ISE 2214 Manufacturing Processes Laboratory
CRN: 16793
Laboratory Report

SB-A: Switch Box Assembly

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Introduction:

The objective of the SB-A: Switch Box Assembly lab is for students to learn and gain perspective of manufacturing utilizing assembly lines. Five students reenact an assembly line producing switch boxes, while the other students will time intervals using stop watches. The main purpose of this is for students to understand basic concepts of assembly lines as well as emphasizing time efficiency.

Equipment:

The equipment used in the Switch Box Assembly:

Conveyor Belt: used to moved components to each stage of the production line
Raw Materials: the switch box components such as: switch, light, screws, back plate, box, wires, on/off indicator, and various washers/nuts
Tools: screwdriver to screw down back plate, wires connected to battery to check if switches were faulty
Measuring devices: stopwatches used to measure workers' production times

Procedure:

SB-A lab's procedure includes conducting five separate experiments with a five-station assembly line. Unpaced lines (lines where the parts are moved when a worker is done with it) are used in Experiments 4 and 5, whereas paced lines (parts are moved by conveyor at time intervals) are used in Experiments 1, 2, and 3. Experiment 1 was done at 1 minute 30 second cycle time, Experiment 2 was done at 1 minute cycle time, Experiment 3 was done at 20 second cycle time. The information gathered throughout the experiments by students who recorded the times was documented using copies of pages 13–14 from the lab manual. Experiment 1 was of the best quality as it had no rejections, but only four cycles in 6 minutes. Experiment 2 followed, where the cycle time decreased to four cycles in four minutes, but quality decreased as there were two rejects. For Experiment 3, there were a total of 6 cycles in 2 minutes, but there were four rejects. None of the components were moved between the stations in experiments 1,2, or 3, and for these experiments there were five-time recorders. The unpaced lines had seven-time recorders, with extra ones at the beginning and end recording arrival and departure. Experiment 4 had a total work time of three minutes and had two rejects. There were no bottlenecks during Experiment 4, the only starved station was 5 the quality control operator. Experiment 5 started with the instructor moving components around between station 1-4 (quality control cannot do any work as they must remain impartial). The total working time for this experiment was 2 minutes and 30 seconds and there were no rejects, but there were some faults. Bottlenecks sprouted up at station 2 and 4, station 1 and 3 were blocked and their productivity fell dramatically. Similarly, to Experiment 4 station 5 was also starved during this final experiment.

Presentation of Results:

Below is a table representing the data collected from the data sheets

Station 1									
Experiment #	Cycle 1 (s)	Cycle 2 (s)	Cycle 3 (s)	Cycle 4 (s)	Cycle 5 (s)	Cycle 6 (s)	Cycle 7 (s)	Cycle 8 (s)	Avg Cycle (s)
1	51	46	29	41	N/A	N/A	N/A	N/A	41.75
2	40	18	16	22	N/A	N/A	N/A	N/A	24.00
3	15	17	15	16	13	19	N/A	N/A	15.83
4	34	19	26	15	20	22	24	N/A	22.86
5	5	4	4	2	2	4	4	4	3.63
Station 2									
Experiment #	Cycle 1 (s)	Cycle 2 (s)	Cycle 3 (s)	Cycle 4 (s)	Cycle 5 (s)	Cycle 6 (s)	Cycle 7 (s)	Cycle 8 (s)	Avg Cycle (s)
1	14	16	13	12	N/A	N/A	N/A	N/A	13.75
2	40	33	25	44	N/A	N/A	N/A	N/A	35.50
3	20	20	17	17	18	20	N/A	N/A	18.67
4	25	19	24	20	24	25	22	N/A	22.71
5	22	26	15	23	33	N/A	N/A	N/A	23.80
Station 3									
Experiment #	Cycle 1 (s)	Cycle 2 (s)	Cycle 3 (s)	Cycle 4 (s)	Cycle 5 (s)	Cycle 6 (s)	Cycle 7 (s)	Cycle 8 (s)	Avg Cycle (s)
1	21	30	23	23	N/A	N/A	N/A	N/A	24.25
2	36	33	27	38	N/A	N/A	N/A	N/A	33.50
3	20	12	13	14	11	17	N/A	N/A	14.50
4	34	33	33	33	34	N/A	N/A	N/A	33.40
5	18	24	32	17	32	N/A	N/A	N/A	24.60
Station 4									
Experiment #	Cycle 1 (s)	Cycle 2 (s)	Cycle 3 (s)	Cycle 4 (s)	Cycle 5 (s)	Cycle 6 (s)	Cycle 7 (s)	Cycle 8 (s)	Avg Cycle (s)
1	23	22	22	24	N/A	N/A	N/A	N/A	22.75
2	18	37	23	24	N/A	N/A	N/A	N/A	25.50
3	20	15	15	15	18	19	N/A	N/A	17.00
4	30	54	32	33	32	N/A	N/A	N/A	36.20
5	66	70	N/A	N/A	N/A	N/A	N/A	N/A	68.00
Station 5 (QC)									
Experiment #	Cycle 1 (s)	Cycle 2 (s)	Cycle 3 (s)	Cycle 4 (s)	Cycle 5 (s)	Cycle 6 (s)	Cycle 7 (s)	Cycle 8 (s)	Avg Cycle (s)
1	13	14	13	11	N/A	N/A	N/A	N/A	12.75
2	21	11	15	15	N/A	N/A	N/A	N/A	15.50
3	11	11	13	30	20	20	N/A	N/A	17.50
4	15	16	14	15	15	N/A	N/A	N/A	15.00
5	11	13	N/A	N/A	N/A	N/A	N/A	N/A	12.00

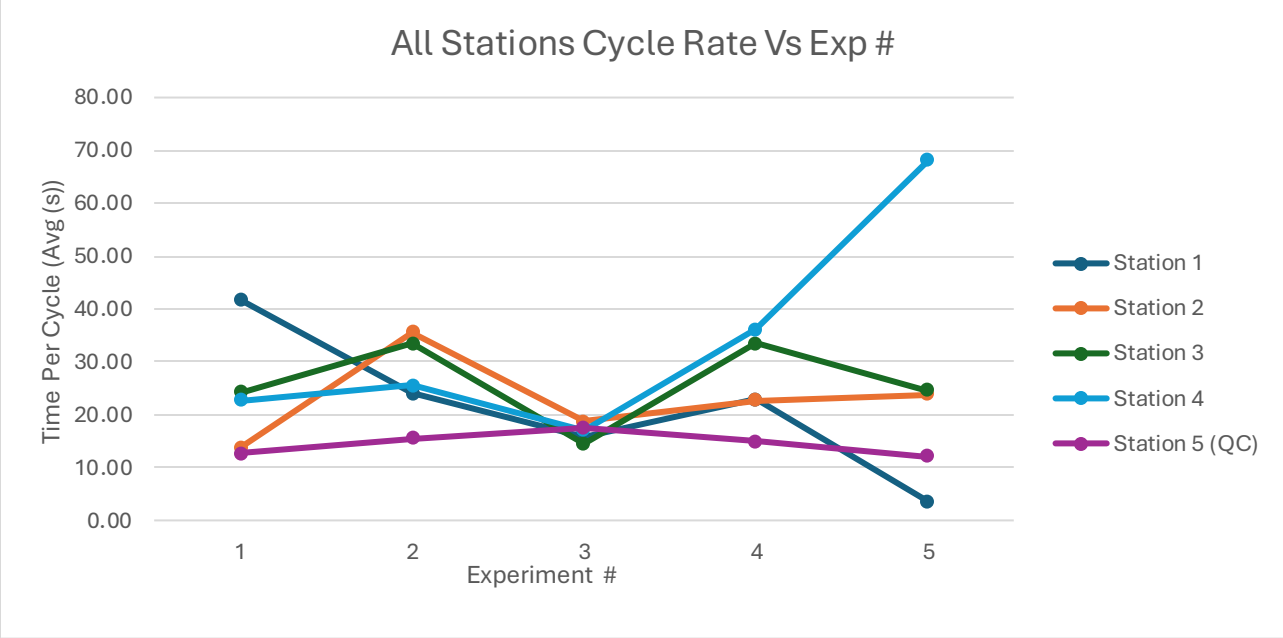
Below is a table with the required calculated values for this experiment

Experiment #	Throughput (Parts/hr)	%Rejects	Parts In Progress	Line Imbalance	Avg Idle Time %
1	40	0%	5	108.76	74%
2	60	50%	5	51.56	55%
3	180	67%	5	2.04	17%
4	100	40%	5.25	60.09	18%
5	48	0%	8.5	493.32	43%

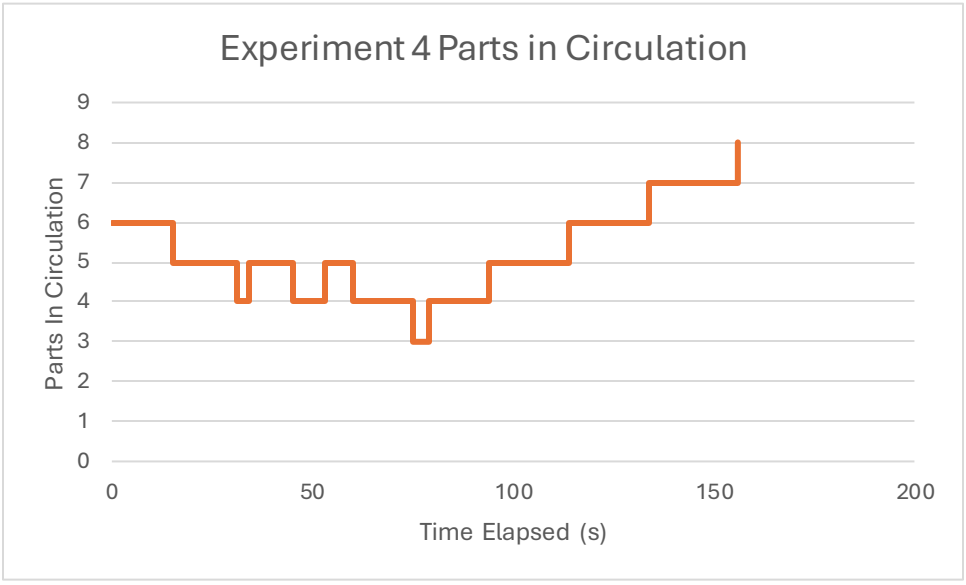
Below is a table with the task time values for each station and experiment

All Stations Avg By Experiment						
Experiment #	Station 1	Station 2	Station 3	Station 4	Station 5	All Stations
1	41.75	13.75	24.25	22.75	12.75	23.05
2	24.00	35.50	33.50	25.50	15.50	26.80
3	15.83	18.67	14.50	17.00	17.50	16.70
4	22.86	22.71	33.40	36.20	15.00	26.03
5	3.63	23.80	24.60	68.00	12.00	26.41

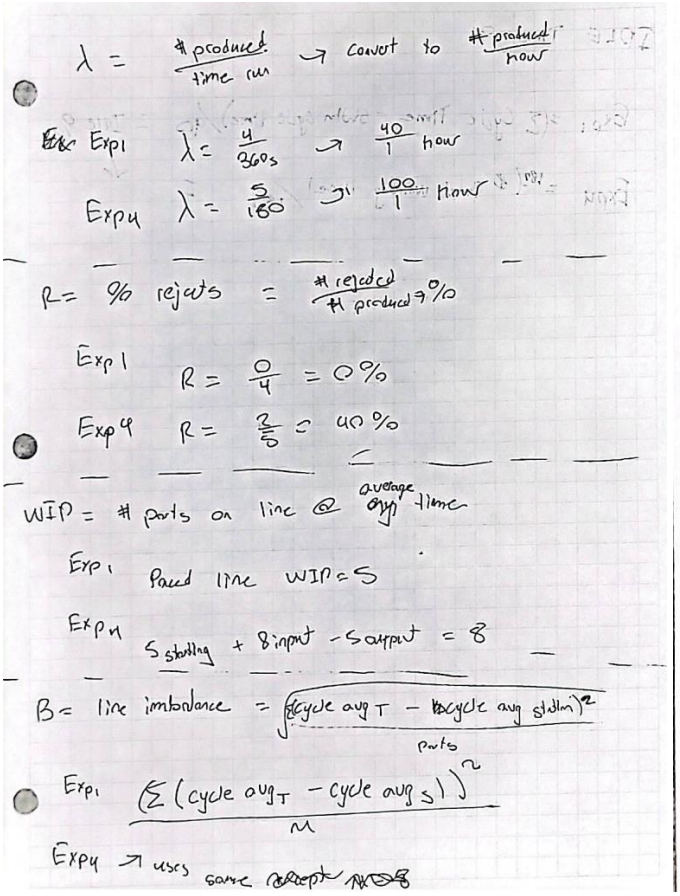
Below is an additional Graph of cycle rates for all stations

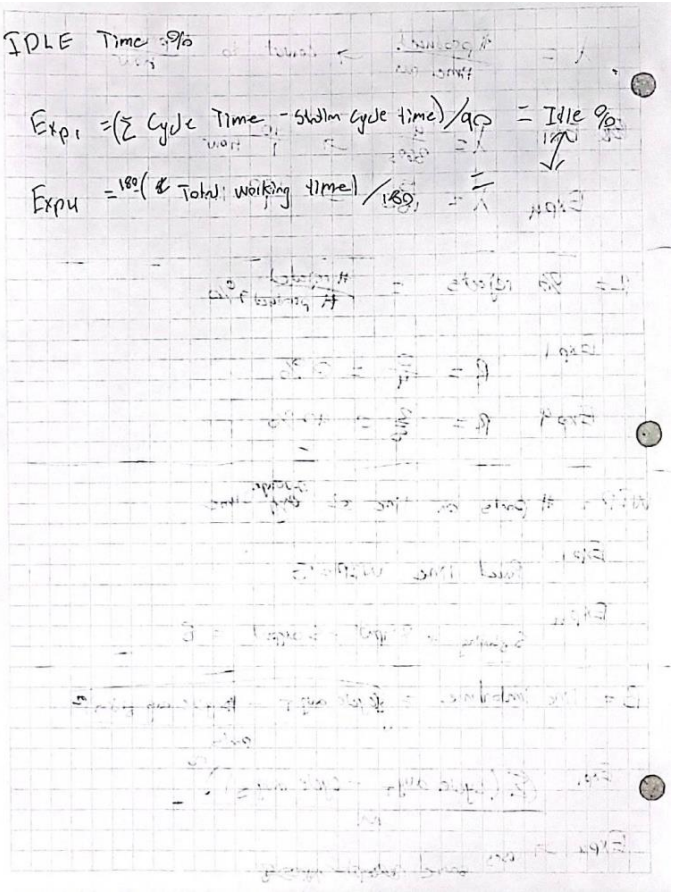


Below is the required w(t) graph for Exp 4:



Below is the work done for Experiments 1 and 4 calculations





Discussion of Results:

1. I believe that the best result from the paced lines was achieved with the 3rd experiment. This is because the number of acceptable parts per hour was the highest, the average idle time was the lowest, and the imbalance between stations was at the lowest. While the line had qc issues the overall average acceptable output remained the highest at 60 parts per hour.
2. I believe that the best result from the un-paced line experiments was achieved with experiment number 4. This experiment had a higher throughput of the two as well as a lower imbalance of work between stations. All being said however the throughput of acceptable parts was the same as experiment 3 with experiment 4 having more drawbacks on average.
3. As mentioned above in part 2 the measured drawbacks from experiment 4 are greater than those of experiment 3. While this is un-intended and not what the lab intended to show the results speak for themselves as between the 2 runs of 60 acceptable parts per minute the disparity and parts on the line is higher for experiment 4. Experiment 4 does however waste far less parts per produced acceptable part.
4. Experiment 4 only experienced starving at station 5, the quality control station. This occurred because station 5's task length was only a couple seconds long as it was just connecting the box to power and checking if the light turned on and off. This meant that station 5 was done much quicker than the other stations with their task and therefore experienced starving. During Experiment 5, blocking occurred at stations 1 and 3, also starving persisted at station 5. The cause for the blocking in experiment 5 was the fact that the lab instructor moved the box components around between stations hoping to even the workload between the workers. What ended up happening was stations 2 and 4 became overloaded with work bottlenecks appeared, and lead to blocking at stations 1 and 3.
5. Considering the experiments performed one condition in which a paced line would be better than an unpaced line would be if that amount produced was the priority, we saw that that more cycles were completed in a shorter amount of time with paced lines than unpaced. Even though quality suffered, if production quantity is your goal, then paced lines would be the best option. Another condition is which paced lines would be preferred to unpaced lines is if you want to keep workers working consistently, unpaced lines can have imbalance and some stations on the production line can sit idle for long periods of time. While in a paced line of for example 45 seconds the workers have something to do every 45 seconds and there still may be some idleness at stations, but it won't be as much as with an unpaced line. This would bode well for large companies as they would want production line employees to do roughly the same amount of work per shift, no matter where they are on the line.

Conclusions:

The results of this lab concluded that the third experiment with a paced line and the fourth experiment with an unpaced line were the most effective from each method. If the company was valuing quantity over quality, experiment three paced would be the best strategy. However, if they were prioritizing quality, then the design of the fourth unpaced experiment would be the ideal option. The instructor gave us multiple scenarios, good and bad, that showcased how minor changes to the production line can drastically affect the overall production speed and quality. Especially seen in the unpaced lines how blocking scenarios that can take place at stations

that are overworked, and starving can happen at stations that are underworked. One of the main takeaways from this lab is that a paced manufacturing line is ideal, because companies' main goal is to meet product demands. This would also be ideal for workers since they would essentially be contributing an equal amount of effort, and they are likely to be paid the same—aside from the inspectors. This lab also introduced us to a few key skills we will be utilizing in future labs, inspecting and reflecting on results.