage in the following table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Capacity of Storage = | 34 | 38 | 42 | 46 | 50 | 54 |
| Overall mean cycle time in Storage = | 5.36 | 6.10 | 6.99 | 8.02 | 9.03 | 10.31 |

What level of inventory do you recommend to achieve a service level of .99?

46 .

**Question 5: Exercise 19 on page 81 in the SimQuick book.**

Comments:

* Throughput is the final inventory of Finished Goods.
* Cycle time of process consists of all potential delays in the process including working time at WS, cycle time of internal buffer at WS, and cycle time at Buffer.

1. The overall mean throughput is 114.20 .  
   The overall mean cycle time through the process from the time it enters WS1 to the time it leaves WS3 is 33.68 .
2. The overall mean throughput is 135.23 .  
   The overall mean cycle time through the process from the time it enters WS1 to the time it leaves WS3 is 30.74 .
3. The overall mean throughput is 119.20 .  
   The overall mean cycle time through the process from the time it enters WS1 to the time it leaves WS3 is 32.84 .
4. Report the overall mean throughput and the overall mean cycle time through the process in the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Capacity of both Buffers = | 1 | 3 | 5 | 7 | 9 |
| Overall mean throughput = | 130.60 | 134.70 | 135.23 | 135.63 | 135.50 |
| Overall mean cycle time through the process = | 41.31 | 55.85 | 65.13 | 68.50 | 69.43 |

1. The overall mean throughput is 140.27 .  
   The overall mean cycle time through the process from the time it enters WS1 to the time it leaves WS3 is 38.71 .
2. Summarize your results from parts a through e. In particular, discuss the relationship between inventory, working time variability, throughput, and cycle time.

As inventory increases, throughput increases to a point, after which it remains the same.

As inventory increases, cycle time of process increases.

As working time variability decreases, throughput increases while cycle time of process decreases (even if the variability is reduced at only one place in the line).

Comments: Please refer to the solution for all the relationships between concepts.

1. Report the overall mean inventory and the overall mean maximum inventory of the added Buffers in the following table:

|  |  |  |  |
| --- | --- | --- | --- |
| Time units = | 2000 | 5000 | 10000 |
| Overall mean inventory at the Buffer between WS1 and WS2 = | 2.57 | 4.80 | 5.60 |
| Overall mean maximum inventory at the Buffer between WS1 and WS2 = | 6.80 | 11.37 | 14.53 |
| Overall mean inventory at the Buffer between WS2 and WS3 = | 1.68 | 3.16 | 5.60 |
| Overall mean maximum inventory at the Buffer between WS2 and WS3 = | 5.50 | 9.30 | 14.47 |

Comments:

* “The inventory numbers are off. Please double check your simulation model.”
* “The inventory level is supposed to increase. This mistake may be due to insufficient initial # of objects for Raw Materials.”

What does this imply about inventory levels in a factory where Buffer sizes are large and production runs are long?

It appears that inventory levels, when unconstrained by space, grow as the length of production runs increases.