UNIVERSITY OF JEDDAH

FACULTY OF ENGINEERING

INDUSTRIAL & SYSTEMS ENGINEERING DEPARTMENT

ENIE 310

INDUSTRIAL SYSTEMS SIMULATION

<WAREHOUSE SIMULATION>

FINAL REPORT

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1 Introduction

The Al Hassan Ghazi Ibrahim Shaker Company has a long and illustrious history that spans over 70 years. Despite the challenges of the business landscape, the company has managed to thrive and become the exclusive agent for LG air conditioners in Saudi Arabia, however shaker group have two types of warehouses, first one is for a fully functional devices that they sell directly to customers, second one is for spare parts usually the spare parts could be classified into three types, type A which is small parts these are the minor parts that often need to be replaced, such as nuts, screws, fuses, sensors, and other small pieces, second is the type B which is medium parts these are the parts that are larger and more important than the small parts, but not as big or complex as the large parts, lastly type C which is large parts these are the parts that are the most sizable and sophisticated, such as condensers, compressors, or major frames, as its shown in below figures. Moreover, the case study was conducted on the second type of warehouse as it was easy to understand and modelled.

Figure 1 Small Spare Parts

Figure 2 Medium Spare Parts

Figure 3 1 Large Spare Parts

1.1 System Description

The system boundaries starts outside the warehouse where forklift load and gets inside the warehouse then unload the crates(the system entities), after being unloaded the sorting process starts where workers takes the unloaded crates and sorting it by putting each crate in its place in the warehouse, afterward the parts will be held in storage until someone orders it each part have different change of being ordered as A 50%, part B 30% and part C 20%, lastly if someone order one of the parts the last process starts which is preparation of the specific part that has been ordered or requested.

1.2 Describing System Operation

The process begins with the arrival of parts, which are then transported to the warehouse using a forklift. Upon reaching the warehouse, the parts undergo categorization based on their size small, medium, or large by two workers. Following categorization, a decision is made regarding their placement within the warehouse, and they are stored accordingly. When an order is placed, warehouse workers prepare the order for shipment, ensuring that the correct items are gathered and packaged. Finally, the prepared order is sent out for delivery.

2 Problem Definition

A critical area that requires improvement in the Shaker Warehouse is the stacking of different types of spare parts (Part A, Part B, Part C). A number of challenges exist as a result of the current stacking that is being predicted in the warehouse operations, affecting their efficiency and organization. Risk of Damage during Stacking: There is a risk that delicate components among the large spare parts may be susceptible to breakage or scratches, compromising the overall quality and integrity of the warehouse. Shaker Warehouse must address these stacking related challenges to increase efficiency, accuracy, and safety of operations. The goal is to run the simulation for 4 days.

3 Input Variables, Parameters, and Constraints

3.1 Input Variables and Parameters

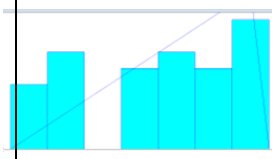
Table 1: Summary of Data about Major System Characteristics

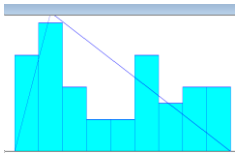
Description	Value
Number of Forklifts	**1**
Number of Sorting Workers	**2**
Number of preparation workers	3

Table 2: Summary of Processes Cycle Time (Minutes)

3.2 Input Data Analyses

Table 3: Summary of Arena Input Analyzer Results of Processing Time

Process Name and Distribution Summary	Process Histogram	Goodness of Fit	Data Summary
Sorting Process Time Distribution: Triangular Expression: TRIA (4.5, 11, 11.5) Square Error: 0.043618	 Histogram Range = 4.5 to 11.5 Number of Interval= 7	Chi Square Test Number of interval= 5 Degrees of freedom= 3 Test Statistic = 3.06 Corresponding p-value = 0.401	Number of Data Point = 34 Min Data Value = 5 Max Data Value =11 Sample Mean = 8.47 Sample Std Dev=2.14

Prepare Order Times Distribution:Triangular Expression:TRIA(6.5,8,15.5) Square Error:0.047300	 Histogram Range = 6.5 to 15.5 Number of Intervals = 9	Chi Square Test Number of intervals= 5 Degrees of freedom = 3 Test Statistic = 14.7 Corresponding p-value < 0.005	Number of Data Points = 39 Min Data Value = 7 Max Data Value = 15 Sample Mean = 10.5 Sample Std Dv= 2.79

3.3 Constraints and Assumptions

- Working hours (8:00 AM – 4:00PM)
- No Overtime Procedures assume that employees accomplish tasks during their designated work hours and overtime is not required.
- Stable Workload that remains relatively stable, without significant fluctuations.
-Availability of Resources: Assumption that necessary resources, such as forklifts and packing materials are consistently available during working hours.
-No External Disruptions: The process assumes minimal external disruptions
-No Defects: Assumes that goods arriving in good condition
- Storage Capacity: Assumes that the warehouse has sufficient storage capacity

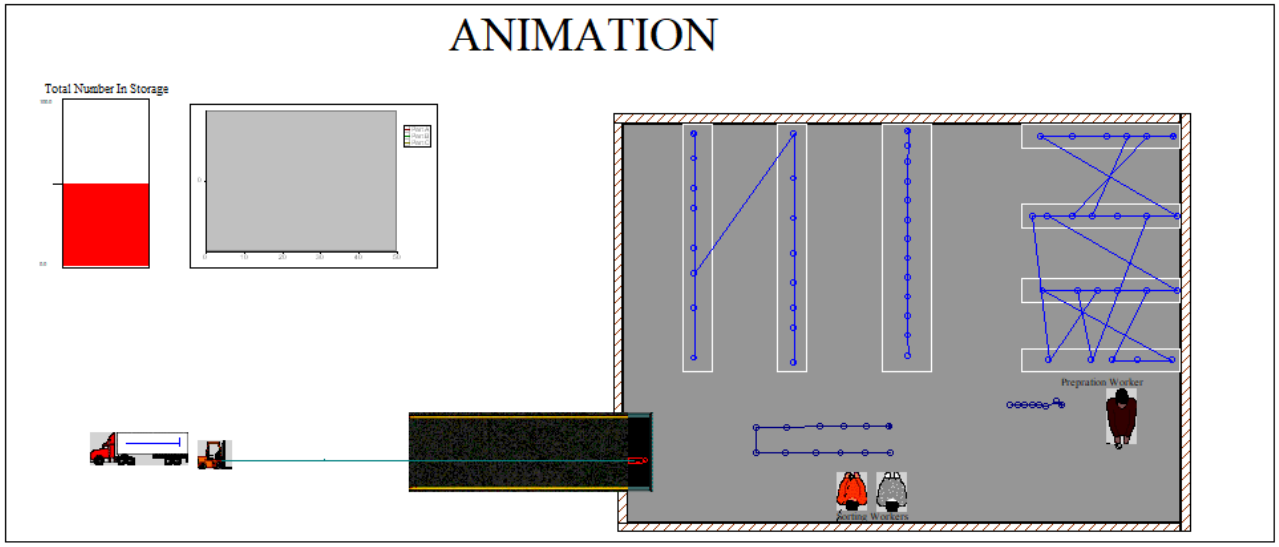
4 System Performance Measures

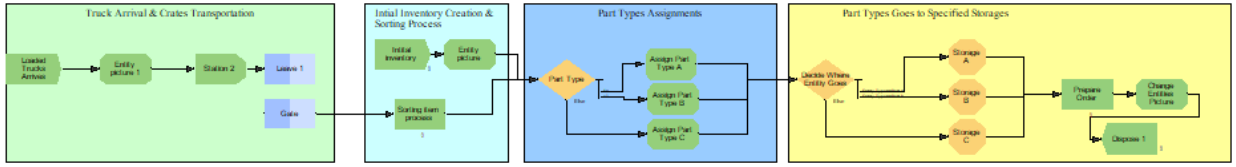
System performance measures were as follows, queue length and queue time for each type A, B, C in the warehouse and total number in storage.

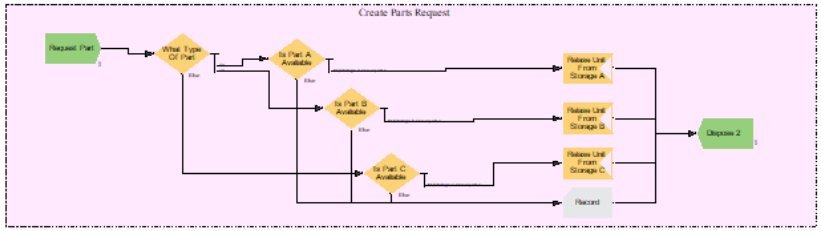
5 Simulation Model Building, Verification, and Validation

5.1 Simulation Model Building

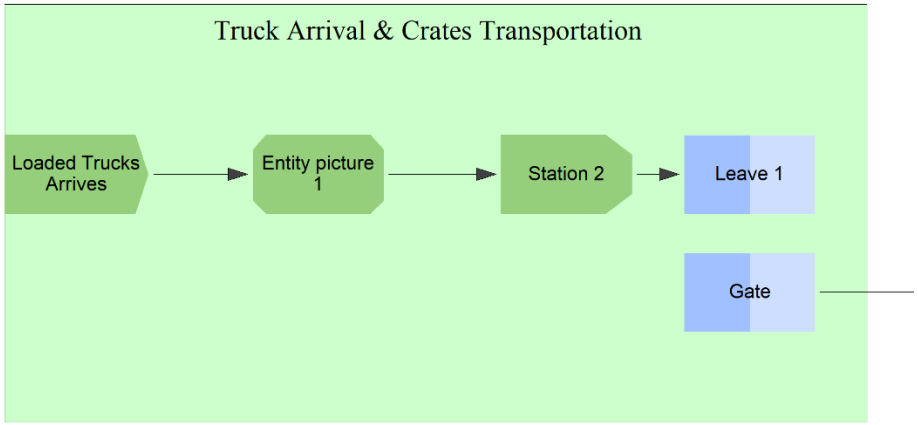
Is fully illustrated in below pages.


ANIMATION
Total Number In Storage
Prepration Worker
Sorting Workers

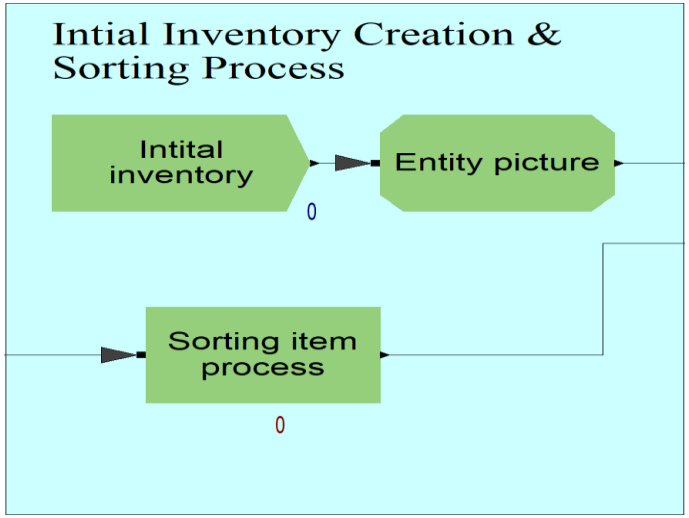

Truck Arrival & Crates Transportation
Loaded Trucks Arrives
Entity picture 1
Station 2
Leave 1
Gate
Intial Inventory Creation & Sorting Process
Initial Inventory
Entity picture
Starting item process
Part Types Assignments
Part Type
Assign Part Type A
Assign Part Type B
Assign Part Type C
Part Types Goes to Specified Storages
Decide Where Entity Goes
Storage A
Storage B
Storage C
Prepare Order
Change Entities Picture
Dispose 1

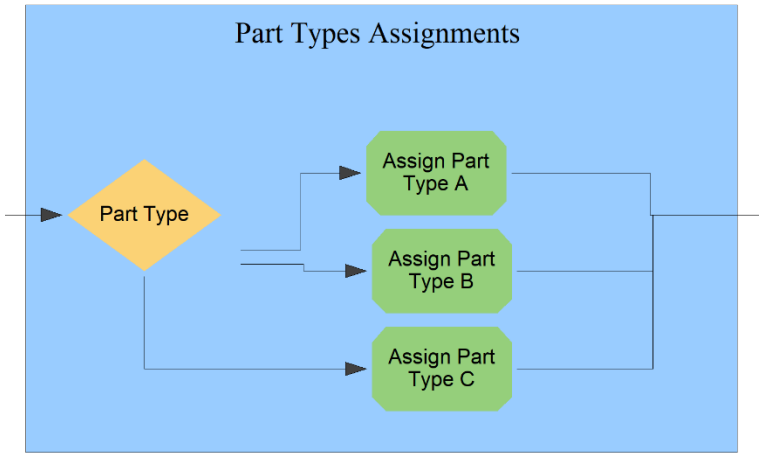

Create Parts Request
Request Part
What Type Of Part
Is Part A Available
Is Part B Available
Is Part C Available
Release Unit From Storage A
Release Unit From Storage B
Release Unit From Storage C
Record
Dispose 2

Main Model 1

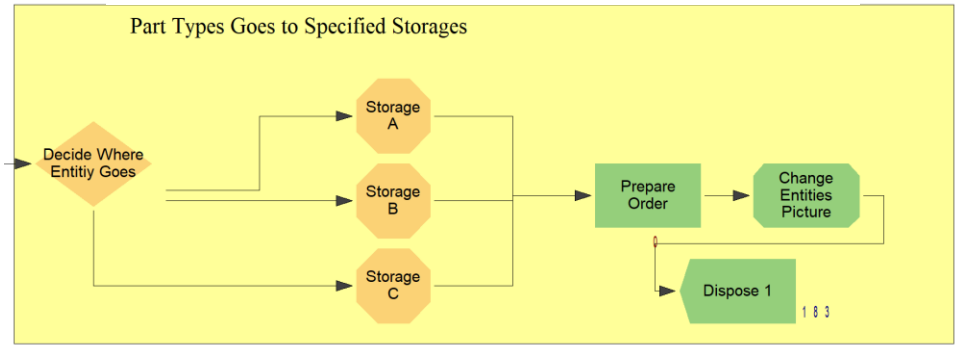

Truck Arrival & Crates Transportation
Loaded Trucks Arrives
Entity picture 1
Station 2
Leave 1
Gate

Submodel 1

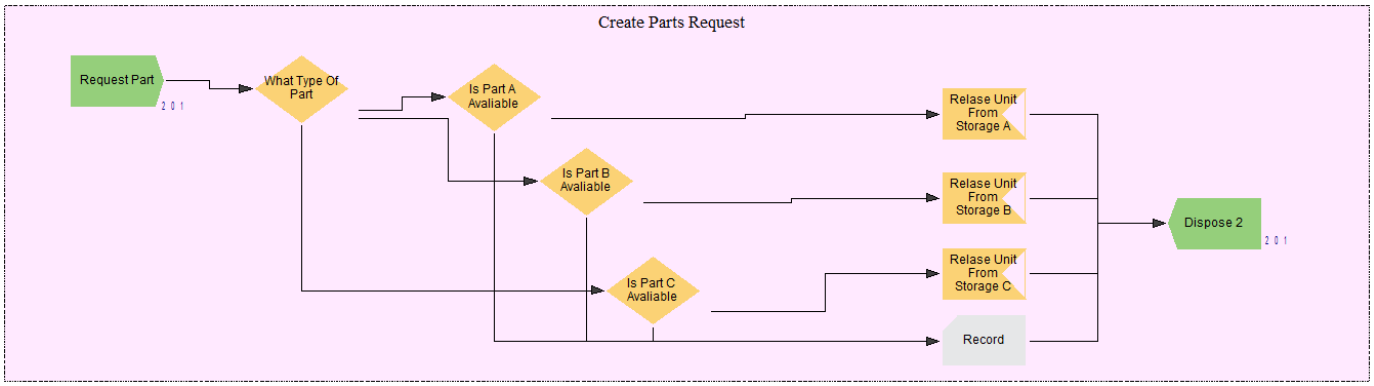

Intial Inventory Creation & Sorting Process
Intital inventory
0
Entity picture
Sorting item process
0



Submodel 3



Submodel 4


Create Parts Request
Request Part
2 0 1
What Type Of Part
Is Part A Avaliable
Is Part B Avaliable
Is Part C Avaliable
Relase Unit From Storage A
Relase Unit From Storage B
Relase Unit From Storage C
Record
Dispose 2
2 0 1

Submodel 5

5.2 Verifying the Model

As for verification of the model, the model system is simulating the real system after showing the modelled system to the engineer and preview the animation, it got their blessing, thus based on that the system is verified, since the system is not complex.

5.3 Validating the Model

As for validity of the model it Is impossible to reach a reasonable result due to the limitations of Arena student version, it cannot reach further than 150 entities in the system, however it is still possible to simulate the system since the input parameters is correct.

6 Results and Analysis

After performing the simulation for 4 days 32 hours in total the results as following:

Discrete-Time Statistics (Tally)			
Storage A.Queue	Waiting Time	Queue	6.263825986
Storage B.Queue	Waiting Time	Queue	11.25951543
Storage C.Queue	Waiting Time	Queue	2.587935923

Continuous-Time Statistics (Time Persistent)			
Storage A.Queue	Number Waiting	Queue	24.34710216
Storage B.Queue	Number Waiting	Queue	33.4938518
Storage C.Queue	Number Waiting	Queue	2.933790922

total number in storage	87

Observing the above results table its noticeable that there is some unnecessary stacking for part B also in the end of the run the total B parts in storage 51, the queue for A is reasonable due to high demand for this part but it results in 34 parts in A storage, C part has the lowest queue time and length due to lack of orders and moderate demand.

7 Conclusion

After performing the simulation and obtaining the results it shows that part B would be more likely to have the stacking problem, part A has the highest number out due to its high order, part C is unlikely to have the stacking problem.

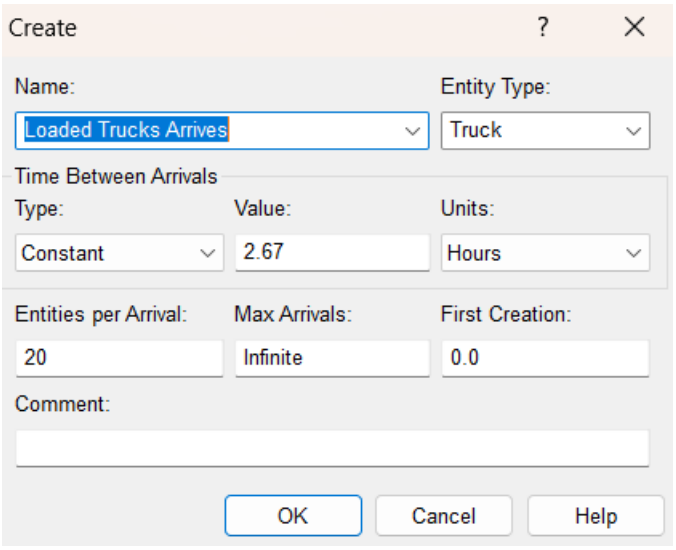
8 Recommendations

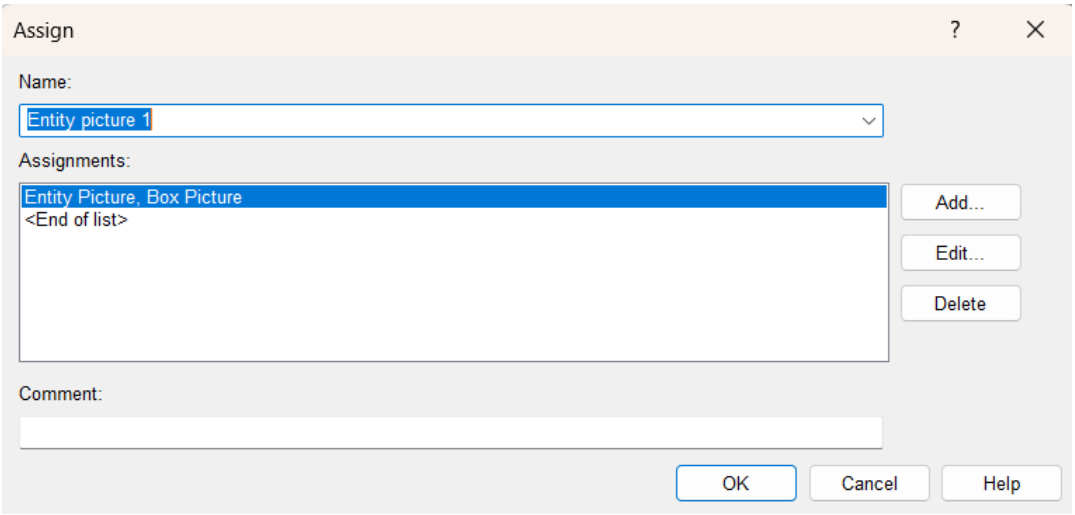
After interoperation of results some parts need to have less order because it might cause the warehouse to have some unnecessary or unneeded parts thus will result in holding cost and order or manufacturing cost.

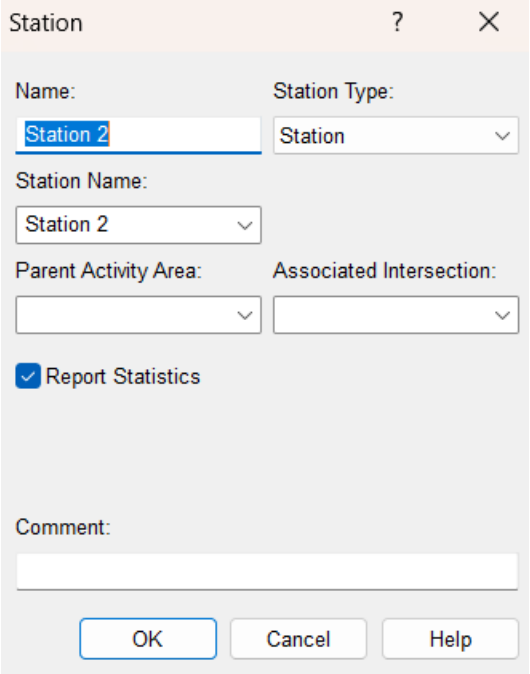
9 Appendix

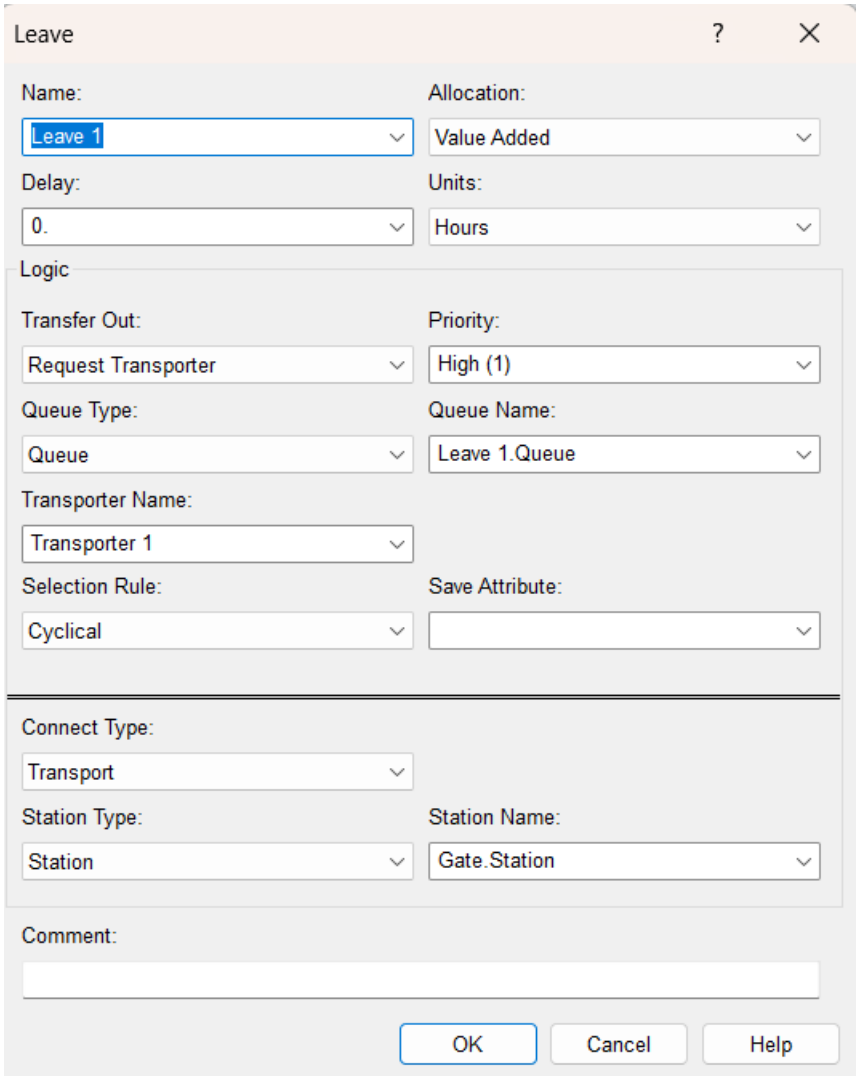
Summary of the information Entered in the Arena Model

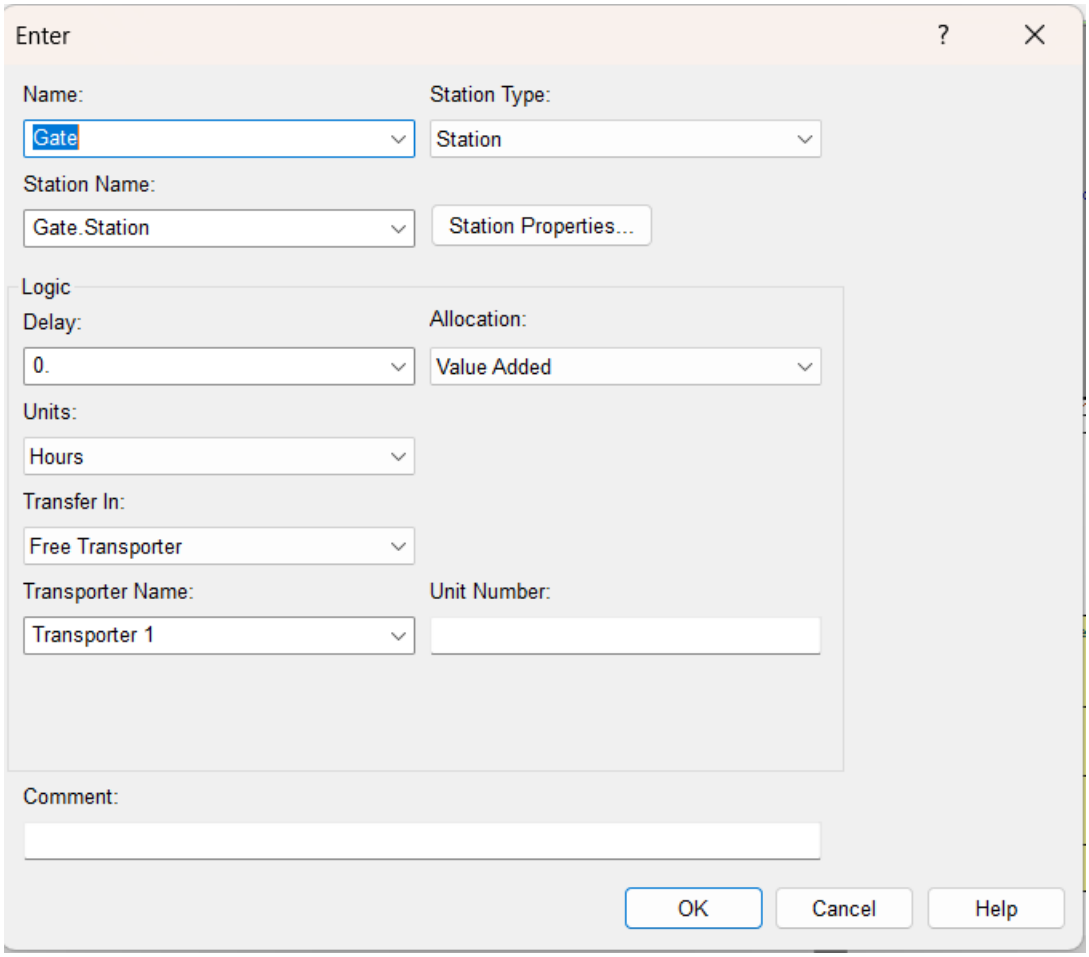
<Insert snap shots of dialog boxes edited while building your model>

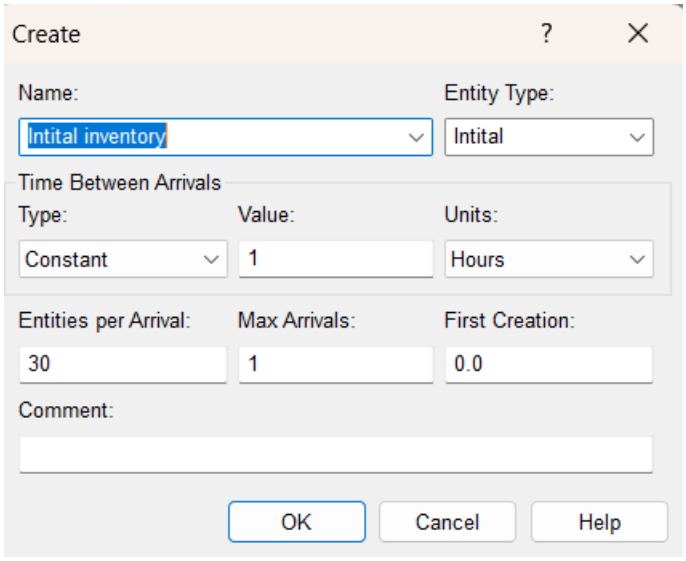


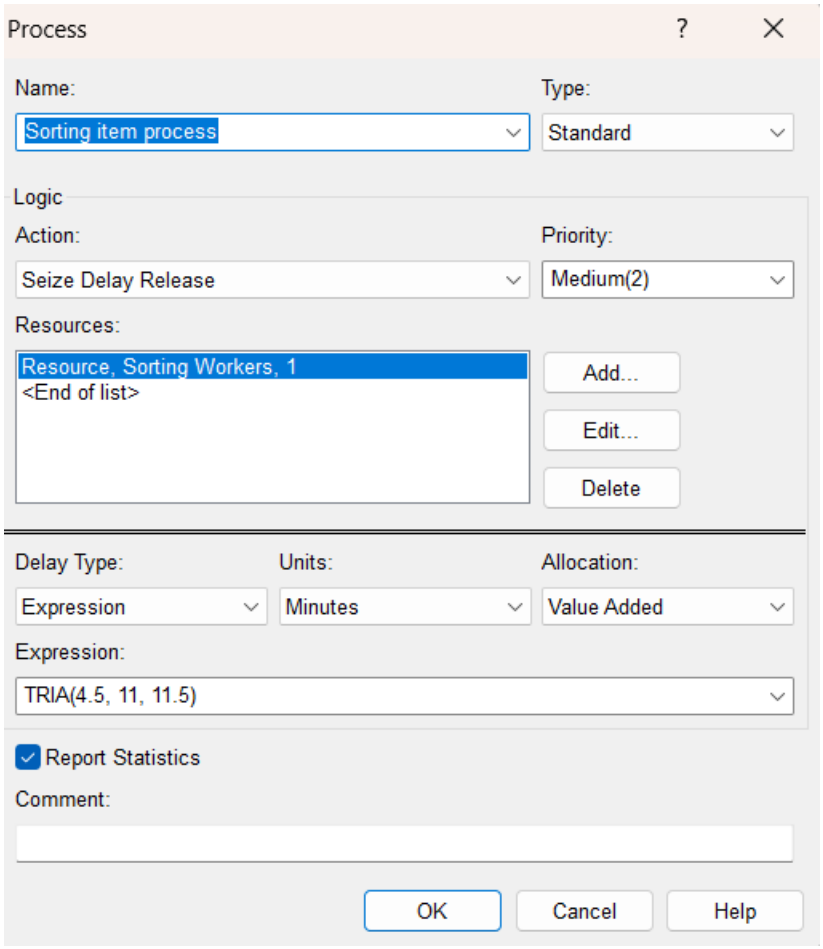


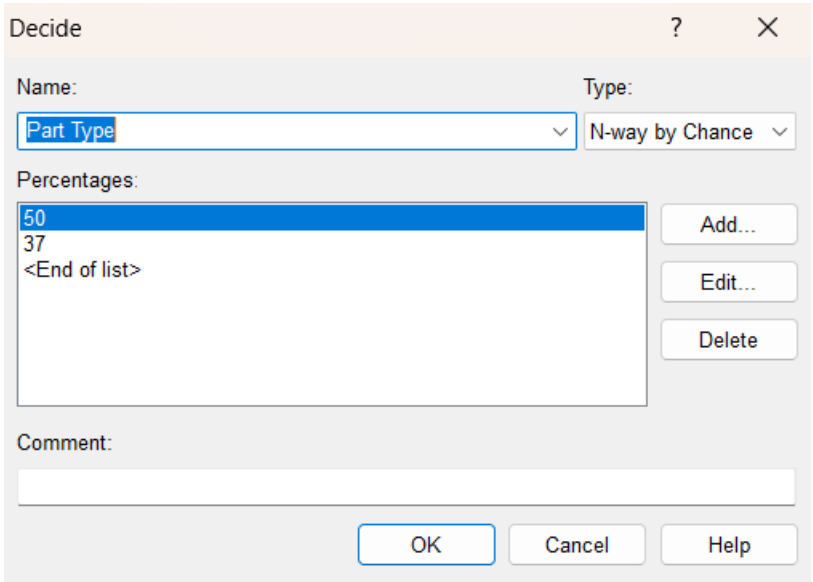

Station
?
Name:
Station Type:
Station 2
Station
Station Name:
Station 2
Parent Activity Area:
Associated Intersection:
Report Statistics
Comment:
OK
Cancel
Help

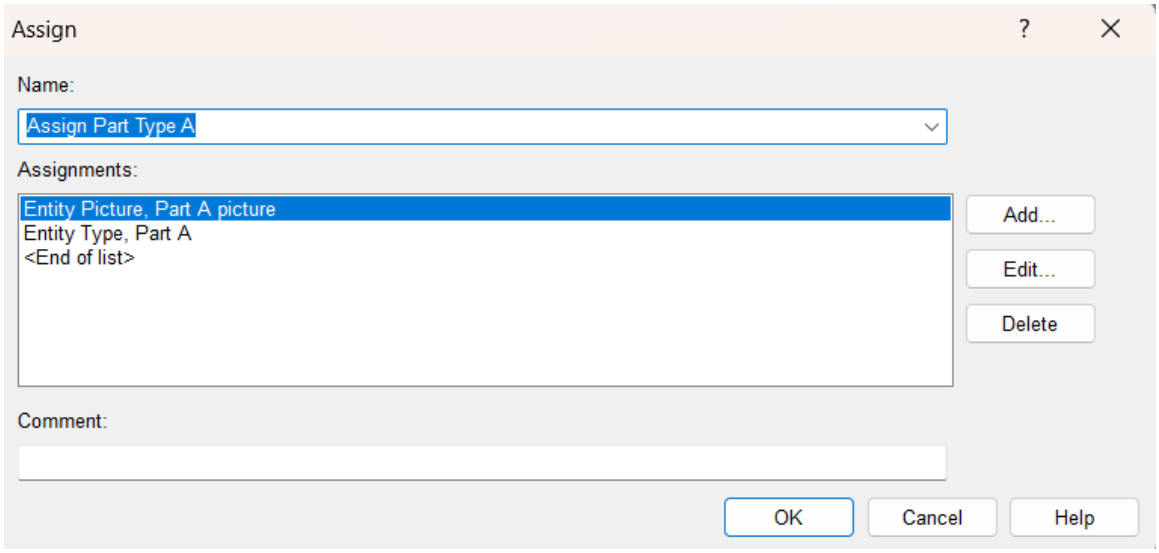

Leave
Name:
Leave 1
Allocation:
Value Added
Delay:
0.
Units:
Hours
Logic
Transfer Out:
Request Transporter
Priority:
High (1)
Queue Type:
Queue
Queue Name:
Leave 1.Queue
Transporter Name:
Transporter 1
Selection Rule:
Cyclical
Save Attribute:
Connect Type:
Transport
Station Type:
Station
Station Name:
Gate.Station
Comment:
OK
Cancel
Help

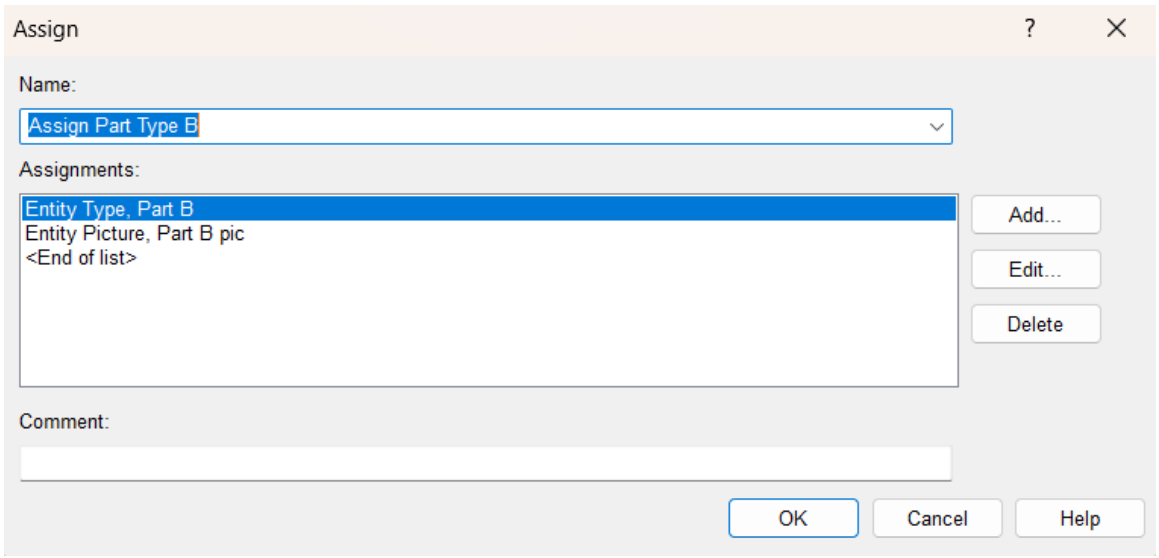

Enter
Name:
Gate
Station Type:
Station
Station Name:
Gate.Station
Station Properties...
Logic
Delay:
0.
Allocation:
Value Added
Units:
Hours
Transfer In:
Free Transporter
Transporter Name:
Transporter 1
Unit Number:
Comment:
OK
Cancel
Help

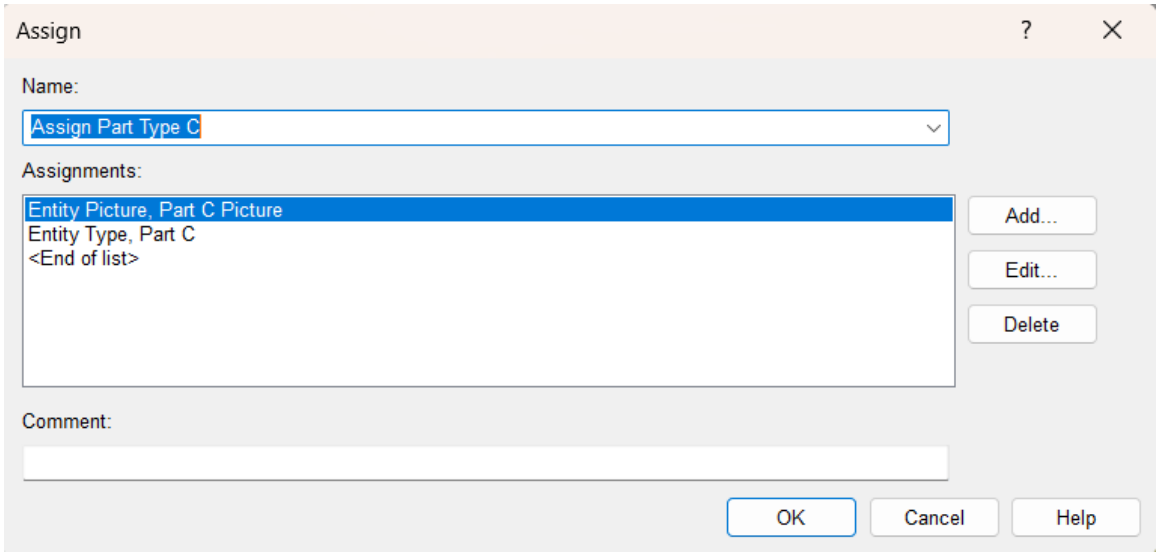

Create
Name:
Intital inventory
Entity Type:
Intital
Time Between Arrivals
Type:
Constant
Value:
1
Units:
Hours
Entities per Arrival:
30
Max Arrivals:
1
First Creation:
0.0
Comment:
OK
Cancel
Help

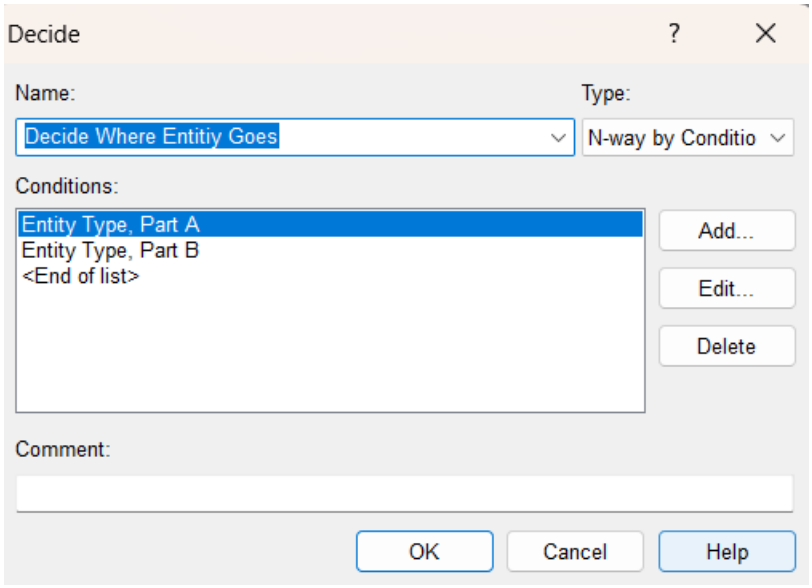

Process
Name:
Sorting item process
Type:
Standard
Logic
Action:
Seize Delay Release
Priority:
Medium(2)
Resources:
Resource, Sorting Workers, 1
<End of list>
Add...
Edit...
Delete
Delay Type:
Expression
Units:
Minutes
Allocation:
Value Added
Expression:
TRIA(4.5, 11, 11.5)
Report Statistics
Comment:
OK
Cancel
Help

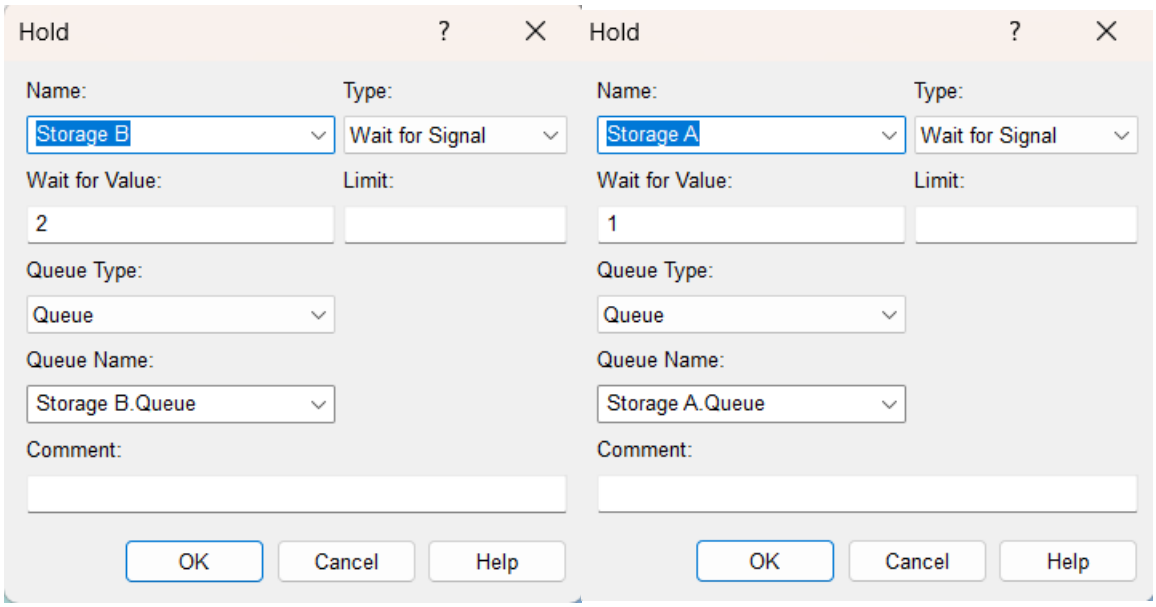

Decide
Name:
Part Type
Type:
N-way by Chance
Percentages:
50
37
<End of list>
Add...
Edit...
Delete
Comment:
OK
Cancel
Help

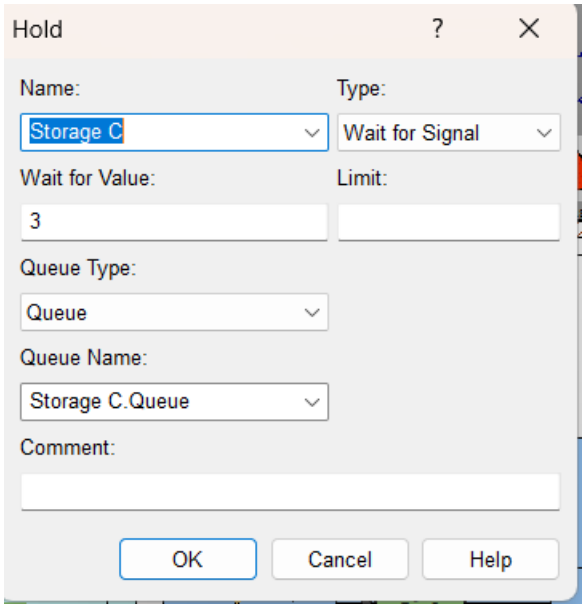

Assign
Name:
Assign Part Type A
Assignments:
Entity Picture, Part A picture
Entity Type, Part A
<End of list>
Add...
Edit...
Delete
Comment:
OK
Cancel
Help

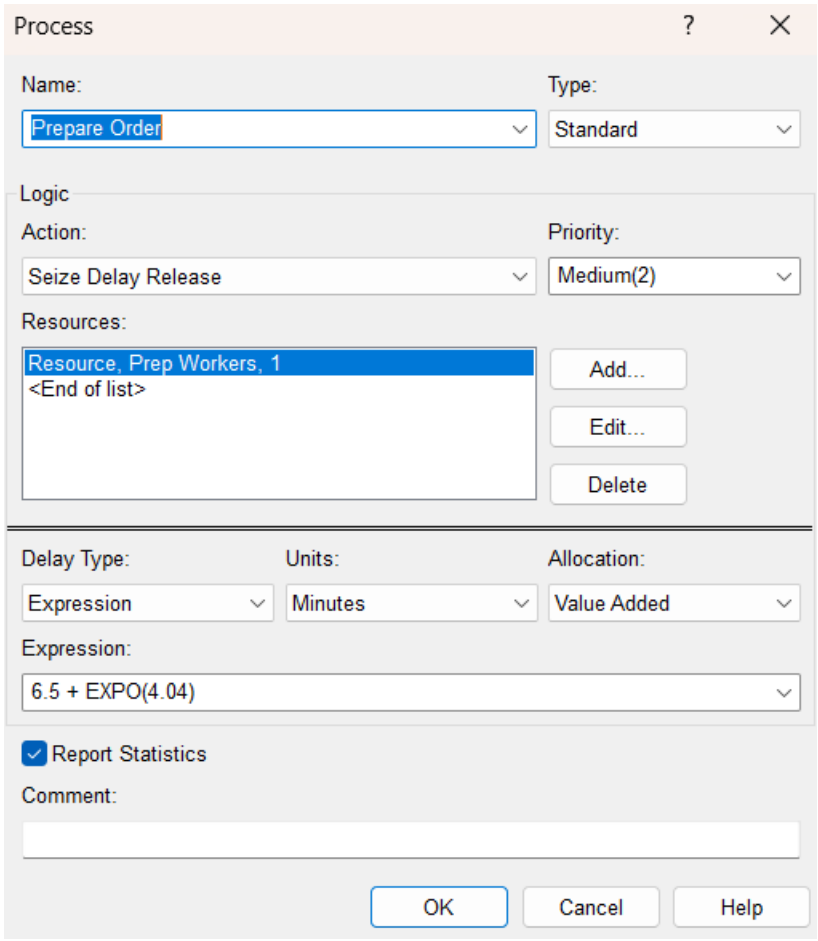

Assign
Name:
Assign Part Type B
Assignments:
Entity Type, Part B
Entity Picture, Part B pic
<End of list>
Add...
Edit...
Delete
Comment:
OK
Cancel
Help

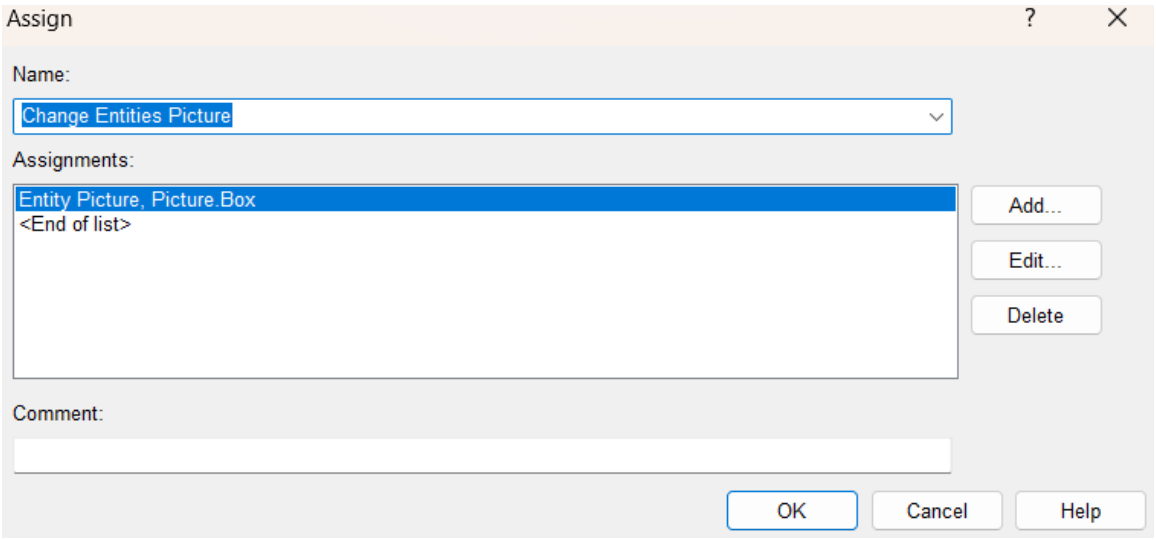

Assign
Name:
Assign Part Type C
Assignments:
Entity Picture, Part C Picture
Entity Type, Part C
<End of list>
Add...
Edit...
Delete
Comment:
OK
Cancel
Help

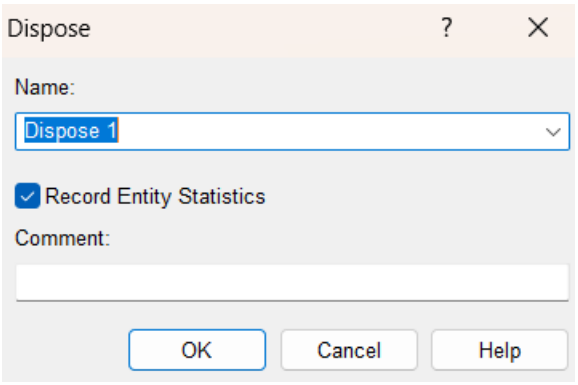

Decide
Name:
Decide Where Entitiy Goes
Type:
N-way by Conditio
Conditions:
Entity Type, Part A
Entity Type, Part B
<End of list>
Add...
Edit...
Delete
Comment:
OK
Cancel
Help


Hold
Name:
Storage B
Type:
Wait for Signal
Wait for Value:
2
Limit:
Queue Type:
Queue
Queue Name:
Storage B.Queue
Comment:
OK
Cancel
Help
Hold
Name:
Storage A
Type:
Wait for Signal
Wait for Value:
1
Limit:
Queue Type:
Queue
Queue Name:
Storage A.Queue
Comment:
OK
Cancel
Help


Hold
Name:
Storage C
Type:
Wait for Signal
Wait for Value:
3
Limit:
Queue Type:
Queue
Queue Name:
Storage C.Queue
Comment:
OK
Cancel
Help


Process
Name:
Prepare Order
Type:
Standard
Logic
Action:
Seize Delay Release
Priority:
Medium(2)
Resources:
Resource, Prep Workers, 1
<End of list>
Add...
Edit...
Delete
Delay Type:
Expression
Units:
Minutes
Allocation:
Value Added
Expression:
6.5 + EXPO(4.04)
Report Statistics
Comment:
OK
Cancel
Help


Assign
Name:
Change Entities Picture
Assignments:
Entity Picture, Picture.Box
<End of list>
Add...
Edit...
Delete
Comment:
OK
Cancel
Help


Dispose
Name:
Dispose 1
Record Entity Statistics
Comment:
OK
Cancel
Help