SEG2106
Assignment 4

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Presented to:
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Task 1

The first task consisted of modeling the system using Java. We followed OOP standards and kept a high-level of abstraction between classes.

Upon running the simulation, the statistics were as shown in Figure 1.

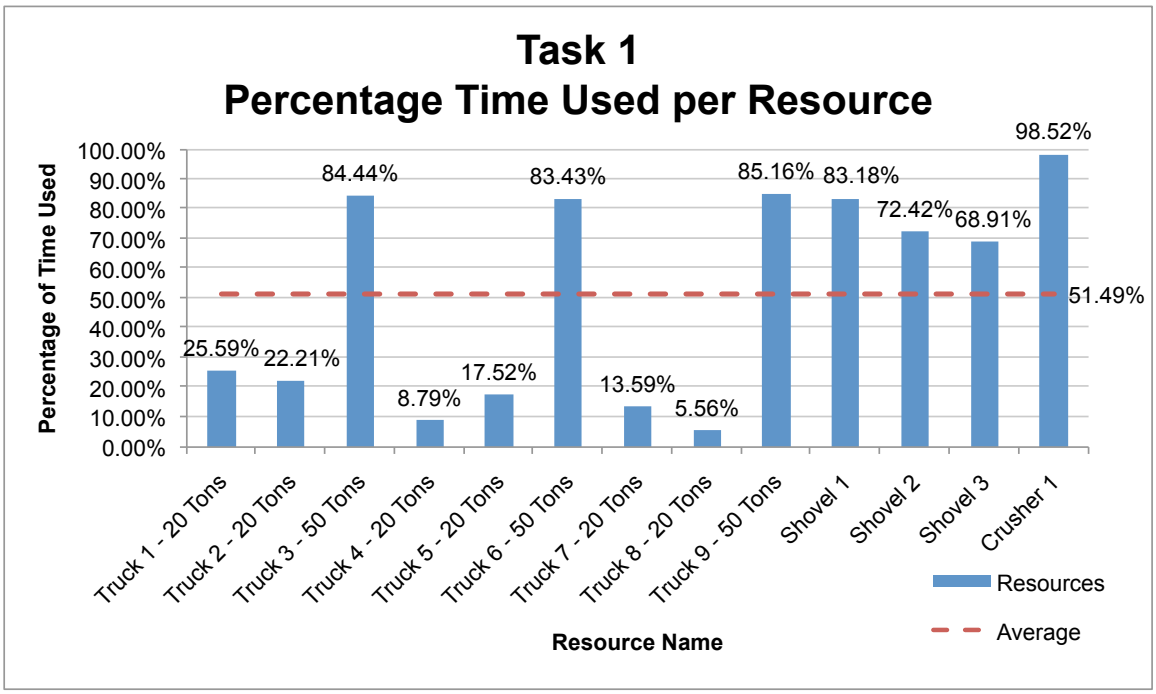

Figure 1 - Task 1 Results

As seen in the above results, you can clearly see that Truck 3, Truck 6 and Truck 9 have a higher ratio of time used then the other trucks. This clearly demonstrated the priority present on the 50 tone trucks on the Crusher.

Shovel 1	• Truck 1 • Truck 2 • Truck 3	Crusher 1
Shovel 2	• Truck 4 • Truck 5 • Truck 6	
Shovel 3	• Truck 7 • Truck 8 • Truck 9	

Table 1 - Shovel and Truck Assignments

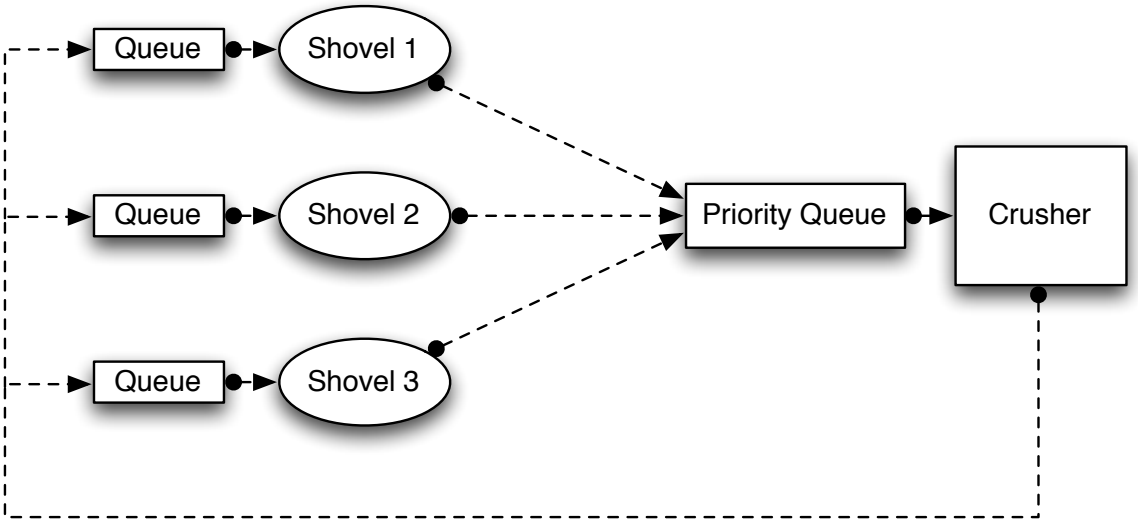

Figure 2 - The abstract layout of the system

Task 2

The second task consisted of changing the first model as demonstrated in <> in order to assign Shovel 1 priority and not the 50 tone trucks as in Task 1.

The results are shown in Figure 3.

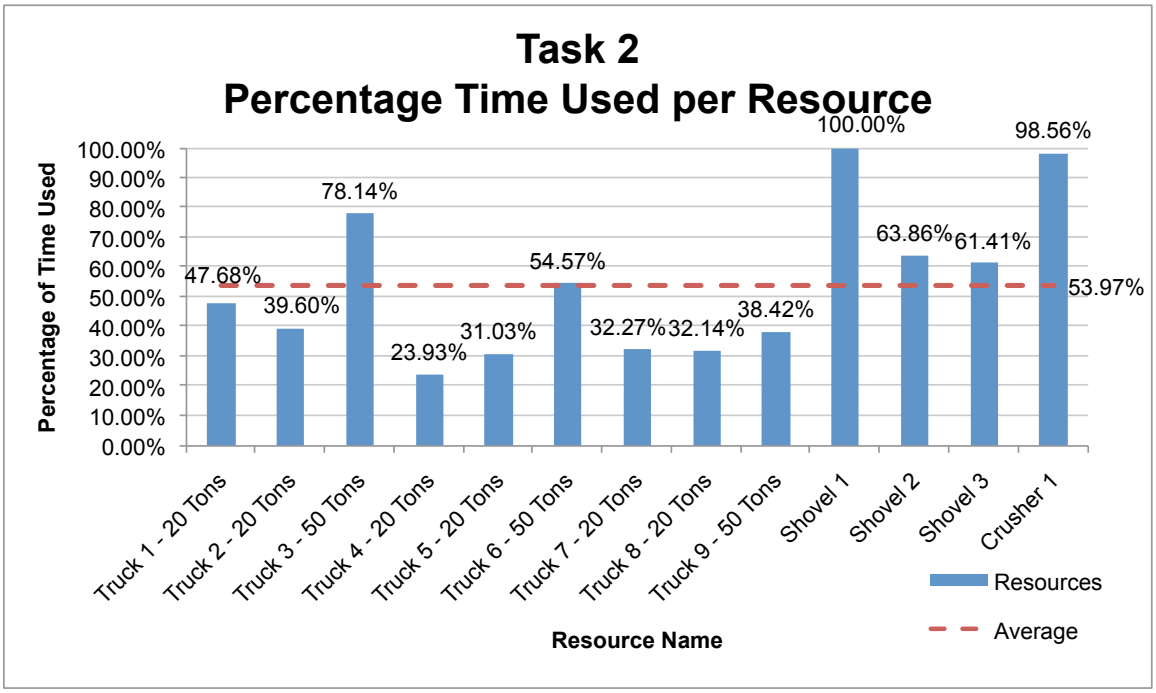

Figure 3 - Task 2 Results

As seen Figure 3 - Task 2 Results, Shovel 1 (see Table 1 - Shovel and Truck Assignments) has a higher usage time on average than the other Shovel's as noted in Table 2. The Shovel 1 is also being used at 100%, which makes sense since Shovel 1 has priority at the Crusher, its trucks are being chosen before Shovel 2 and 3.

Task 2 - Truck Averages	
Shovel 1	55.14%
Shovel 2	36.51%
Shovel 3	39.66%

Table 2 - Truck Averages per Shovel - Task 2

Task 3

This task was meant to find the optimal solution for the utilization ration. Below are some tests which were performed in order for us to find the optimal resource usage.

Test 1. 50-tone Truck test

The simulation tested using the same resources, namely 3 Trucks per Shovel, using one Crusher, except that every truck was 50-tones. The results are shown in Figure 4.

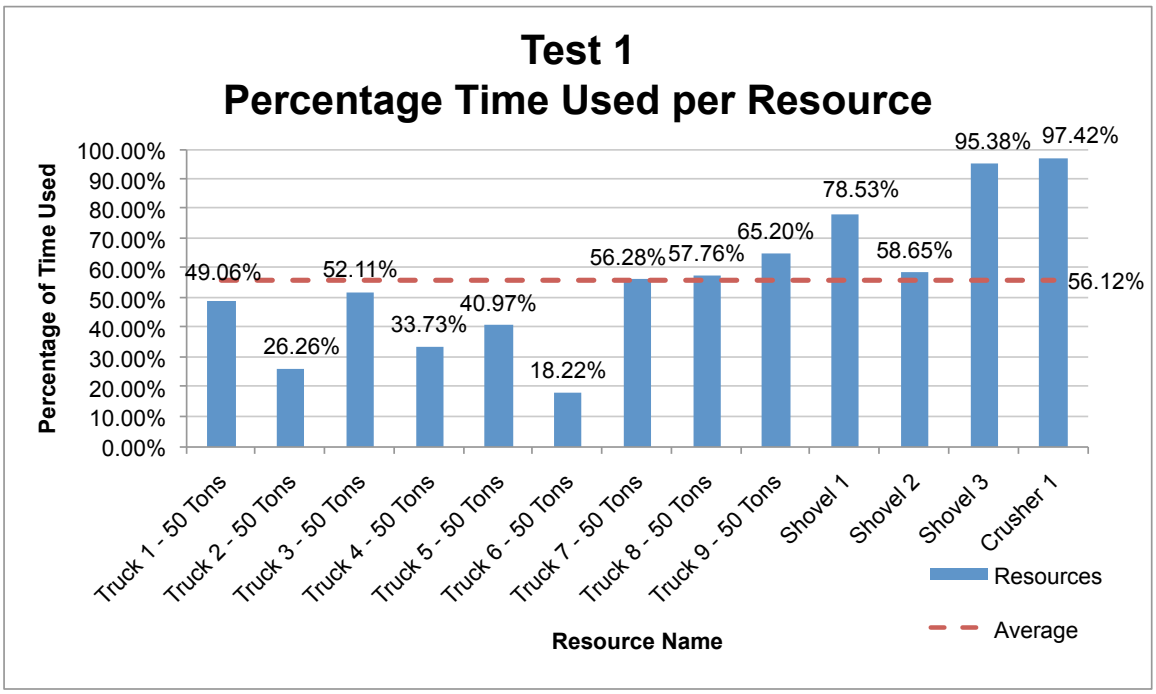

Figure 4 - Test 1 - All trucks are 50-tones

As you can see from the figure above, the trucks utilization ratios are quite low. It is likely that the bottleneck is the Crusher since they are being queued and loosing utilization efficiency.

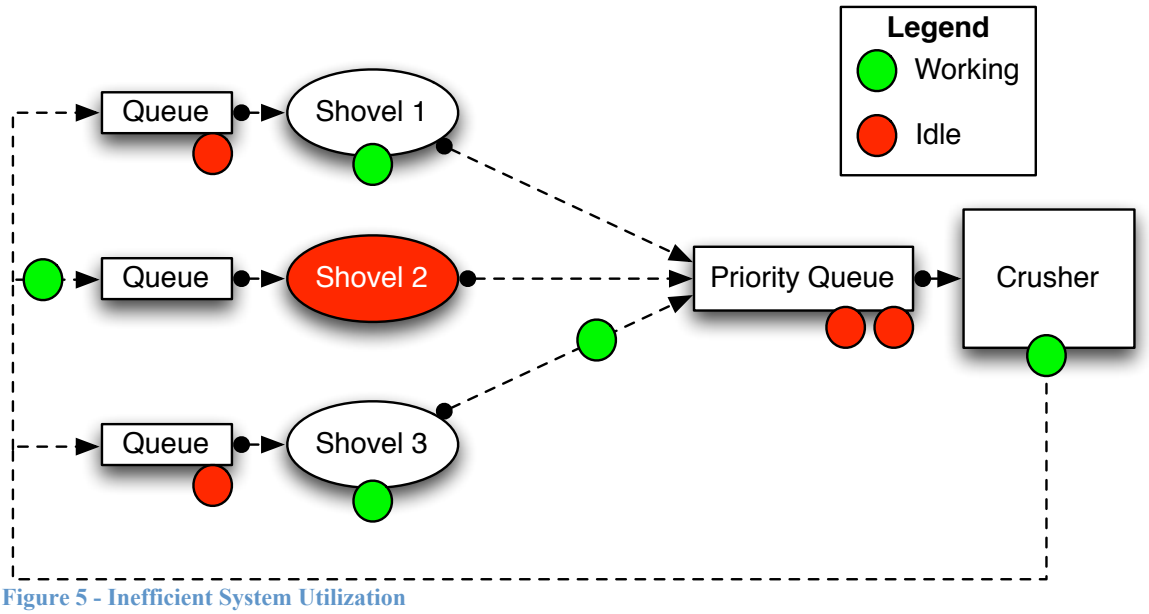

Figure 5 - Inefficient System Utilization

Seen in Figure 5 is a representation of what Test looks like, as you can see there are many idleling Trucks (and one Shovel). You can clearly see the Crusher's

queue building up which explains the usage ratio of the Crusher's being so high while other resources are idleling.

Test 2. Two Trucks per Shovel (4 Shovels / 8 Trucks)

This simulation tested two trucks per shovel versus having three. We have a total number of four Shovels and eight Trucks. The simulation results are displayed in Figure 6 below. Note that the trucks used in this test are all 20 tones.

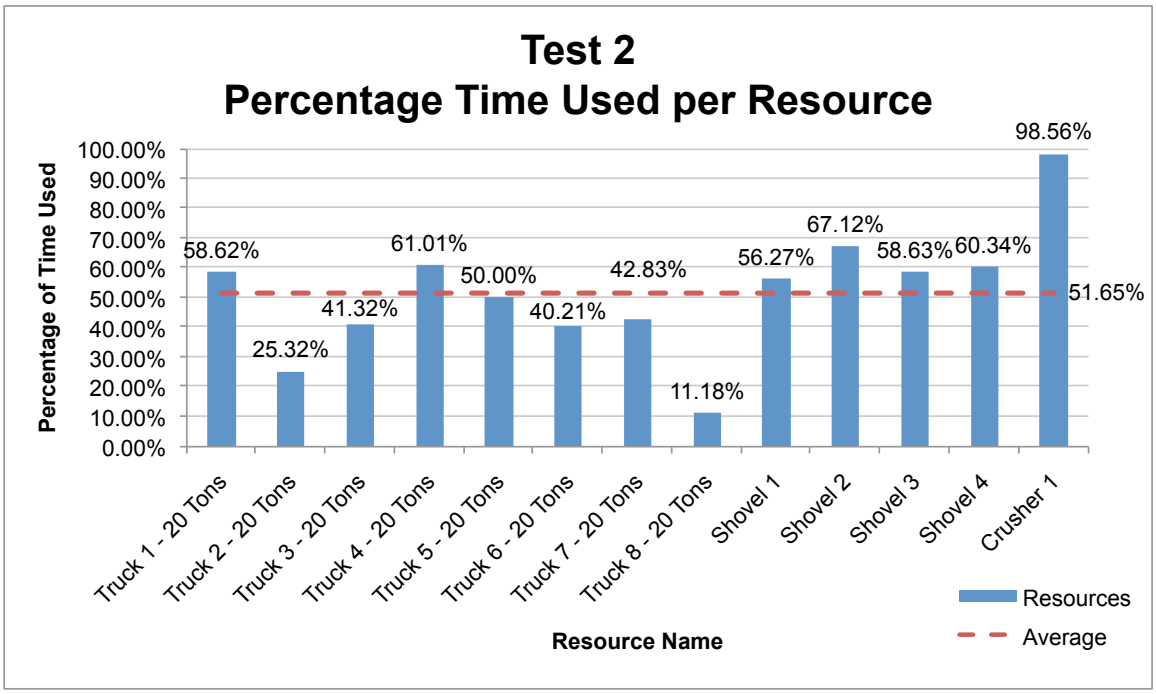

Figure 6 - Test 2 - Two Trucks per Shovel Test

The Truck utilization has improved over *Test 2 above*, but they are still not even used 50% of the time. The Crusher still seems to be the bottleneck.

Test 3. New Crusher using 3 Trucks per Shovel

In this new test, we decided to test using a different configuration. As the Crusher always seemed to be the bottleneck at close to 100% utilization, we decided a new Crusher is a good idea. This new crusher called the *SharedCrusher* utilizes the same queue as the original Crusher, as such the calling priority of trucks remains untouched.

The statistics using this new approach is shown in Figure 7 below.

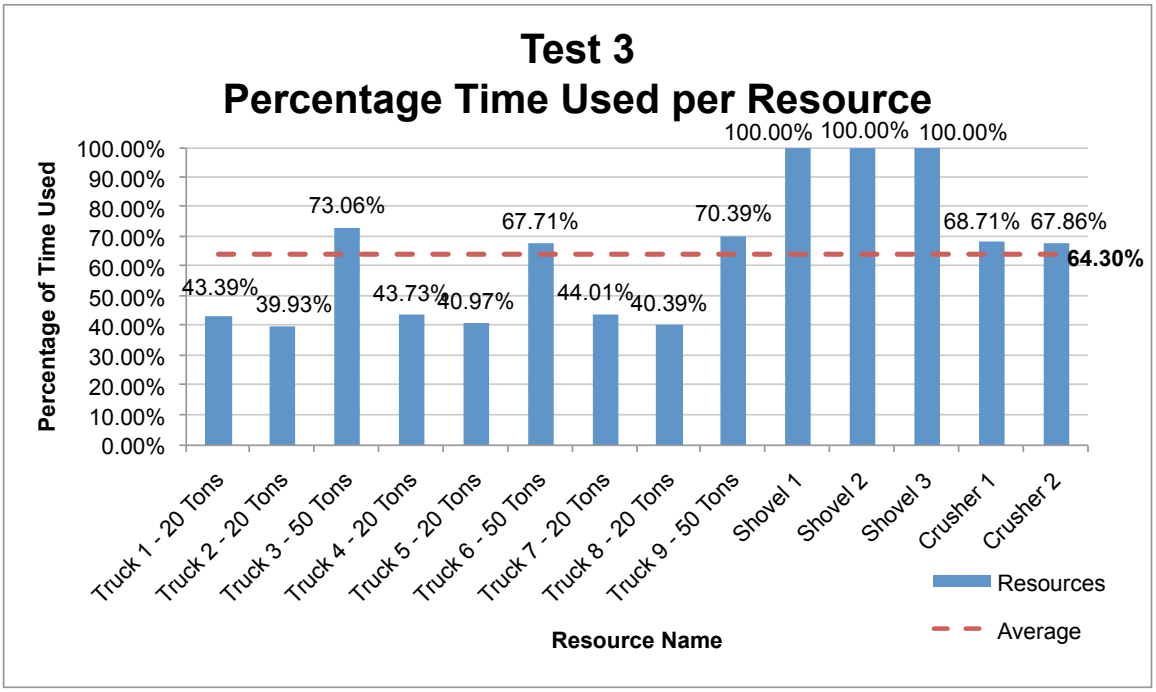

Figure 7 - Test 3 - A new Crusher

The new crusher seems to relieve the stress off of the other, being that they are both used about 70% of the time. The new bottleneck is clearly the Shovel's, all three being at 100% utilization, meaning they are getting through the Crusher now but queue'ing up at their respective shovel's and waiting more time to be served.

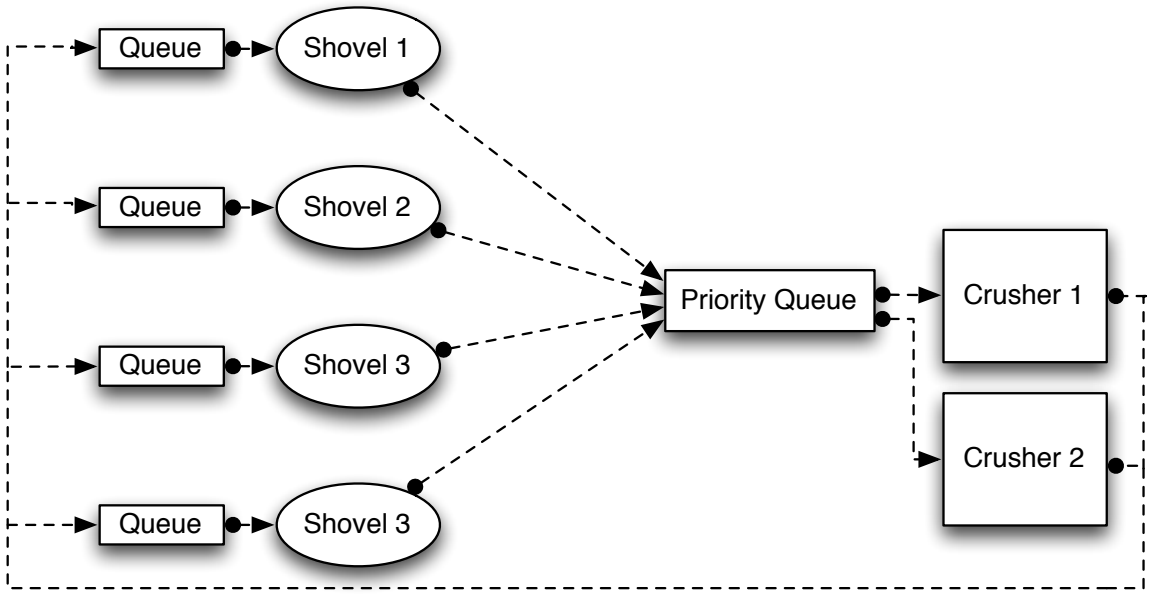

Figure 8 - Abstract representation of the System with a new Crusher

Test 4. Using the new Crusher with 2 Trucks per Shovel

The latest test proved a success for improving idle time at the Crusher's but not more stress is put into the Shovel's, which decreases both the trucks and Crusher's productivity.

This new test introduced another Shovel and assigned only two Trucks per Shovel, the results are shown below in Figure 9.

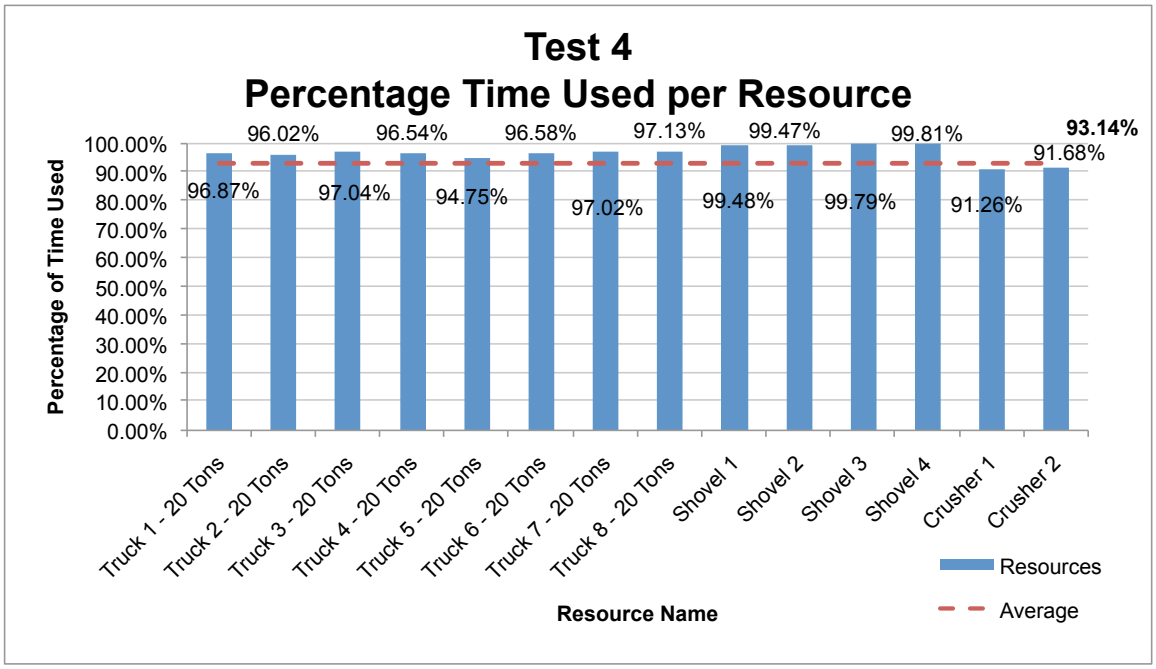

Figure 9 - Test 4 – Introducing a new Shovel and reassigning Trucks

It is clearly shown above that every resource is being used efficiently (93.14%), the idle time is minimized and the resources are being used at an optimal rate.

The configuration uses two Trucks (20 tone) per Shovel and using the two Crushers with a shared queue, which definitely seems to work perfectly.

The optimal configuration is clearly 4-2-1, meaning 4 Trucks, 2 Shovels with the Trucks equally distributed and 1 Crusher.

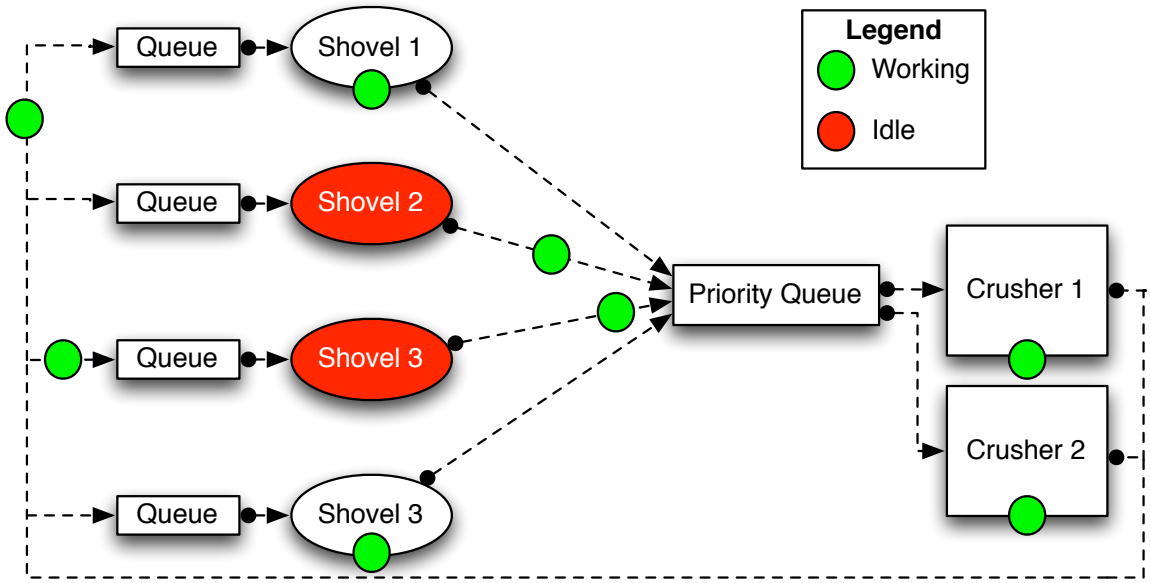

Figure 10 - Test 4 - Optimal Utilization System