Solution 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.

a. 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.

b. 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

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.

Hint for model setup: 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 .

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

Entrances:

1	
Name →	Arrivals
Time between arrivals →	Exp(4)
Num. objects per arrival →	1
Output destination(s) ↓	
Line	

Buffers:

1			2	
Name →	Line		**Name →**	Served Customers
Capacity →	6		Capacity →	Unlimited
Initial # objects →	Nor(2,.5)		Initial # objects →	0
Output destination(s) ↓	Output group size ↓		Output destination(s) ↓	Output group size ↓
CS Person 1	1			
CS Person 2	1			
CS Person 3	1			
CS Person 4	1			

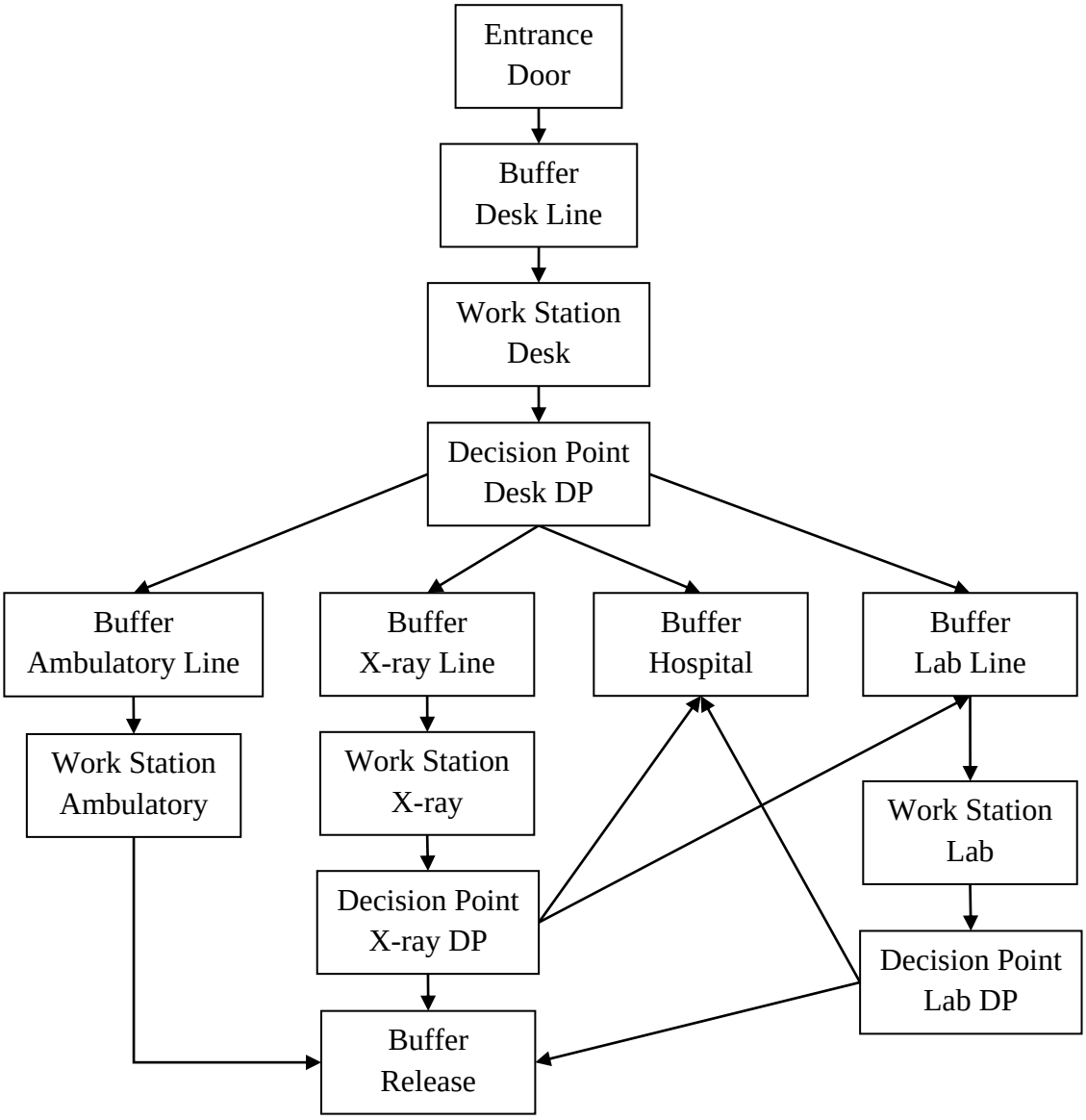
Work Stations:

	1				2		
	Name →	CS Person 1			**Name →**	CS Person 2	
	Working time →	Nor(10,2)			Working time →	Nor(10,2)	
Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓	Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓
Served Customers	1			Served Customers	1		

	3				4		
	Name →	CS Person 3			**Name →**	CS Person 4	
	Working time →	Nor(10,2)			Working time →	Nor(10,2)	
Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓	Output destination(s) ↓	# of output objects ↓	Resource name(s) ↓	Resource # units needed ↓
Served Customers	1			Served Customers	1		

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

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



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 .

b. 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.

c. 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.

a. 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 .

b. 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.

a. 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 .
b. 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 .
c. 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 .
d. 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

e. 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 .

f. 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).

g. 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

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.