Homework 5

DESIGN AND ANALYSIS OF PRODUCTION SYSTEMS

Nick Morris
10/30/2015

Problem 1

Table 1 below includes the capacity in parts/hour for each of the described assembly lines A – E.

Table 1: Capacity Calculations

Metric	Value	Units
Capacity_A	9	[part/hr]
Capacity_B	4	[part/hr]
Capacity_C	3	[part/hr]
Capacity_D	10	[part/hr]
Capacity_E	12	[part/hr]
Capacity_F	8	[part/hr]

Problem 2

The bottleneck, bottleneck rate, raw processing time, critical WIP, and WIP given 50% uptime for Station 2, is shown below in that order from the first to last row of Table 2. Critical WIP drops by one unit when uptime drops from 75% to 50% for Station 2. This shows that less WIP is necessary due to the likelihood of downtime. If WIP where to be any higher, then the raw processing time, under this condition, would be unachievable due to a buildup in front of Station 2 during its downtime events.

Table 2: Production Metrics of a Three Station Line

Metric	Value	Units
BottleNeck	Station 2	NA
r_b	3.75	[part/hr]
T_0	41	[min]
W_0	2.6	[parts]
W_0|UT_2=50%	1.7	[parts]

Problem 3

Table 3 below gives the bottleneck for each of the three scenarios A – B where the ratio of volume of incoming parts for two different parts vary. I would chose scenario C, where the volume of bearings is nine times that of the volume of bushings, because it results in a more desirable utilization, without overworking the process at Station 3.

Table 3: PM Manufacturing Line Bottlenecks

Metric	Value	Utilization
BottleNeck_A	Station 3	23.8%
BottleNeck_B	Station 3	38.1%
BottleNeck_C	Station 3	81%

Problem 4

Table 4 below gives the current bottleneck for the print shop and corresponding utilization. Station 1 is the bottleneck due to having the highest utilization between the two stations under comparison.

Table 4: Two-Station Print Shop (Part 1)

Metric	Value	Utilization
BottleNeck	Station 1	86.7%

Problem 5

Table 5 below gives the production metrics for a production line across 5 different scenarios A – E where station capacity and processing times vary. Scenario A represents the current state. Scenario B adds a station to the bottleneck which doubles the bottleneck throughput. Scenario C cuts down the processing time of the bottleneck station in half which reduces the raw processing time, in these conditions, by one hour. Scenario D adds a station to the station just before the bottleneck which has no impact on the bottleneck throughput or raw processing time of the line. Scenario E cuts down the processing time of the station just before the bottleneck in half which reduces the raw processing time, in these conditions, by half an hour.

These scenarios show that if an hour is saved at a non-bottleneck station, due to cycle time improvements, will reduce the raw processing time of the line. If an hour is saved at a non-bottleneck station, due to throughout improvements, then no improvement to the line will be made.

Table 5: Production Metrics of a Four Station Line

Metric	Value	Units
r_b_A	0.5	[job/hr]
T_0_A	5	[hr/job]
r_b_B	1	[job/hr]
T_0_B	5	[hr/job]
r_b_C	1	[job/hr]
T_0_C	4	[hr/job]
r_b_D	0.5	[job/hr]
T_0_D	5	[hr/job]
r_b_E	0.5	[job/hr]
T_0_E	4.5	[hr/job]

Problem 6

Table 6 below gives the bottleneck under the worst case scenario for the print shop and corresponding utilization. Station 2 is the bottleneck due to having the highest utilization between the two stations under comparison.

Table 6: Two-Station Print Shop (Part 2)

Metric	Value	Utilization
BottleNeck	Station 2	100%

Problem 7

Table 7 below gives the bottleneck under the practical worst case scenario for the print shop and corresponding utilization. Station 2 is the bottleneck due to having the highest utilization between the two stations under comparison.

Table 7: Two-Station Print Shop (Part 3)

Metric	Value	Utilization
BottleNeck	Station 2	100%

Problem 8

Table 8 below gives the current state bottleneck rate, raw processing time, and critical WIP in the first section. The second section gives the line's cycle time under best case, worst case, and practical worst case scenarios where WIP is fixed at a value of 20 parts. The third section gives the line's WIP under best case, worst case, and practical worst case scenarios where throughput is fixed at 90% of the bottleneck rate, a value of 18 parts/hour.

If the line currently maintains the critical WIP level but performs at a cycle time of 100 minutes, then the line is approximately twice as bad as the raw processing time and bottle neck rate. This line has a better cycle time than the practical worst case of the 20 WIP line. This line has significantly better WIP than the practical worst case in the 90% of bottleneck rate line. Overall I would place this design better than the 90% of bottleneck rate line but worse than the 20 WIP line and optimal line. This line has room for improvements at the bottleneck station because parts must be piling up in the queue of the bottleneck station which results in a lead time twice as slow as the raw processing time despite the line following the critical WIP design.

Table 8: Production Metrics of a Three Station Line

Metric	Value	Units
r_b	20	[part/hr]
T_0	0.8	[hr]
W_0	16	[part]
WIP	20	[part]
CT|BC	1	[hr/part]
CT|WC	16	[hr/part]
CT|PWC	2	[hr/part]
TH	18	[part/hr]
WIP|BC	14.4	[part]
WIP|WC	> 135	[part]
WIP|PWC	135	[part]

Problem 9

Table 9 below shows the bottleneck rate, raw processing time, and critical WIP for each of the two lines under comparison, Old and New. The Old line has larger WIP due to a more imbalanced line with slower processing speeds at each station. This results in a lower bottleneck rate but a significantly larger raw processing time compared to the New line. The current production of the Old line compared to its practical worst case is very similar, whereas the current production of the New line compared to its practical worse case is much lower. In both cases there is much room for improvement to approach the best case performance. But management is wrong to criticize the Old line when the New line is underutilizing it's capabilities and performing more inefficient relative to the Old line.

If I were the manager I would first improve the New line by reducing and controlling its WIP levels because the processing times at each of the stations warrant a continuous flow process which requires minimal WIP. This is supported by the critical WIP value of 3.92 ≈ 4 for a 4 station line. I would then improve the Old line by first line balancing the process to warrant a continuous flow process that currently isn't possible. After line balancing I will then be able to recalculate the critical WIP value to approach.

Table 9: Positively Rivet Inc. Production Metrics Comparison

Metric	Value	Units
Old_r_b	40	[part/hr]
Old_T_0	0.22	[hr/part]
Old_W_0	8.8	[part]
New_r_b	120	[part/hr]
New_T_0	0.03	[hr/part]
New_W_0	3.92	[part]
Old_CT|PWC	10.2	[hr/part]
Old_TH|PWC	39.2	[part/hr]
Old_TH_Actual	39.4	[part/hr]
New_CT|PWC	2.9	[hr/part]
New_TH|PWC	119	[part/hr]
New_TH_Actual	85	[part/hr]

Problem 10

Table 10 shows the bottleneck rate, raw processing time, critical WIP, practical worst case cycle time, and practical worst case throughput. The estimated average WIP level is given as WIP_Actual in Table 10. The current performance of the line is very similar to the practical worst case. Increasing the production capacity of the bottleneck station while holding the current levels of WIP would increase the throughout and decrease the cycle time. Replacing a single station with 4 parallel stations at equivalent cumulative production capacity, and maintaining the same level of WIP, would maintain the current systems throughput but increase the cycle time of the line. A batch system instead of the current one-piece flow would increase utilization of each station, and increase line cycle time.

Table 10: Floor-On Ltd. Production Metrics

Metric	Value	Units
r_b	2000	[part/day]
T_0	0.0313	[day/part]
TH_Actual	1700	[part/day]
CT_Actual	0.219	[day/part]
WIP_Actual	371.9	[part]
CT|PWC	0.217	[day/part]
TH|PWC	1716	[part/day]