Littlefield Simulation Game Report

Course: BUDT578V – Operations Analytics
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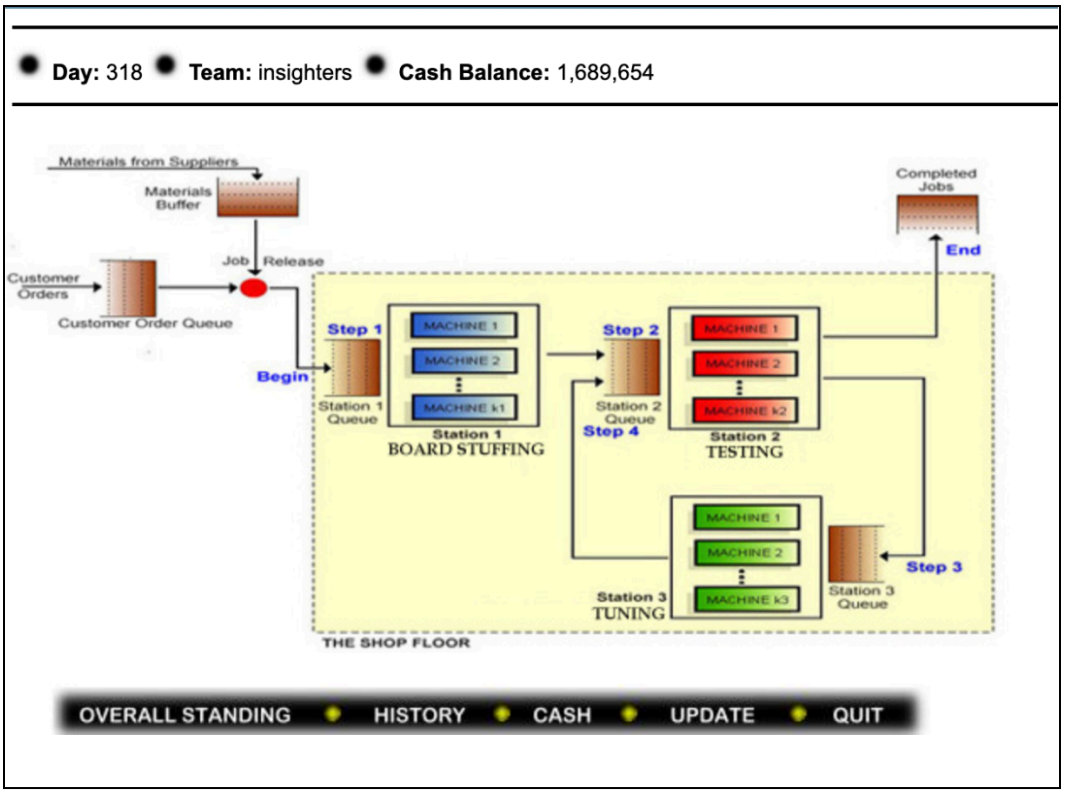

Introduction:

In the fast-paced realm of production management, informed decision-making is essential for improving operational efficiency and maximizing profitability. During the seven-day simulation exercise, our team focused on strategies to reduce lead times and switch to Contract 3 quickly to increase our factory's cash balance. This report details our journey, explaining the rationale behind our decisions, the strategies we used, and reflections on potential areas for improvement. Before starting the game, we analyzed trends to identify the need to adjust reorder points and quantities, buy a new machine, and immediately reduce lead times.

Day 50-51: Reevaluating Reorder Points and Contracts

The initial game reorder point of 2,000 kits was too low, leading to inventory shortages while waiting for new supplies due to the four-day delivery lead time. We recalculated the reorder point using the Q, R policy formula, ensuring a 98% service level by incorporating safety stock to prevent any stockouts. The average demand and standard deviation over the first 50 days were 12.22 and 3.39, respectively. The safety stock was calculated as SS = z + std + sqrt(L) = 7.4 batches or 446.89 kits. After the game ended, we realized that we mistakenly used addition

instead of multiplication, resulting in lower safety stock and occasional inventory shortages. The correct reorder point was 56.32 using the formula R = AVG * L + SS = 12.22 * 4 + 446.89. We rounded it to 57 batches, setting the reorder point to 3,060 kits instead of 2,000. If the correct formula had been used, a higher reorder point could have optimized costs even further. However, the error did not affect the order quantity, which was calculated at 3,060 kits using Q = sqrt(2 * ordering cost * avg / h) = sqrt(2 * 1000 * 60 * 12.22 / 0.16) = 51 batches **(Exhibit 1)**.

We considered switching from Contract 1 to Contract 2 based on lead times, recognizing the potential to increase revenue under Contract 2. After one hour (equivalent to one game day), the lead time trend indicated that switching to Contract 2 would yield at least $750 or more in profit if the lead time was below two days, so we switched to Contract 2. (**Exhibit 2**).

Day 52-55: Investing in Capacity Expansion

Understanding that bottlenecks were hindering production capacity, we invested in new machinery strategically. By analyzing the last 20 days out of the first 50, we identified Station 3 as the bottleneck due to its 92.75% utilization compared to Station 1's 89.29% and Station 2's 76.47% utilization **(Exhibit 3)**. We waited a few days to accumulate enough cash to purchase a machine at Station 3 for $100,000 and secure an order. By Day 54.65, we had enough cash to buy the machine, which alleviated production constraints and increased efficiency. We maintained the batch size of 60 at Station 1 due to its proximity to the bottleneck. Changing the batch size could have led to Station 1 becoming the new bottleneck due to its longer setup time compared to other stations.

Day 57-64: Fine-Tuning Operations and Contract Optimization

To maintain optimal operational performance, we continued refining our strategies. After analyzing data up to Day 64, we recalculated the average demand and standard deviation between Days 51 and 64 **(Exhibit 4**). As a result, we updated the reorder point to 63 batches (3,780 kits) and the reorder quantity to 54 batches (3,240 kits). These adjustments, along with the switch to Contract 3, demonstrated our dedication to maximizing revenue while minimizing costs. Further investments in machinery at Stations 1 and 2 augmented our production capacity for sustainable long-term success.

Day 64-79: Adapting to Changing Dynamics

Adding an extra machine at Station 3 significantly reduced its utilization and expedited overall lead times. However, this created a bottleneck at Station 1, which consistently reached 100% utilization for several consecutive days **(Exhibit 5)**. On Day 73, we assessed our available funds and determined we could afford a $90,000 machine while covering additional orders. Our analysis showed that switching to Contract 3 when lead times dropped below 0.6 days would yield the same $1,000 profit as Contract 2. Observing lead times below 0.6 days from Day 72 to Day 79, we switched to Contract 3 **(Exhibit 6)**. In hindsight, we should have switched on Day 72, as lead times were already consistently below 0.6 days, which would have generated more revenue.

To handle the increased production flow from both Stations 1 and 3 due to their improved production rates, we bought a machine at Station 2 on Day 83.5 to keep utilization below 80%. This helped maintain lead times below 0.6 days, ensuring Contract 3 was used efficiently.

Day 120-153: Continuous Improvement and Strategic Forecasting

Around Day 120, we debated changing the reorder point and quantity because inventory was close to stockout levels, with only 120 units remaining. This situation was due to a sudden increase in demand, which led to higher utilization at Station 1 and caused a slight increase in lead times. We analyzed the demand patterns further and calculated potential losses to determine if buying another machine at Station 1 was justified.

On Day 144, we decided to reduce the reorder quantity to 3,000 kits (50 batches) to minimize holding costs and lost interest in cash due to excess safety stock. However, we felt the need to increase the reorder quantity to 55 batches (3,300 kits) from 54 batches to reduce the risk of stockouts.

Day 196-218: Final Analysis and Decisions Before the Game Auto-Simulates

Between Days 196 and 218, we analyzed the demand trends and re-evaluated the reorder point and quantity. We reduced the batch size to 54 batches but ensured enough inventory would remain available with minimal safety stock. Again, we wanted to avoid stockouts, so we increased the reorder point back to 55 batches (3,300 kits).

We also discussed a strategy that included stocking up once to save on ordering costs. However, after analyzing the newsvendor formula involving the cost of overage and underage, we realized that holding too much inventory would lead to a loss in interest income almost equivalent to the total fixed ordering costs under our Q, R policy **(Exhibit 7)**. We decided to continue with our current strategy for the 100 days when the game auto-simulated from Day 218 until Day 318.

Insights and Conclusion

After the simulation ended on Day 318, we finished third with a cash balance of $1,689,654, just $30,000 short of first place due to an order processed on Day 311. In retrospect, our alternative strategy could have optimized performance by stocking up before auto-simulation and avoiding additional orders **(Exhibit 8)**. Using the correct formula for safety stock calculations and switching to Contract 3 earlier would have made a difference.

Ultimately, we achieved a significant reduction in lead times from 2.1 days initially to 0.4 days by the end of the simulation **(Exhibit 6).** Maximizing revenue was a critical objective, and we closely monitored metrics to align our decisions with profitability. Our efforts resulted in a 62.81% revenue increase in the last 52 days compared to the first 52 days, showcasing the effectiveness of our strategies **(Exhibit 9)**. The strategic decisions made throughout the simulation enabled us to maximize revenue while minimizing costs, providing valuable insights into efficient production management.

Appendix:

SS=z*std*sqrt(L)	446.8897252	kits	7.448162086	batches
R=AVG * L + SS	3380	kits	56.328	batches
Q= sqrt(2*k*avg / h)	3027	kits	50.45625168	batches
Ordering cost= ($10*Q)+1000	$31,273.75	<-- make sure we have this amount		
Money in hand to start	$150,794.00			

Exhibit 1
Calculations

Avg lead times	Revenue Contract 1	Revenue Contract 2	Revenue Contract 3
	<7 days = $750		
0	$750	$1,000	$1,250
0.1	$750	$1,000	$1,250
0.2	$750	$1,000	$1,250
0.3	$750	$1,000	$1,250
0.4	$750	$1,000	$1,250
0.5	$750	$1,000	$1,250
0.6	$750	$1,000	$1,000
0.7	$750	$1,000	$750
0.8	$750	$1,000	$500
0.9	$750	$1,000	$250
1	$750	$1,000	$0
1.1	$750	$975	$0
1.2	$750	$950	$0
1.3	$750	$925	$0
1.4	$750	$900	$0
1.5	$750	$875	$0
1.6	$750	$850	$0
1.7	$750	$825	$0
1.8	$750	$800	$0
1.9	$750	$775	$0
2	$750	$750	$0

Exhibit 2
Comparison of Contract 1,2, & 3 Revenues

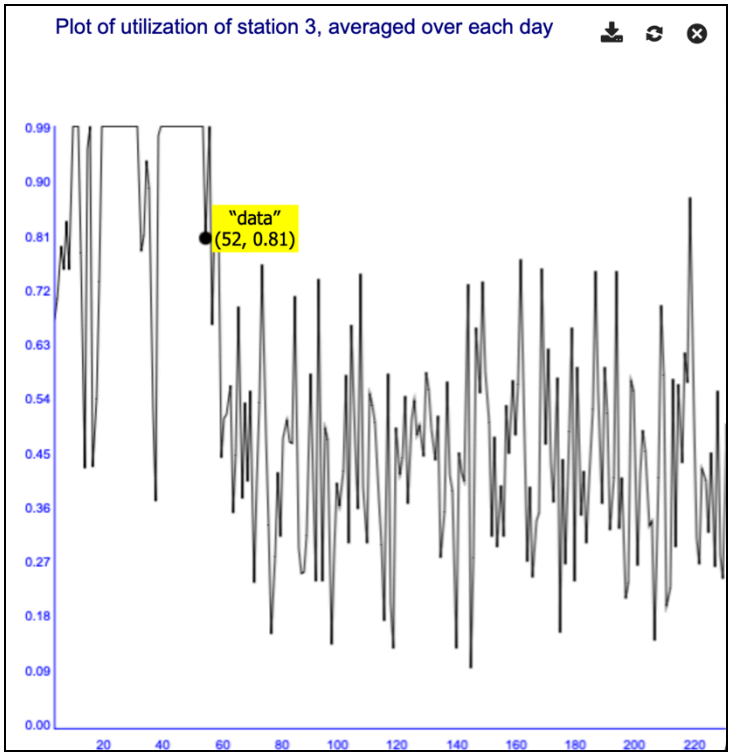

Exhibit 3
Utilization for Station 3 on Day 52.

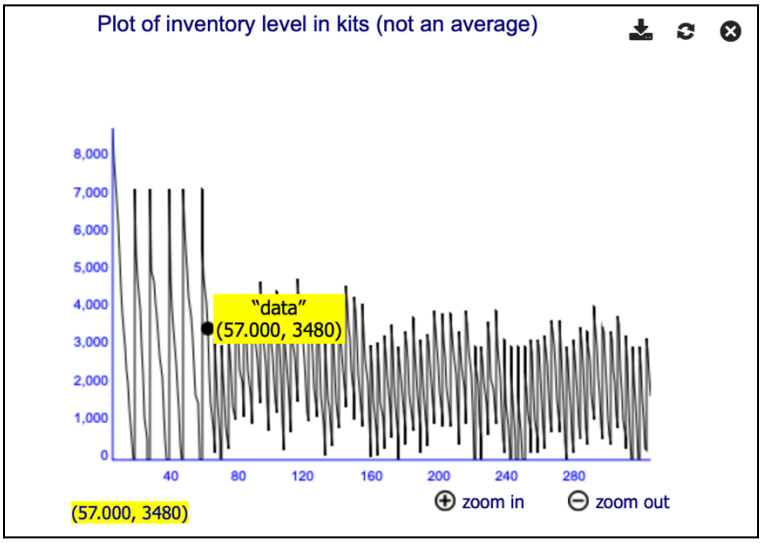

Exhibit 4
Average Demand on Day 57

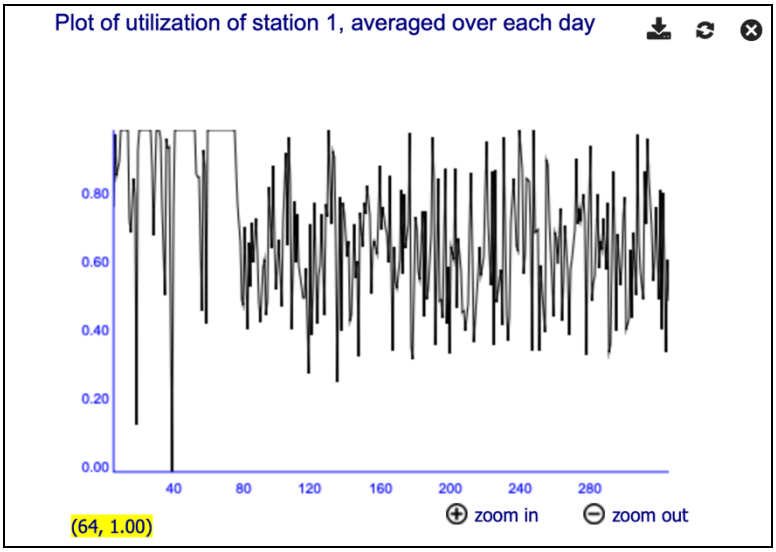

Exhibit 5
Utilization for Station 3 on Day 64

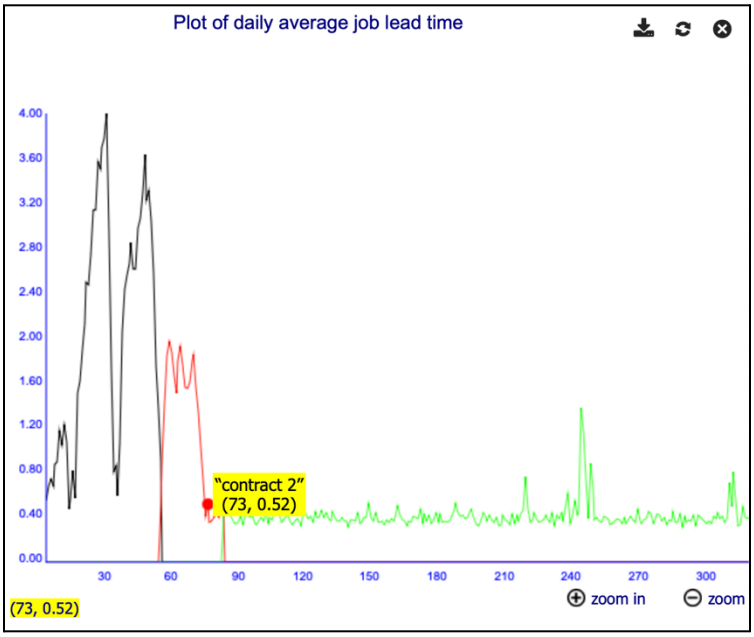

Exhibit 6
Average Lead Time on Day 73

average 100 day demand	STD	
11.64356436	3.378118288	
1164.356436	**337.8118288**	
Cu(net gain)	1250-600	650
Co(overage cost)	600-0	600
F(Q)= cu/(Cu+Co)	0.52	
z=normsinv(.52)	0.05015358351	
Q= u+ z(stdv)	**1181.298909**	batches
	1182	total for 100 days
order cost	**709200**	

Exhibit 7
Analysis for Alternative Strategy

	if we do continous strategy (24 orders)	if we do one order
max revenue	1,455,445.54	1,455,445.54
cost	722,613.86	709200
interest gain/lost	23287.67123	-23287.67123
profit	**756,119.35**	**722,957.87**
total cash at end	**756,119.35**	

Exhibit 8
Comparison between Strategies.

Revenue of first 52 days		Revenue of last 52 days	% increase
39000		63495.3	62.81%

Exhibit 9
Comparison of performance of first 52 vs last 52 days