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Team 29 Assignment Summary

Before the Simulation

Before the Littlefield Lab simulation, our team met to strategize our approach to inventory management for the lab. First, we created a google sheet[1] that compiled all the relevant information from the reading like the purchasing and ordering costs of test kits, both supply and demand lead times, the three different contract levels, the interest rate, the borrowing rate, and the number of machines, their processing time, and the costs of a new machine. From here, we calculated important metrics like the backorder[2] and holding[3] costs, as well as the processing time, capacity, and utilization of each station[4]. Our goal was to calculate our own reorder point r and order quantity Q for optimizing the (r, Q) inventory model for the lab. Once the simulation was made available, we were able to add the daily demand into our google sheet to calculate the average daily demand and its variability. With this information, we were able to determine an optimal (r, Q) given all the parameters. Additionally, we set up this sheet so that we could add in demand information throughout the simulation and the reorder point and quantity would automatically update with the most recent mean and standard deviation.

Though we had already determined our optimal reorder point and quantity, we needed more to our strategy than adjusting r and Q. We used the station utilizations and capacities that we had calculated to motivate our strategy going into the simulation. We identified the centrifuging station as the bottleneck in our system, and thus decided that buying a new centrifuge would be our first action in the game once our funds were sufficient. Further, we updated our model to identify which station would be the bottleneck after we bought a new centrifuge, and determined

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[1] link for reference: https://docs.google.com/spreadsheets/d/1_fhdCoNOwftKJmY8wC7tX7hKd720YKMPAZvUpKWrdv0/edit?usp=sharing

[2] b = contract level price / (contract level max lead time - quoted lead time). For example, for contract 1, b = 750 / (14 - 7), which is approximately 107.14.

[3] h = (interest rate / working days) * purchasing cost. Therefore, h = (.1 / 310) * 600, which is approximately 0.19.

[4] Sample preparing: station processing time (in hours) = 1.77, station capacity (per hour) = 0.57, station capacity (per day) = 13.6, utilization = 95%
Testing: station processing time (in hours) = 0.95, station capacity (per hour) = 1.05, station capacity (per day) = 25.3, utilization = 51%
Centrifuging: station processing time (in hours) = 1.8, station capacity (per hour) = 0.56, station capacity (per day) = 13.3, utilization = 97%

that we would buy a new sample processing machine after buying the centrifuge. After purchasing these two machines, we predicted that the utilization of each station would be sufficient for the system. With our prioritized “christmas list” of machines and our google sheet ready with the ability to continuously update the (r, Q) model, we felt prepared for the simulation.

During the Simulation

When the simulation opened, each of our team members had volunteered to more closely monitor the lab for one hour, though we all were checking it periodically throughout the simulation. Those who were monitoring in the beginning knew to update the r and Q parameters and to buy a centrifuge machine as soon as funds would allow. We quickly realized that our model’s output of optimal (r, Q) was too high considering the minimal funds that we had. We lowered our (r, Q) significantly, ignoring our model and responding more directly to the simulation. Soon after the simulation began, we were able to purchase a centrifuge machine as we had planned and readjust our reorder point and quantity according to the new flow rate[5].

Realizing that our lead times had decreased due to the new centrifuge station capacity, we updated to contract 2 in an effort to generate more revenue so that we could purchase a sample preparing machine, as this station was our new bottleneck[6]. Soon after we had sufficient funds to purchase a new machine for preparing and thus eliminated this bottleneck. At this point, we felt confident with the capacities and utilizations at each station and thus we decided not to purchase any more machines (consistent with our original strategy)[7]. Though the utilization for the sample preparing station was still relatively high at 71%, we saw that the lab seemed to be processing test kits at a rate appropriate for the demand, so we did not need any more machines. At this point in the simulation, we updated our contract to level 3 as we saw our lead times were consistently at or below 0.5 days.

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[5] With two centrifuge machines, the station processing time (in hours) decreased to 0.9, the station capacity (per hour) increased to 1.1, the station capacity (per day) to 26.7, and lowered the utilization = 48%.

[6] At this point, the sample preparing station had a processing capacity of 0.57 kits per hour or 13.6 kits per day, at a utilization of 95%.

[7] With four sample preparing machines, 2 testing machines, and 2 centrifuging machines, the performance metrics are as follows:
Sample preparing: station processing time (in hours) = 1.33, station capacity (per hour) = 0.75, station capacity (per day) = 18.1, utilization = 71%
Testing (unchanged): station processing time (in hours) = 0.95, station capacity (per hour) = 1.05, station capacity (per day) = 25.3, utilization = 51%
Centrifuging: station processing time (in hours) = 0.9, station capacity (per hour) = 1.1, station capacity (per day) = 18.1, utilization = 48%

Finally, we had to settle on a final reorder point and quantity for the lab to continue to run for the remainder of the simulation. We had extensive discussion about the appropriate values of r and Q. One team member felt strongly that we should return to the optimal (r, Q) values according to our model. The rest of the team eventually agreed upon a smaller reorder quantity, to avoid incurring high purchasing costs, and a modest reorder point, to replenish inventory just when it was approaching zero. With our (r, Q) = (70, 90), we ended the simulation on day 210 anxiously hoping to maintain our current status as the top team.

Reflection

We ended this simulation as the #1 team, with $1,524,038 cash balance. Therefore we feel confident in the choices we made during this simulation. Reflecting on what went particularly well, we think it was in our best interest that we knew which bigger actions we wanted to take, like buying machines, before we started the simulation. This way we were able to buy these machines as soon as possible and thus eliminate bottlenecks in the system and increase overall processing capacity. This then allowed us to increase our contract levels so that we could generate more revenue. Once we had upgraded the system so that we were processing test kits at the shortest lead time and charging the highest price point for each order, it was just a matter of maintaining an appropriate inventory to allow the lab to continue running smoothly. We settled on a small reorder quantity because, compared to purchasing costs, order costs were minimal[8]. We analyzed the demand and paid particularly close attention to our inventory plot to determine our reorder quantity. Based on this, we settled for a reorder quantity r = 70 which consistently allowed for a new shipment of test kits to arrive just as inventory was getting low (around Q = 10 or 20). Based on our final cash balance, we think we made the right decisions regarding inventory management of Littlefield Lab, and we had a lot of fun doing it!

[8] With Q = 90 test kits, purchasing costs were $54,000, with only an additional $1,000 ordering cost.

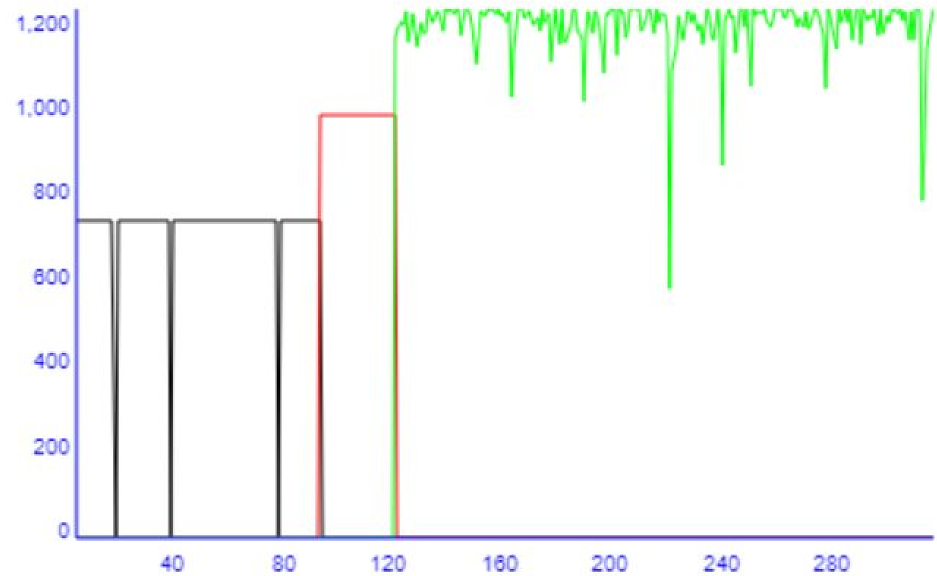
Appendix

Transaction History

Day	**Parameter**	**Value**
50	Reorder point (kits)	104
50	Reorder quantity (kits)	390
57	Reorder quantity (kits)	120
60	Reorder point (kits)	30
62	Reorder quantity (kits)	30
63	Station 3 machine count	2
63	Reorder quantity (kits)	120
67	Reorder point (kits)	12
71	Reorder point (kits)	30
79	Reorder point (kits)	50
85	Reorder point (kits)	60
88	Contract number	2
93	Reorder quantity (kits)	60
94	Reorder point (kits)	75
96	Station 1 machine count	4
107	Reorder quantity (kits)	100
114	Contract number	3
151	Reorder quantity (kits)	90
168	Reorder point (kits)	65
169	Reorder quantity (kits)	100
172	Reorder quantity (kits)	150
206	Reorder quantity (kits)	90
206	Reorder point (kits)	70

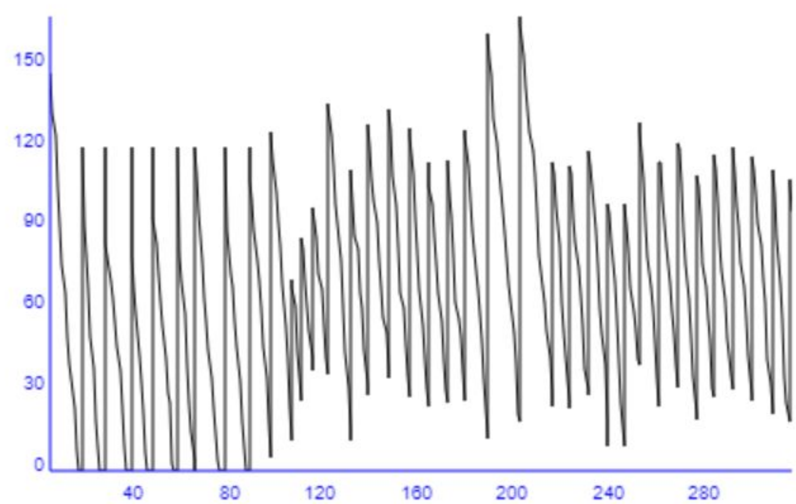
Revenue Plot

Plot of daily average revenue per job



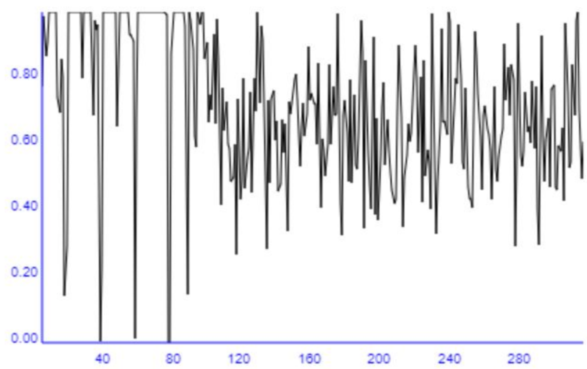
Inventory Plot

Plot of inventory level in kits (not an average)



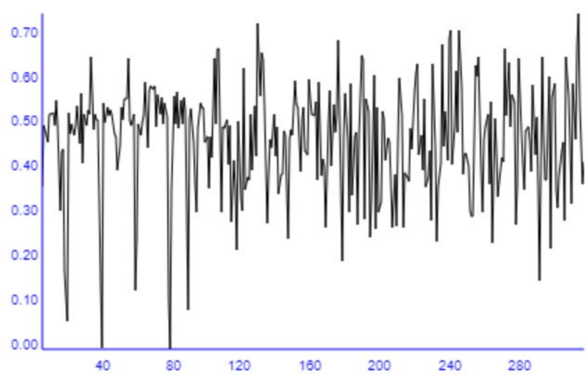
Utilization Plot Station 1: Sample Preparing

Plot of utilization of station 1, averaged over each day



Utilization Plot Station 2: Testing

Plot of utilization of station 2, averaged over each day



Utilization Plot Station 3: Centrifuging

Plot of utilization of station 3, averaged over each day