Progress Report #2

Cross-docking Operations

"Anticipating Labor and Processing Needs of Cross-dock Operations"

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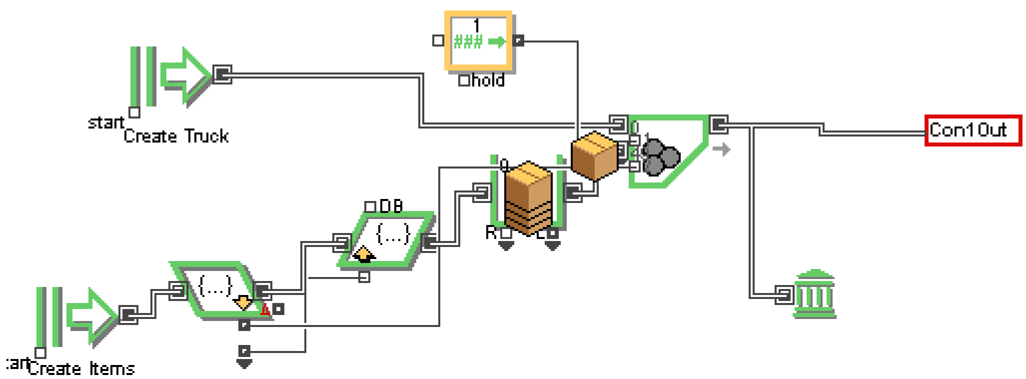
Introduction

This report contains a step-by-step explanation of the current model. Diagrams of each process are also included for clarity. In the end, some ideas for the future model are proposed.

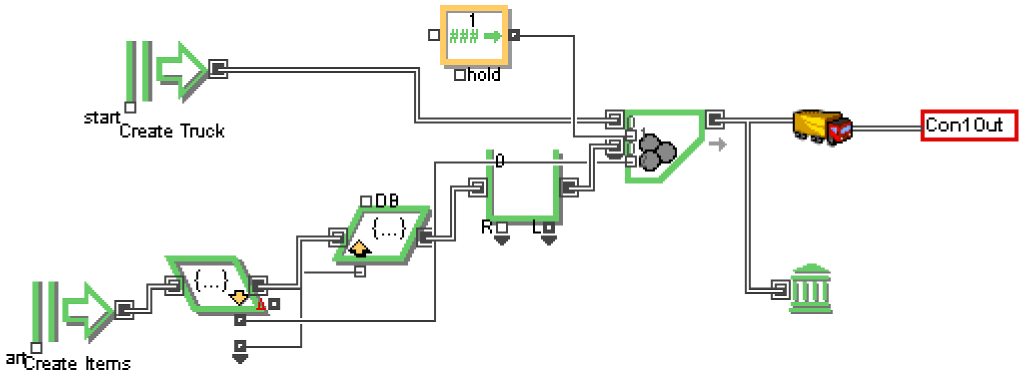
The Model

1. **Filling Items into a Truck**



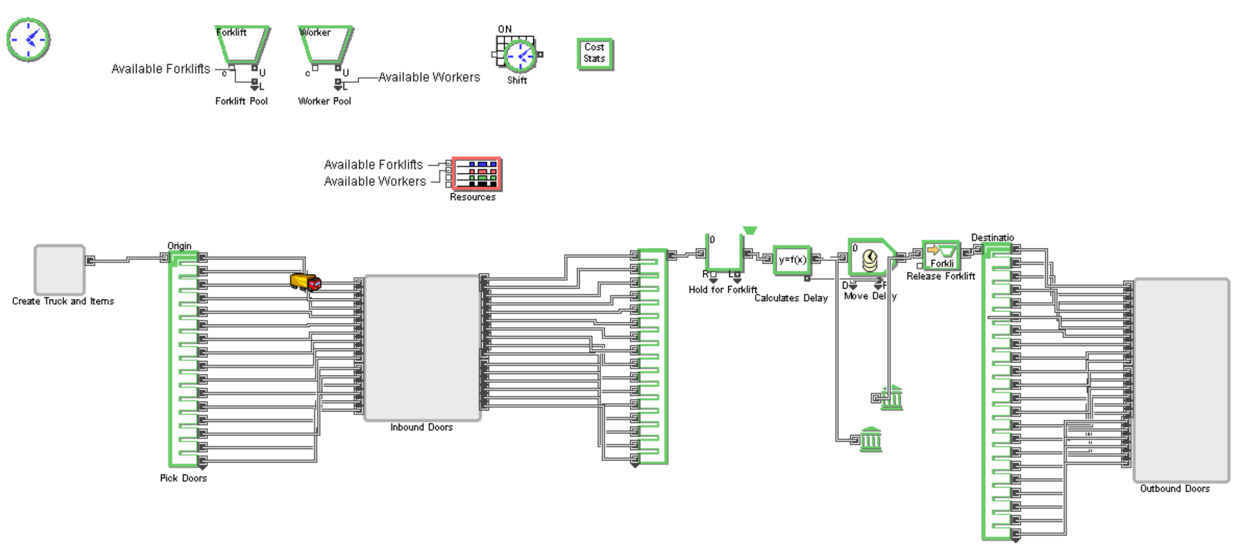
The first step is to create the items and the truck will contain them. The items are individually labeled with their respective destinations and volume. On the graph above, we can see that some items are queuing to be loaded into a truck. This process may be thought as if it takes place in the truck's origin before it arrives at the cross-dock.

2. Truck Filled with Items is Created



After all the items are loaded in the truck, the truck then leaves its origin and on its way to the cross-dock. In the present model, this process does not take any delay. Therefore, it may be assumed that the time when a filled truck is created is equal to the time when it actually arrives at the cross-dock.

3. Arrival at Cross-dock



The truck arrives at the cross-dock and proceeds to the assigned inbound door. Just some side notes about the simulation layout: the graph above indeed is the view of the whole model. The “grey boxes” are called Hierarchical Blocks (H-blocks), and clicking each of them will lead to more other processes and blocks that are contained inside. For example, if the leftmost block is clicked—labeled “Create Truck and Items”—it will open up the picture that is used for the previous explanations. The reason why I made a couple of H-blocks is to simplify the view of the whole model, otherwise it would be really hard follow the whole model.

Since the graph above oversees the whole model, I would like use this graph to explain some blocks that are not directly involved in the process, namely, the 5 “green blocks” and 1 “red block” at the top.

The leftmost green block may not be significant in explaining the cross-docking process, but it is actually the most significant block since it has to be present in every Discrete Event model. It stores variables, keeps track of the time, and does many other processes that are needed to run the simulation.

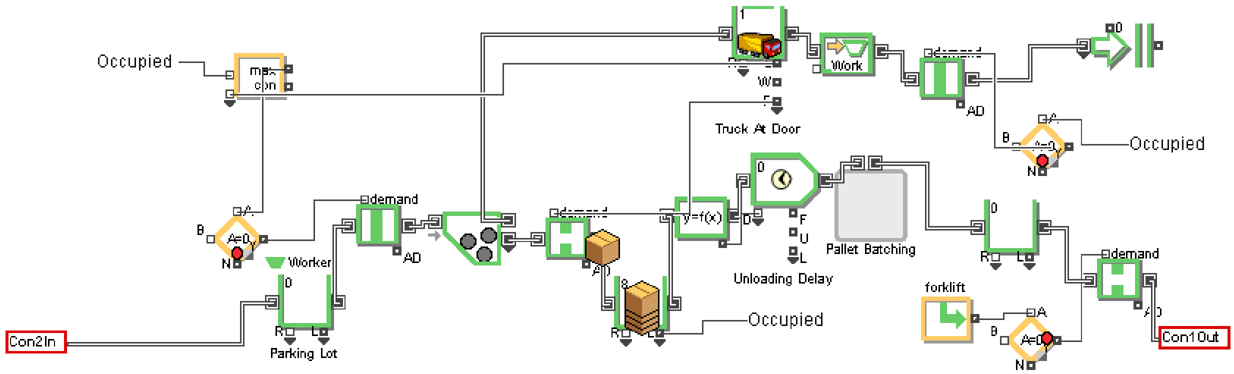
The third and second blocks from the left are the resource pools for forklifts and workers, respectively. Forklifts are used to move the pallets across the floor; workers are needed to unload items from the incoming trucks and load them to the outgoing trucks.

The fourth block from the left controls the shift of forklifts and workers. It is used to reduce the resources during certain period of times when fewer forklifts and workers are needed.

The fifth block from the left shows the total amount of cost of the model. This could be a good indicator to measure the effectiveness of a bad or a good assignment/schedule.

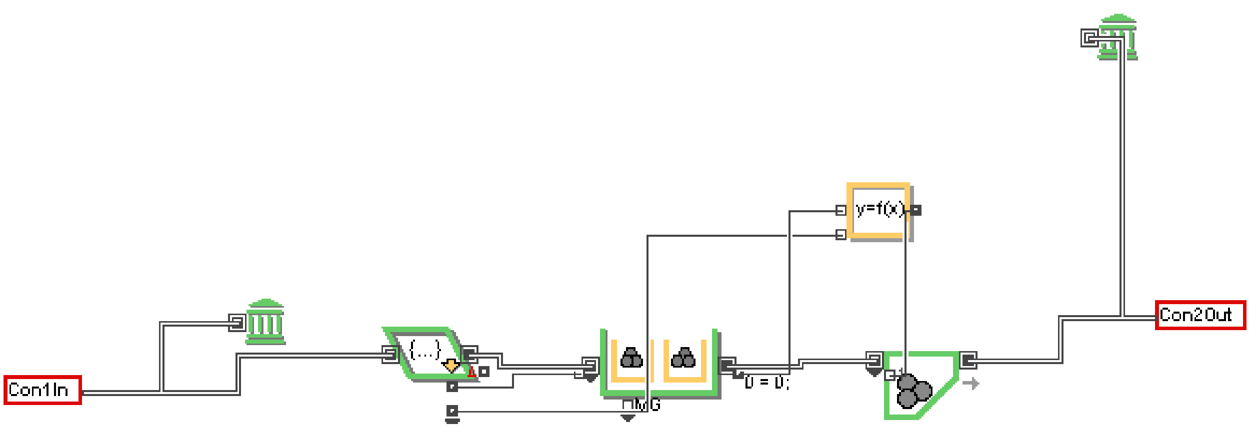
The red block is used to plot the graphs at the end of the simulation. The tables that are used for the graphs are also produced; these may be useful in analyzing the results of the simulation.

4. **Unloading the Truck at Inbound Door**



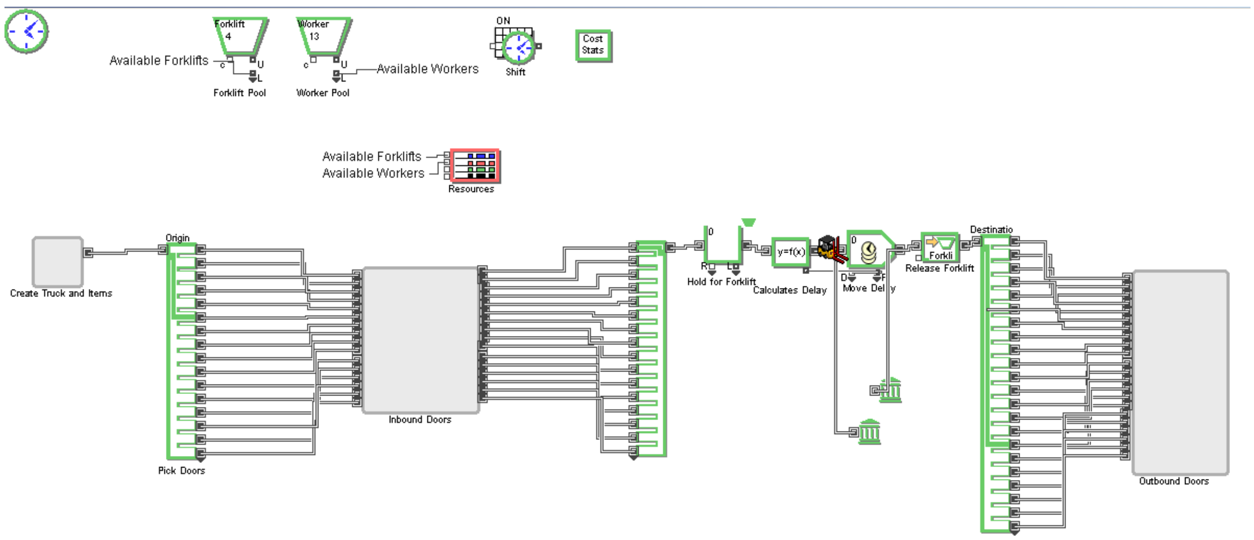
As we can see on the graph, the truck sits at the door while the items are being unloaded. Unloading a truck requires 1 idle worker, and hence if no worker is available then this process waits until a worker is idle. Moreover, only 1 truck at 1 door can be unloaded at a time. If another truck arrives at an occupied inbound door, the truck has to wait in a queue until the inbound door is empty. Each item undergoes an Unloading Delay. After that, the items go to the Pallet Batching process. Once all the items have been unloaded, the empty truck will leave the simulation and the worker is now idle.

5. **Pallet Batching**



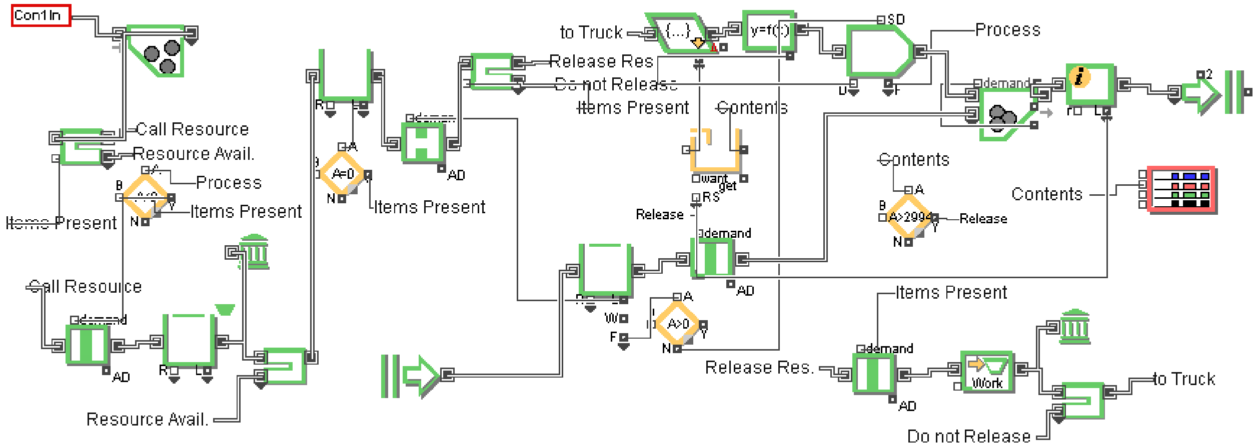
Here, items are batched into pallets by their destinations. The maximum volume a pallet can hold is 80 feet^3. Therefore, this method of pallet batching ensures that the volume of any given pallet is less than or equal to 80 feet^3.

6. Moving the Pallets across the Floor



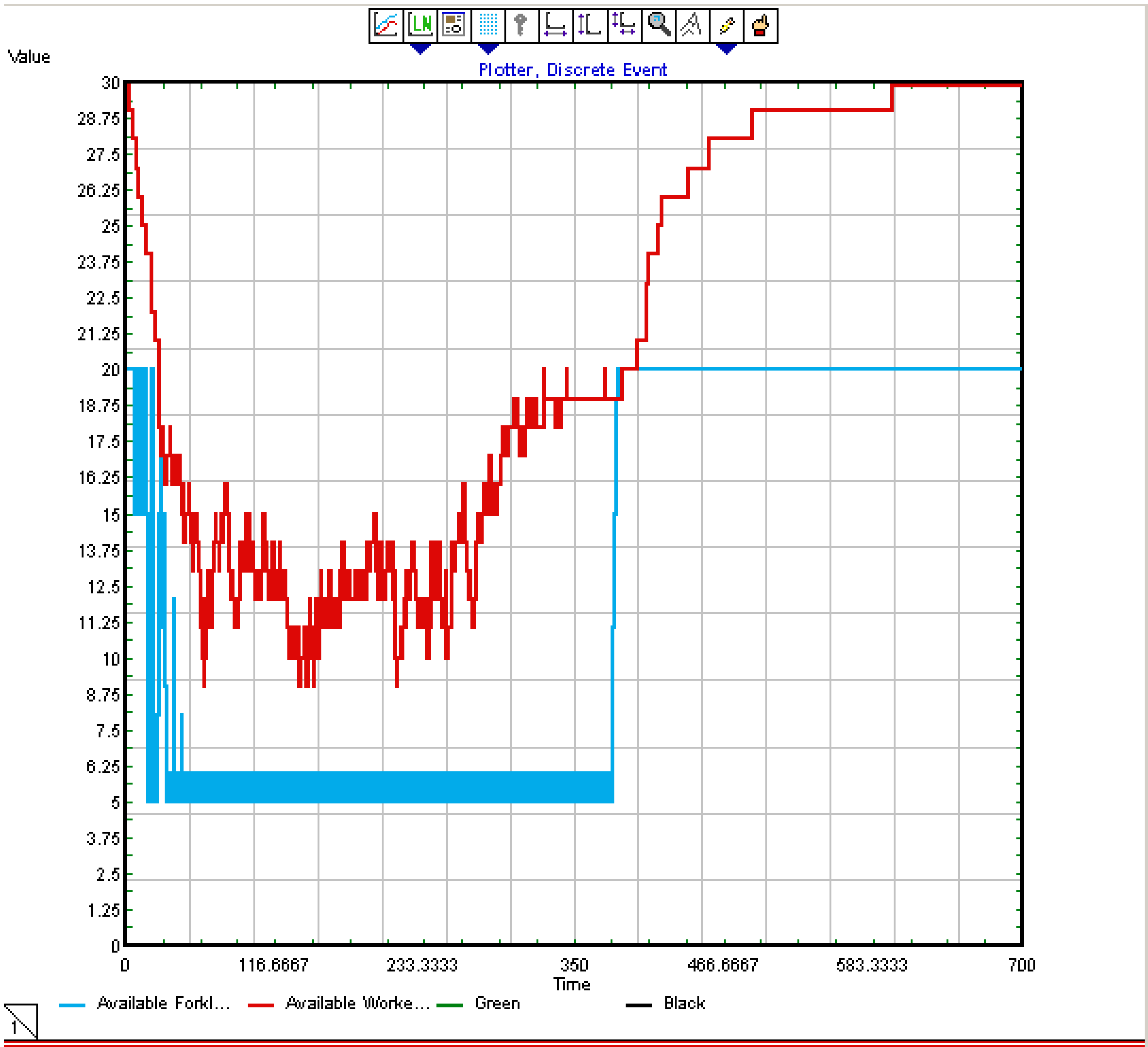
The pallets are then moved across the floor with a forklift; this requires 1 idle forklift. When there are no available forklifts, the pallets have to wait in the queue until a forklift is finally available. The forklift then undergoes a move delay that is calculated by the Manhattan Distance between the inbound door (that the pallet was palletized at) and the outbound door (the destination of the pallet). After this process is completed, the forklift becomes idle again.

7. Loading into the Truck at Outbound Door



This process requires 1 idle worker to proceed. Then, the items are un-batched and loaded into the truck. The loading undergoes a Loading Delay which is larger the delay of the previous Unloading Delay. Each truck has a maximum capacity of 3000 feet^3; every truck has to be filled until it cannot take any more items, then it exits the simulation. As soon as this happens, another truck stands-by at the outbound door. The worker becomes idle if and only if there are no more items waiting in the queue that need to be loaded to a truck.

Resources Plot



	633.68	0.52516	633.68	0.52516	633.68	0.52516	63
Point Number	1 Time	1 Available Fo	2 Time	2 Available Wo	3 Time	3 Green	4 Time
3649	383.25	17					
3650	383.28333333333	18					
3651	383.45	19					
3652	384.16666666667	20					
3653	598.23333333337	20					
3654	700	20					

In this trial, I used 56 trucks and I assumed there are 20 forklifts and 30 workers. The above graph shows the number of available forklifts (light blue) and workers (red) over time. The fragment of table below the graph shows that all forklifts and workers stop working at the 598th simulation minute, that is, at that time the number of available forklifts and workers return to their original value respectively. An interesting note to point out is that the graph of the forklifts becomes thick during the peak hours. This is because of the repeated “taking” and “releasing” of the forklifts when there are a great number of pallets to be moved across the cross-dock. The whole simulation, if run without animation, takes approximately 5 minutes to finish.

Future Model

The current model is able to handle basic cross-dock operations. However, some more complicated operations have not been implemented, and they are, but not limited to:

1. The possibility of items being put in the center of the cross-dock before being loaded into the outgoing trailers.
2. The use of clamp truck to unload items.
3. The possibility of sending a trailer that has not reached its maximum capacity.
4. Delays due to paperwork and other related processes.
5. The possibility of placing an incoming trailer right next to an outgoing trailer when the majority of the items are bound for the same destination.

Some possible performance measures, in addition to the current Resources Plot, are as follows.

1. Number of items not delivered within 2 days.
2. Distance traveled by the forklifts.
3. Queue lengths (in order to determine bottlenecks).
4. Operational costs.