

**Progress Report #3**

***Cross-docking Operations***

*“Anticipating Labor and Processing Needs of Cross-dock Operations”*

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## Introduction

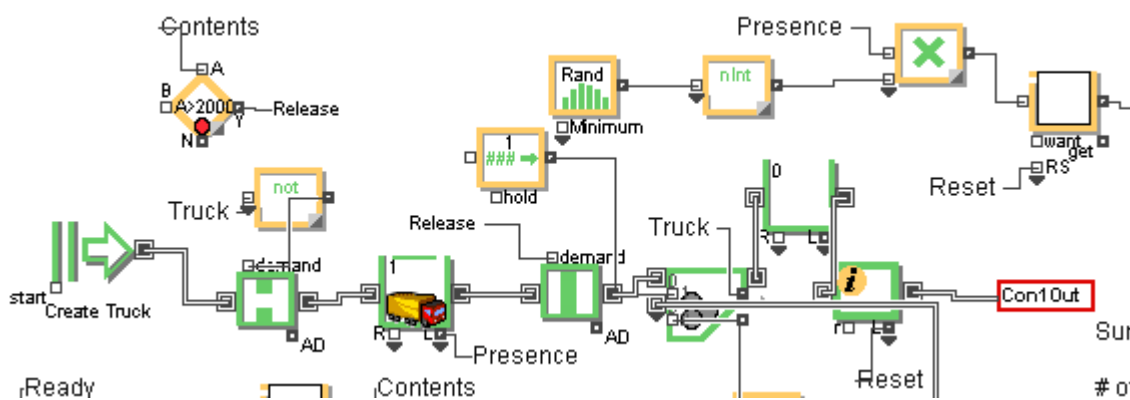
This report contains the step-by-step explanations of the new changes in “Create Truck and Items” H-Block, which now enables the random creation of items according to a set of constraints. Note that since the layout of the whole H-Block is too large, the diagrams included in this reports are only small, cut-off fragments that constitute a bigger H-Block. Thus, some blocks, words and connections in each diagram may seem incomplete or disconnected.

Previously, the items were created according to a schedule that had to be manually typed in into ExtendSim. This was not deemed as efficient, since for a large amount of data, the process would be very tedious and time-consuming. Moreover, having a pre-determined schedule would not add to the randomness of the simulation.

Now, with having the items randomly created and running the whole cross-dock simulation model a number of times, a wide array of outputs can be observed. These outputs can then serve as one of the measures of how well the cross-dock model performs as a whole.

## The New “Create Truck and Items” Block

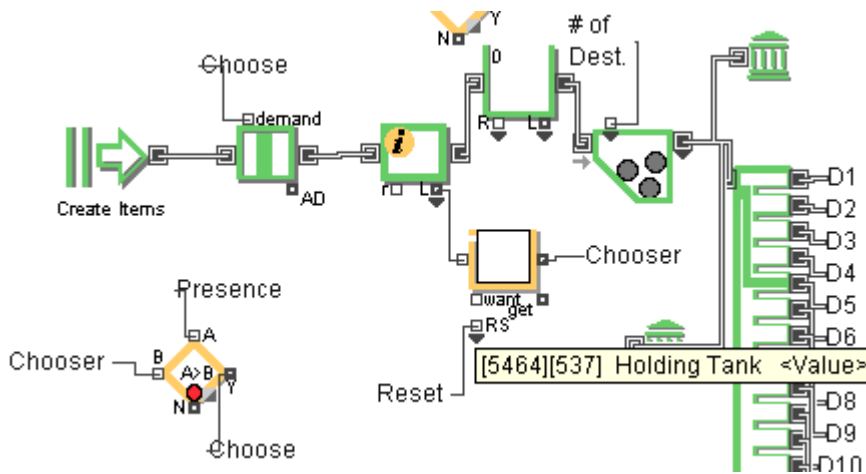
### 1. Waiting for a Truck



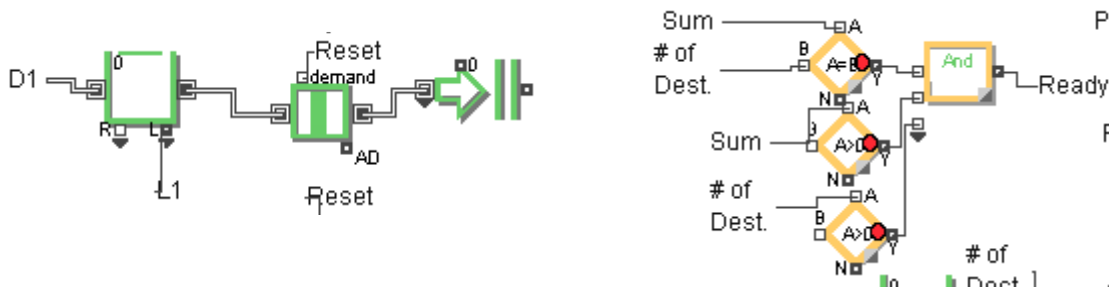
The first step is creating the trucks. For now, the truck creation is still specified by a schedule, unlike the item creation which is randomized. Each truck has its own volume capacity and it will be filled until it has reached its capacity limit. Once a truck is present, a random generator

generates an integer, which will then represent the number of different possible destinations for the items. This random number is specified by a triangular distribution, with minimum = 2, maximum = 12, and most likely = 6. Afterwards, the generated number is rounded to the nearest integer. This integer is contained in the Holding Tank, which means that the number applies to all items for this particular truck, and this number will be reset when another truck comes.

## 2. Choosing the Set of Destinations Using Dummy Items

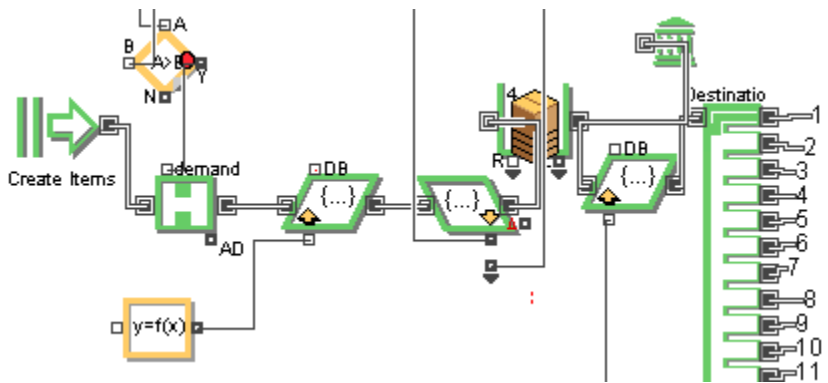


Now we have the number of destinations from the previous step, but we have not chosen our set of destinations, as a destination can be any integer from 1 to 16 (there are 16 possible destinations and each number represents a unique destination). Choosing the set of possible destinations is the purpose of this step. After the presence of a truck, a single dummy item is created. Then, through the Unbatch Block, the dummy item is duplicated according to the number of destinations. Afterwards, each of these dummy items is distributed randomly to the 16 possible Queue Blocks, which all represent the possible destinations. Therefore, if the Queue Block is empty, this means that the corresponding destination is not represented.



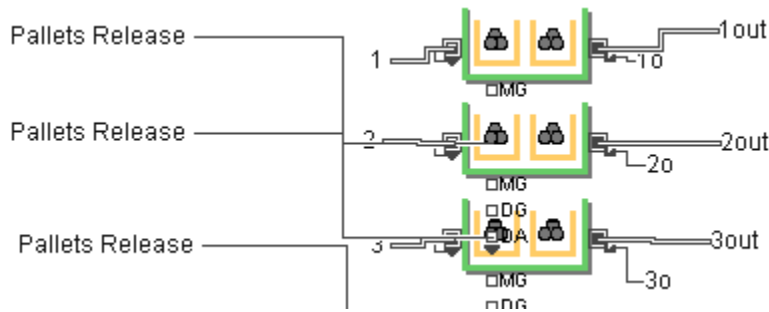
If a dummy item sits on a queue, a connection (in the above diagram on the left, the connection is labeled “L1”) that measures the queue length is used to determine whether a dummy item is present. This connection will be useful later when assigning the destinations to the real items. Once all the dummy items are in their positions, a signal (the “Ready” connection on the right diagram above) is sent to the real items creation, signaling it to start creating. At this moment, we have chosen our set of possible destinations for the items in a particular truck.

### 3. Creating the Real Items



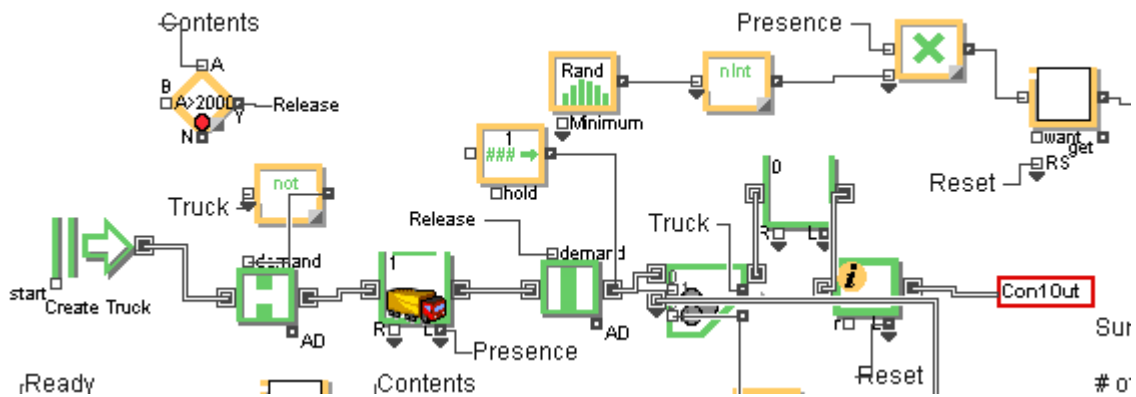
The real items for the truck are now created. The creation stops if and only if the truck is full and all the items have been assigned with their necessary attributes. Each item is randomly assigned with a volume attribute (either 1, 2, or 6 cubic feet) and a destination attribute (from steps #1 and #2). The assignments are done through separate Equation Blocks, but with the same logic: an array is created to store all the possible values, and then one of the values in the array is randomly chosen. The created items are then sorted by destination in the Queue Block. At this point, all the items have been created and they have been assigned with volume and destination attributes. However, their pallet quantity attribute has not been assigned. If it is not assigned beforehand, there will be a problem later at the Cross-dock’s Pallet Batching process (refer to Progress Report #2), as the model must know how many same-destination items are needed in a batch. Therefore, the next step is to assign the pallet quantity attribute.

#### 4. Assigning the Pallet Quantity Attribute



In this process, the items are matched by their destinations and each Queue Matching Block (shown above only until destination #3) waits until all the items have been present in the queues. After that, all items are released and the number of quantity in each queue is stored in the respective items' pallet quantity attributes.

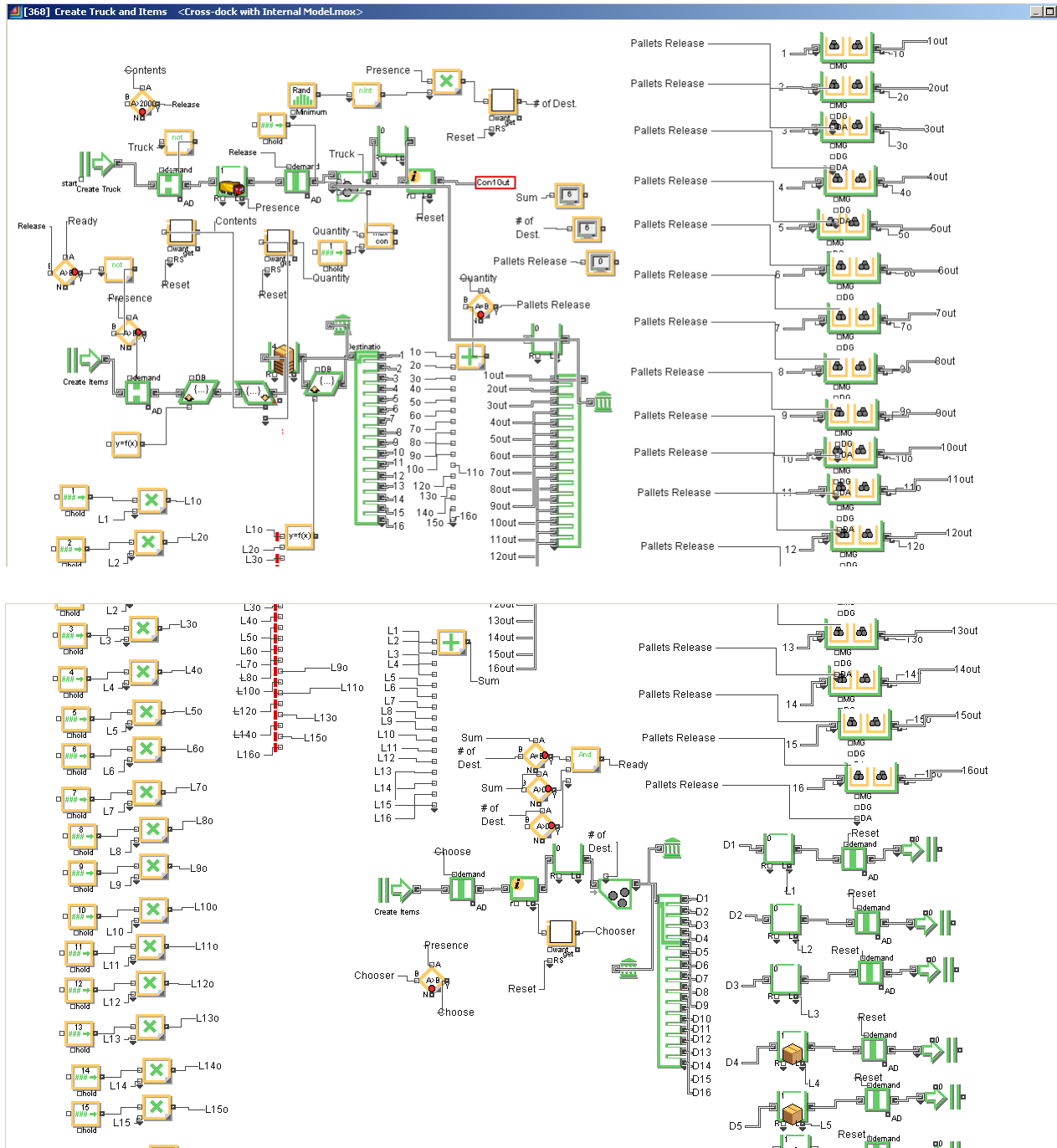
#### 5. Batching the Items with the Truck



Notice that the diagram above is the same as the diagram on step #1. The items—labeled with destination, volume, and pallet quantity—now go to the Batch Block and they are batched together with the Truck. The truck now leaves to the Cross-dock through the “Con1Out” connection. Due to the nature of the simulation, this whole process takes 0 time, i.e., no time is

lost during the whole process of creating the items. This implies that the time when a particular truck comes in to the simulation is the same as the time it arrives at the Cross-dock.

A bigger layout of the “Create Truck and Items” H-Block is shown below.



## 6. Conclusion

The logic of this operation can thus be summed into the following points:

- The number of unique destinations on a truck is generated by a triangular distribution (rounded to the nearest integer) with min=2, max=12, most likely = 6.
- A "set" of destinations then is determined for a given truck. Each item on that truck then is equally likely to have any of the destinations given in the "set".
- The real items are created and they are labeled by volume and destinations attributes.
- Items are then sorted by destination, and their "Pallet Quantity" attribute is assigned to each of the item. "Pallet Quantity" is going to be crucial later at the Cross-dock's palletizing process.
- The truck is filled until it's full. After that, the "set" of destinations is reset; hence the next truck will have a different "set" of destinations.

## Future Model

In addition to the operational enhancements proposed in Progress Report #2, the following implementations are likely to be added to the future model:

1. Randomizing the creating of the trucks, their arrival time and inter-arrival time. A truck can be either a container or a trailer, each having a different volume capacity.
2. Introducing the "Weight" attribute. This will then act as another constraint for truck's capacity, in addition to the "Volume" attribute.
3. Randomizing the Inbound-door assignments for the truck. If possible, also optimizing the door assignments, so that a particular truck will choose the best possible door according to items it carries, in order to minimize distance traveled by the forklifts.