Simulation Case Study Report

IEM Lab Rotation IV

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Task Evaluation Report

Task 1

a.

Performance Indicators	
Profit	-16402€
Revenue	63880€
Costs	80282€
Average WIP	118
Average TTP	3:33:18.6285
DDR	99.5%
UT Cutting	91.206%
UT Drilling	45.528%
UT Milling	52.820%
UT Assembly	97%
UT Grinding	83.300%

Table 1: Performance Indicators of Initial Setup

b.

In the initial setup of the manufacturing process of company XYZ, the total profit is a negative number. This indicates whether the Revenue is not at maximum or the Costs are over budget.

The Revenue can only be reduced by late products that one late product will sell for 100€ instead of 160€; however, the DDR (Due Date Reliability), as calculated below,

$$DDR = \frac{number\ of\ orders\ delivered\ within\ time\ window}{total\ number\ of\ orders\ delivered} * 100\%$$

tells the percentage of the non-late products, in this case, 99.5%.

Only the Costs can be improved since only two products out of 400 are late. According to Table 1, the average WIP (Work in Process) is 118 which cost 5€ per unit per day. This can be reduced by having less total buffer size, because WIP products can only be stored in these buffer storages, if there are not enough space, the sources will stop sending raw materials. How and which ones of the buffers need to be changed will be explained in the next tasks.

On the other hand, the UT (utilization rate) of Drilling and Milling are demonstrating the WS (workstations) of Drilling and Milling are too much. Again, how many to change will be talked in later tasks.

Task 2

a.

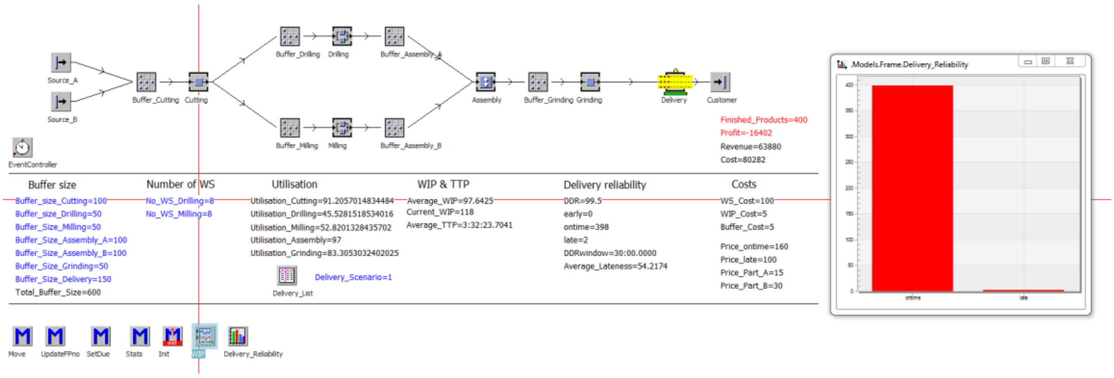


Figure 1: initial setup

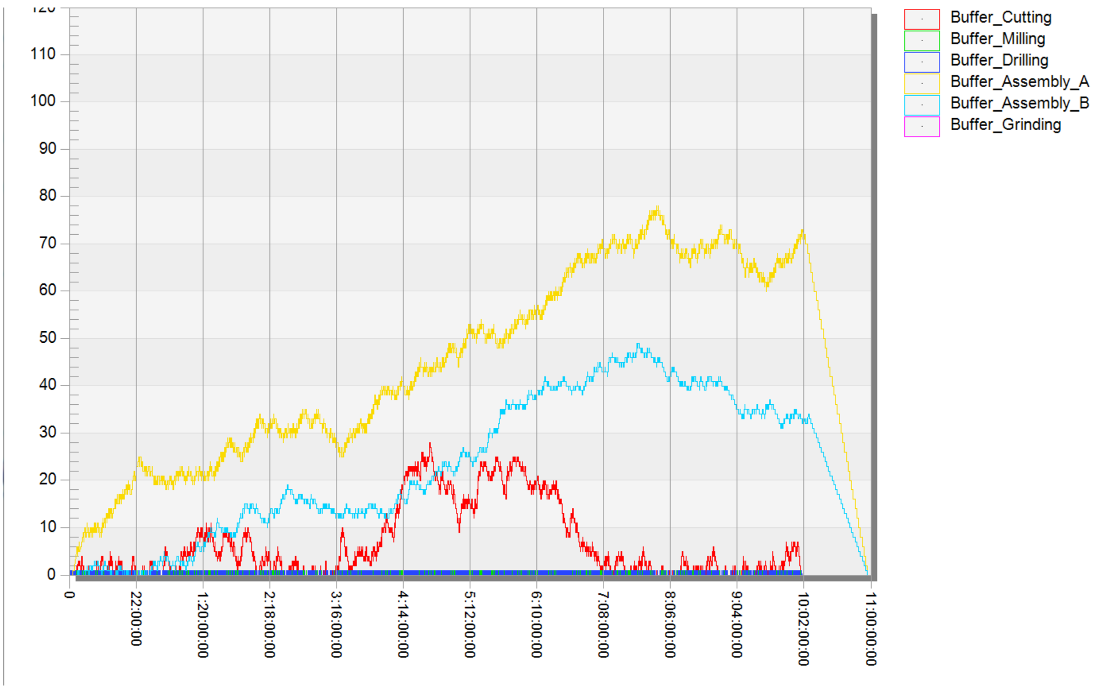


Figure 2: the WIP chart of initial setup

First, we briefly analyzed the WIP chart of the initial setup. We found that the max usage of each buffer didn't reach the size of each buffer. So we adjusted the size of each buffer into the max usage from the initial setup.

The setup and results of first try:

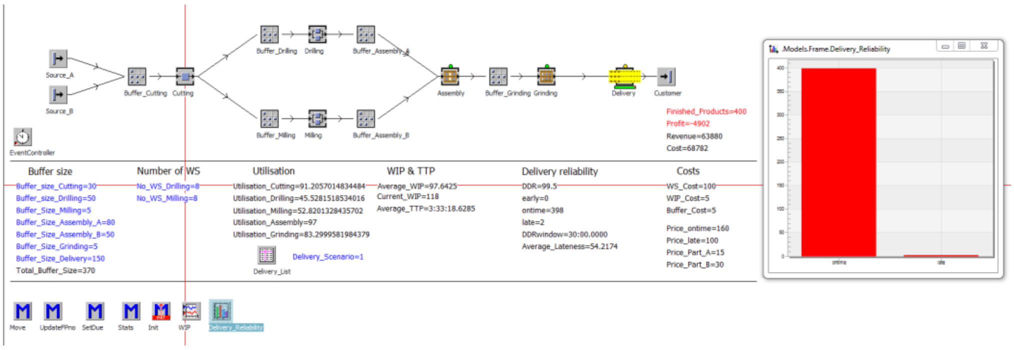


Figure 3: The setup of 1st try

We can see after our first try, the income significantly increased. This is because we cut off the buffer that we never used, thus we reduce the cost of buffers.

Then we continue reduce the buffer sizes, allows the contents in each buffer reach the maximum. We believed it will further reduce the cost of buffers and will not slow down production.

After tried a few setups, we came up with our optimum solution:

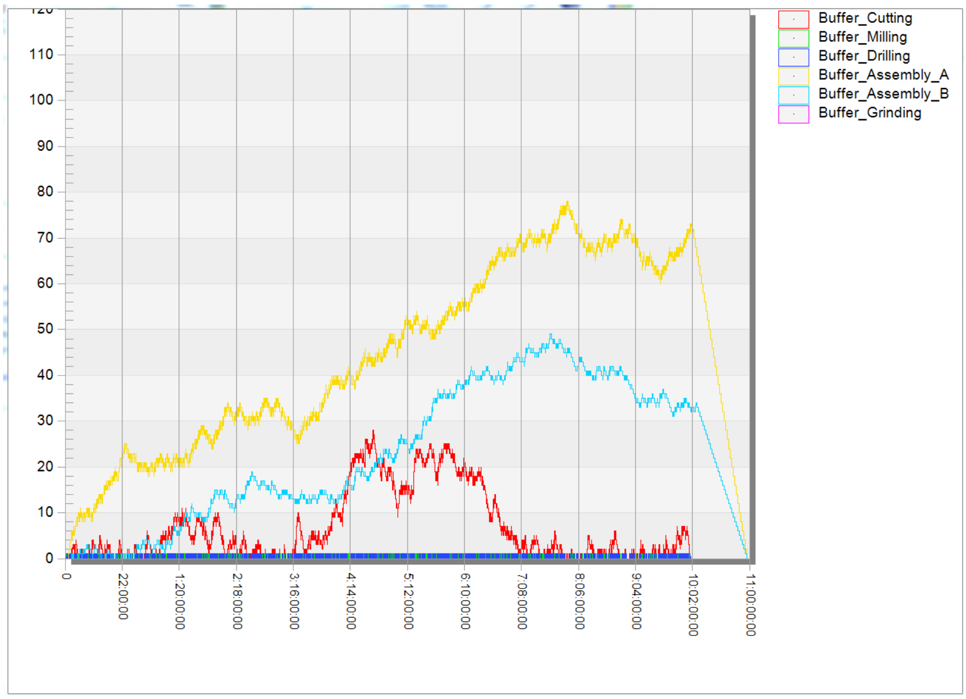


Figure 4: WIP of 1st try

Figure 5: The optimum setup

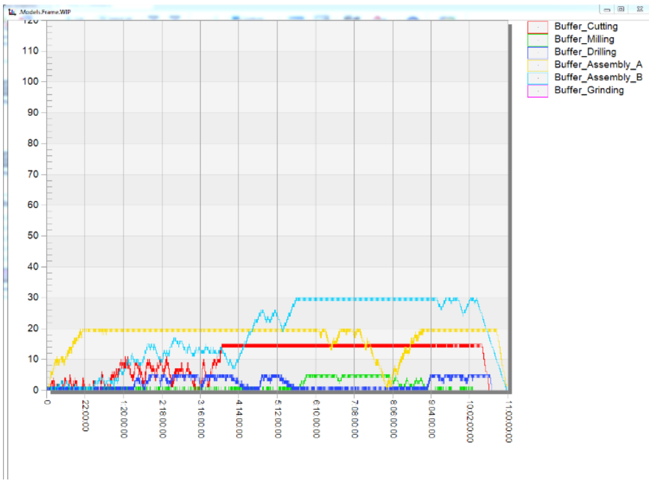
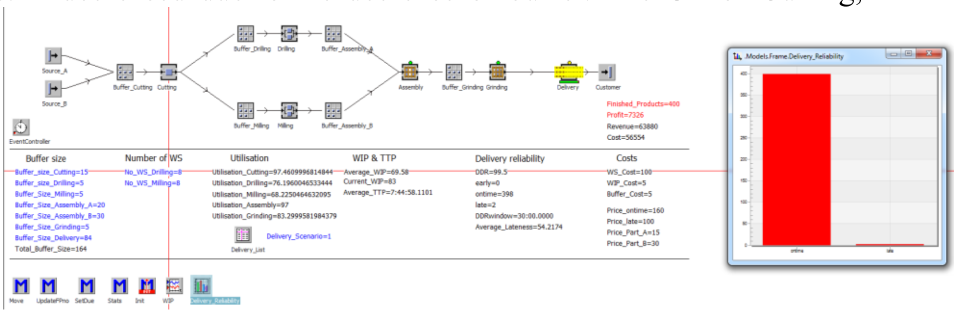


Figure 6: The WIP of optimum setup

Compare with the performance of initial setup, the income increased, the costs decreased, and the WIP decreased due to the decrease of buffer. The UT of Cutting, Drilling and Milling increased, and Grinding remains the same.



b.

Performance indicator	
Income	-16402
Costs	80282
WIP	97.6425
TTP	3:32:23
DDR	99.5
UT Cutting	91.2
UT Drilling	45.5
UT Grinding	83.3
UT Milling	52.8
UT Assembl	97

y	

Table 2: Performance of initial setup

Performance	indicator
Income	-4902
Costs	68782
WIP	97.6425
TTP	3:33:18
DDR	99.5
UT Cutting	91.2
UT Drilling	45.5
UT Grinding	83.3
UT Milling	52.8
UT Assembly	97

Table 3: Performance of 1st try

Performance	indicator
Income	7326
Costs	56554
WIP	69.58
TTP	7:44:58
DDR	99.5
UT Cutting	97.5
UT Drilling	76
UT Grinding	83.3
UT Milling	68.2
UT Assembly	97

Table 4: The performance of optimum setup

c.

For the optimum setup, the WIP is the lowest among all our setups. The TTP is the longest among all our setups. The DDR remains the same as the initial setup. The UT of assembly and cutting reached about 100%, but the grinding, drilling and milling are far behind 100%.

We find that by reducing the size of buffer we can spend less cost on buffer. Also, by reducing the size far below the maximum usage of buffers in initial setup, we can make more utilization on each buffer. It indirectly reduces the cost of buffer since the utilization of each buffer increased.

Task 3:

a.

According to the UT Drilling and UT Milling in Table 1, which is the initial setup, and according to the formula of Utilization Rate as shown below,

$$UT = \frac{working\ time}{total\ avaliable\ time} * 100\%$$

45.53% and 52.82% shows that only about half of the workstations are actual working at their max available usage. In order to get the exact number of workstations the company need in this simulation, use the formula below.

$$No.required\ WS = \frac{No.current\ WS * UT}{100}$$

In this case:

Drilling WS:

$$\frac{8 * 45.53\%}{100} = 3.64$$

Milling WS:

$$\frac{8 * 52.82\%}{100} = 4.23$$

The above results lead to the Drilling WS number of 3 or 4 since there is no 0.6 workstation, and the Milling WS number of 4 or 5. The trial Performance Indicators are shown in part b Table 3.

b.

Key Performance Indicators			
	4Drilling 5Milling	3Drilling 4Milling	4Drilling 4Milling
Profit	-9402€	-16931€	-8402€
UT Drilling	90.71%	99.78%	90.71%
UT Milling	84.51%	96.28%	98.10%
Finished Products	400	391	400
Non-Important indicators			
Costs	73282€	73731€	72282€
Average WIP	97.64	146.62	97.64
Average TTP	4:07:44.2207	1:02:08:57.7454	15:04:00.6224
DDR	99.5	75.4	99.5
UT Cutting	91.206%	96.052%	91.206%
UT Assembly	97%	97%	97%
UT Grinding	83.300%	74.378%	83.300%

Table 5: Performance Indicators of different WS numbers

c.

Since Drilling can be changed into 3 or 4 and Milling 4 or 5, take the bigger numbers for the first trial. As shown above in Table 3, 4 Drilling and 5 Milling workstations increases the profit and fulfills customer demand. However, the Utilization Rate of Drilling and Milling can still be improved.

The second trial takes the smaller numbers. The Utilization Rate of both Drilling and Milling have reached the maximum; however, only 391 products are finished and out of these products only 75% are on time which leads to a great loss of Revenue.

The last trial is the most fit scenario of the Workstations, which takes 4 Drilling and 4 Milling respectively. It has high Utilization Rates, the maximized profit and has fulfilled the customer demand of 400 units.

Task 4

a.

To make the highest profit fulfilling the demand of customers, the size of the buffer and the number of work stations had to be adjusted. First, from the previous task (task 3), we figured it out that work station of 4 drilling and 4 milling is the optimized number of work station.

Then, to determine the buffer size, it was decided using the processing time of the work station and demand pattern.

WS name	Processing time (min.)
Cutting	10
Drilling	60
Milling	140
Assembly	35
Grinding	30

Table6: Processing times for each WS

Cutting is the first production process, so there is no need for buffers before cutting machine. Cutting machine should make two A components and one B component. Therefore, since it takes 10 minutes per piece and have to make 3 pieces, it takes 30 minutes in total.

Processing time for cutting:

$$(1 + 2) * 10 = 30 \textit{(min.)}$$

After cutting is over, two A components enter the drilling machines and one B component enters the milling machines.

Processing time for drilling:

$$\frac{2*60}{4} = 30(min.)$$

Processing time for milling:

$$\frac{140}{4} = 35(min.)$$

Since the processing time is different, for component A should wait for 5 extra minutes to go into assembly together with component B. Therefore, there should be no reason to have drilling buffer but have to have enough assembly A buffer for the drilled component A. On the other hand, component B can go into Assembly right after the milling, which means there is no need to have Assembly B buffer but there should be more buffer before milling.

For the same reason, because grinding is finished in 30 minutes and the assembly takes 35 minutes, the grinding process can be done immediately without the need for a buffer when the assembly is finished.

Lastly, buffer size for the delivery should be in between 80 to 90 since the customer's acceptable time window is ± 30.

b.

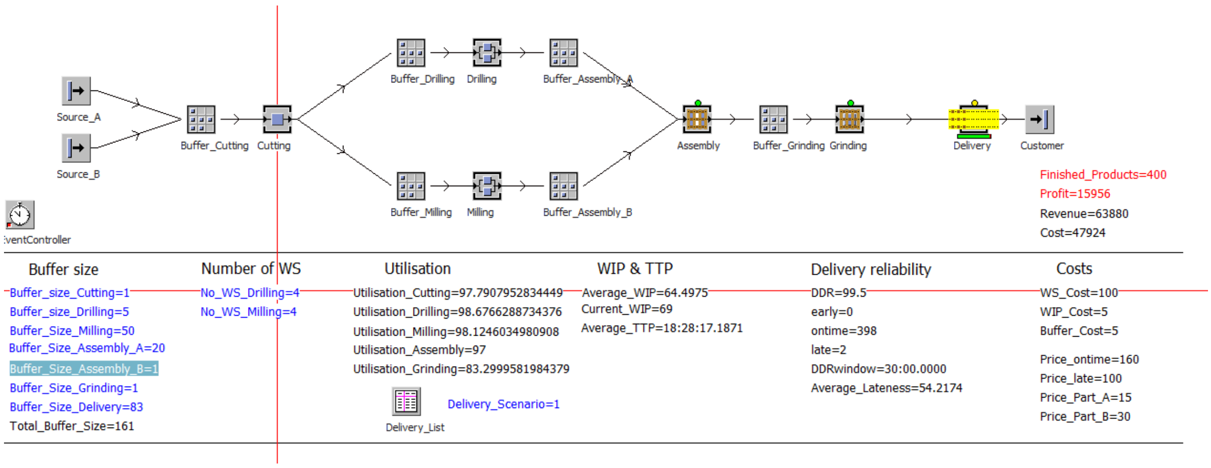


Figure 7: Performance Indicators of Scenario 1

c. Utilization of the machines are mostly over 95 percent which is almost ideal degree. And the UT of Grinding was not close to 100%, because Assembly takes 35mins and Grinding takes 30mins. Totally UT is considered as good. Comparing to the initial setup, average work in process has been greatly reduced from 118 to 64.5

which decrease the blocked capital. However, the average throughput time has been skyrocketed from 3 hours to 18 hours. In this case, it does not matter because they deliver the product in every other day. Due date reliability is also almost an ideal degree that there are only 2 late products out of 400. Since most of the customers got the product in time, DDR is evaluated as very good.

Task 5

a. By changing from scenario1 to scenario 2, the demand pattern of the customers has changed. Customer requires a medium-size batch every other day in the scenario 1, but in the 2nd scenario, the batch sizes are larger and they need to be delivered every third day. Therefore, buffer size for the delivery should be changed to at least 130. And since every process go in same way, every setting besides buffer size stays same as Task4.

b.

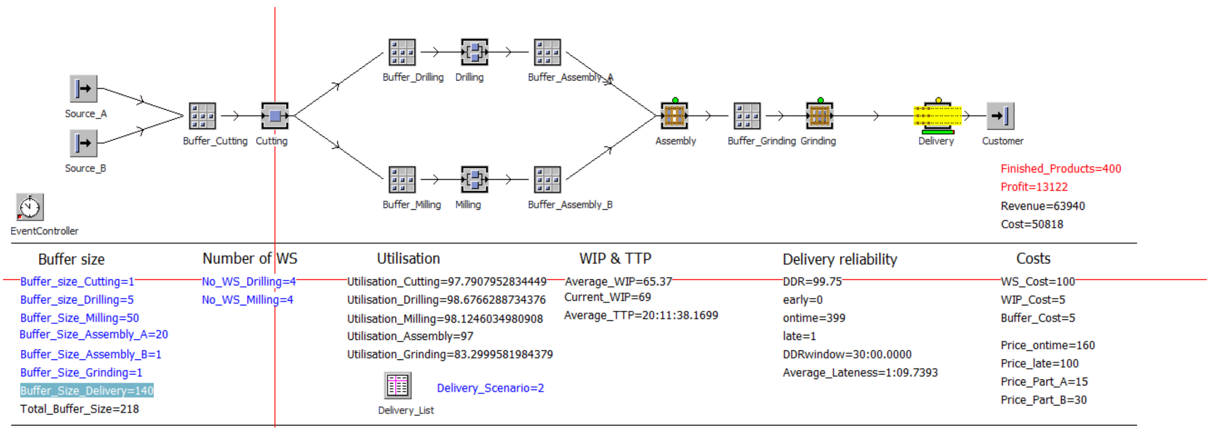


Figure 8: Performance Indicators of Scenario 2

c.

There is not much changes of setting and therefore have similar WIP, TTP, DDR and UT as a result from the previous task.

Task 6

a.

1. receive 1-part B and 2-part A at same time with a fixed interval
2. receive 20-part B and 40-part A at same time with a fixed interval
3. receive 10-part B and 10-part A at same time with a fixed interval

I recommend the first one and additionally requires is with an interval 30 min, because cutting three source requires just 30min, thus we don't need lots of buffers in the process line. But this kind of delivery is not practical. Company won't deliver goods one by one.

Practically, I recommend the second one or all other methods that delivers part B and part A in a ratio of 1:2, since one production requires one part B and two part A.

b.

1. record the storage in each buffer each one second, then divided by total seconds
2. record the storage in each buffer per day, then divided by total days
3. record the storage in each buffer per hour, then divided by total hours

If the measurement take place in simulation, I will recommend the first one, since it is very accurate. And there are seldom events taken within one second so one second is precise enough.

If the measurement take place in real world, I will recommend the third one, since per hour is a reasonable and practical interval of record WIP. One day is to long for recording the WIP of a product that only takes 130 mins to produce.