Advanced Simulation

Homework 1

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2/23/16

Proposed Improvement

Description:

An improvement for this system is a new work schedule for the three work cells. This will have no additional expense of labor, money, or space to implement. The current schedule for each of the three machines is working for three hours, and then taking a break for 3 hours, such that this pattern continues for 24 hours. This current schedule results in higher production variability across the 24 hours and allows WIP to build up and create longer queues. The proposed new schedule leaves one cell working at the current schedule, the second cell starts 3 hours later and follows the same pattern as the current schedule, and the third cell starts 1.5 hours later and follows the same pattern as the current schedule. This solution results in each cell working for 3 hours and taking a break for 3 hours, as it was before, but at any given time during the 24 hours, there is always one or two work cells available to work. This solution was intended to level the production variability through work cell availability, to reduce the average time in system.

It is important to note that the current system needed to be updated such that WIP always choses a work cell with the shortest queue length, given that the work cell is available at the time of the decision. Another update to the current system was that the processing times in the work cell were deterministic, this was changed to stochastic using exponential distributions with means about the given deterministic process times.

Analysis Results:

The analysis chosen to compare these two systems involved the use of common random numbers and the Welch Two Sample t-test. The first data set gathered was 30 replications of the average time in system for WIP in a 24 hour day, for the current system. The second data set gathered was 30 replications of the average time in system for WIP in a 24 hour day, for the system with the proposed improvement. The third data set gathered was 30 replications of the average time in system for WIP in a 24 hour day, for the current system using CRN. The fourth data set gathered was 30 replications of the average time in system for WIP in a 24 hour day, for the system with the proposed improvement using CRN.

The CRN were implemented such that the arrival rate of WIP, and the processing times for each WIP entity follow the same stream of random numbers. The use of CRN allows both systems to be dependent because they're processing the same entities, at the same arrival rate, at the same processing times. The first two data sets gathered, did not use CRN, so these are considered to be independent systems.

The Welch Two Sample t-test, using unequal variance, for the comparison of the independent systems is given below:

```
Welch Two Sample t-test - Unequal Variances - Independent Systems

data:  dat[, 1] and dat[, 2]
t = 35.487, df = 54.038, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 3.094019 3.464546
sample estimates:
mean of x mean of y
 7.551240  4.271957
```

This test states that the data shows we can be 95% confident that the difference in average time in system between the current system and the new system is between 3.09 and 3.46 hours where the new system has smaller time in system.

The Welch Two Sample t-test, using unequal variance, for the comparison of the dependent systems is given below:

```
Welch Two Sample t-test - Unequal Variances - Dependent Systems

data:  dat[, 3] and dat[, 4]
t = 30.157, df = 54.697, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 2.993703 3.419963
sample estimates:
mean of x mean of y
 7.499291  4.292458
```

This test states that the data shows we can be 95% confident that the difference in average time in system between the current system and the new system is between 2.99 and 3.42 hours where the new system has smaller time in system.

The width of the confidence interval for the independent system comparison is 0.3705 whereas the width of confidence interval for the dependent system comparison is 0.4262. This is unexpected as the use of CRN in the dependent system comparison is expected to yield smaller confidence intervals. The sample variance of the difference in average time in system for the independent systems is 0.2065 whereas the sample variance of the difference in average time in system for the dependent systems is 0.1094. This is expected, showing that the use of CRN decreases variance in the difference between two systems.