

BU 610.615

Simulation for Business Applications

Homework 1

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**Part 1: Assembly Line Simulation Exercise**

* **Question A**:

Assume that the system is in steady-state

Assume all stations have the same processing time

* + **Bottleneck**:

MAX([10 mins, 10 mins, 10 mins, 10 mins]) = 10 mins

VARIANCE([10 mins, 10 mins, 10 mins, 10 mins]) = 0

All four stations are bottlenecks in this system

* + **Cycle time**:

10 mins

* + **Throughput time**:

10 mins + 10 mins + 10 mins + 10 mins = 40 mins

* + **WIP inventory**:

6 units/hr \* (40/60 hr) = 4 units

* + **Capacity utilization**:

100 %

* + **5000 mins total output**:

6 units/hr \* (5000/60 hr) = 500 units

* **Question B**:
  + **Total output**:

74 + 76 + 73 + 71 + 73 = 367

|  |  |  |  |
| --- | --- | --- | --- |
|  | **% Utilization** | **% T Blocked** | **% T Starved** |
| **Station 1** | 73.7 % | 26.3 % | 0.0 % |
| **Station 2** | 70.9 % | 21.4 % | 7.6 % |
| **Station 3** | 73.7 % | 13.0 % | 13.4 % |
| **Station 4** | 73.6 % | 0.0 % | 26.4 % |

* + **Throughput Time Avg.**:

5000 / 367 \* 4 = 54.496

* + **WIP Inventory Avg.**:

3.525

* **Question C**:

Due to the introduction of random variation of process time, blockages and starvations start to emerge within the system. As a result, stations aren’t always running in full capacity (either waiting for the next station to be available or the previous station to finish), which leads to lower total output and % capacity utilization.

* **Question D**:

The total output and % capacity utilization states slightly decreased comparing to the 4-station system. (total output: 367 -> 361, % utilization: 73% -> 71%) This could be caused by the uncertainty brought by the newly added station. In other words, the fifth station could cause blockage or starvation between station 4 and 5 that of which decreases the efficiency of the entire system.

* **Question E**:

The total output and % capacity utilization states slightly decreased comparing to process time std. div. of 4. (total output: 367 -> 342, % utilization: 73% -> 68%) This could be caused by the increased uncertainty derived from a higher process time variance. Consequently, the probability of blockage or starvation between stations occurring increased.

* **Question F**:

Comparing total output of three buffer inventory options (between 1 and 2, 2 and 3, and 3 and 4), placing the buffer between machine 2 and 3 yielded the highest output. (1-2: 373, 2-3: 396, 3-4: 375) This could be explained by the phenomenon that buffer inventory eliminates wait time for both stations, which greatly reduced blockage and starvation rate in that part of the system.

**Part 2: Probability Warm-up Questions**

* **Question G**:
  + **Avg.**:

(1 + 2 + 3 + 4 + 5 + 6) / 6 = 3.5

* + **Std. Div.**:

* **Question H**:
  + Binomial Distribution
* **Question I**:
  + 5000 \* 0.001 = 5
* **Question J**:
  + 5000 \* 0.001 \* (1 - 0.001) = 4.995
* **Question K**:
  + (1 - 0.001) ^ 5000 = 0.6721 %