Final Project Report

Course:Simulation & Modelling

Semester Project

By

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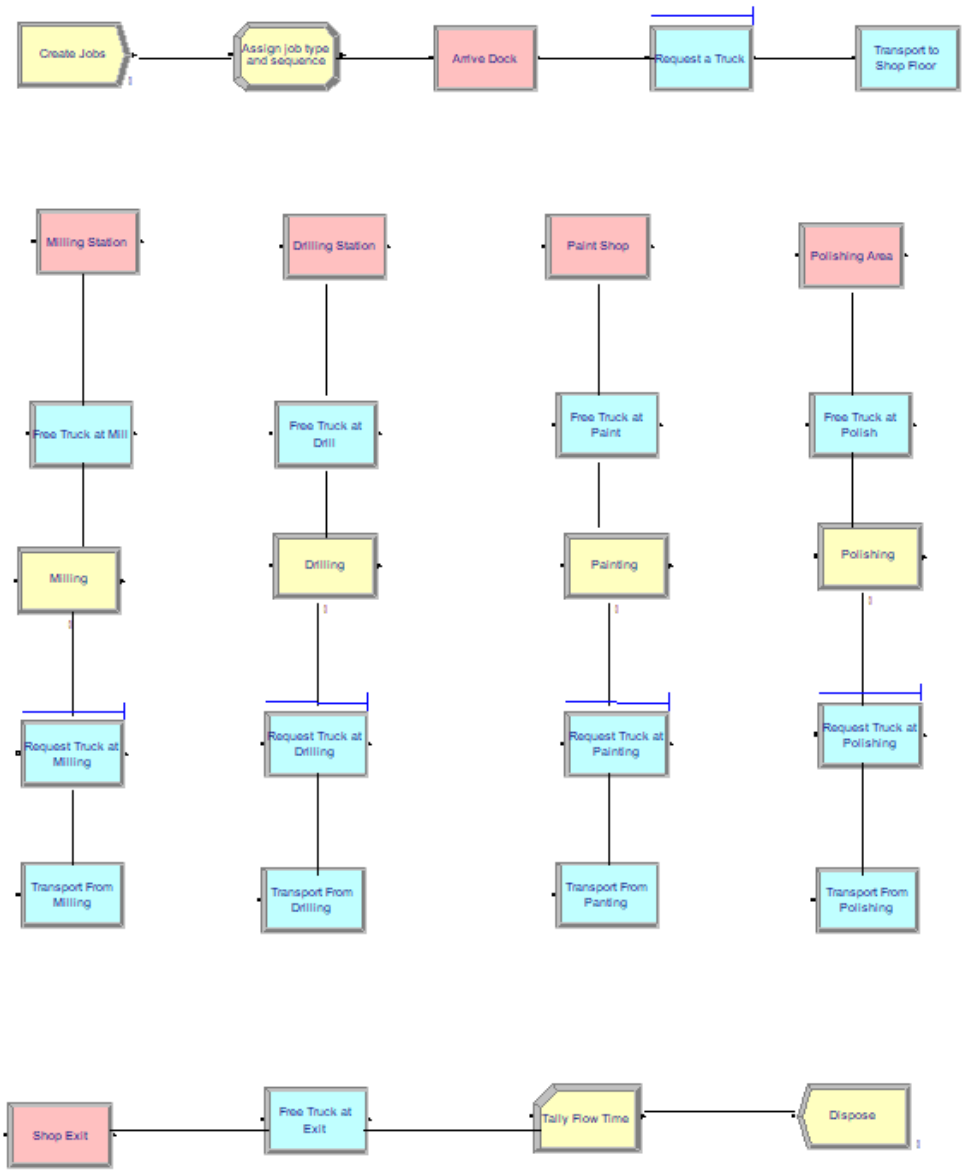
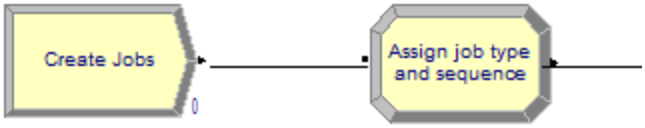
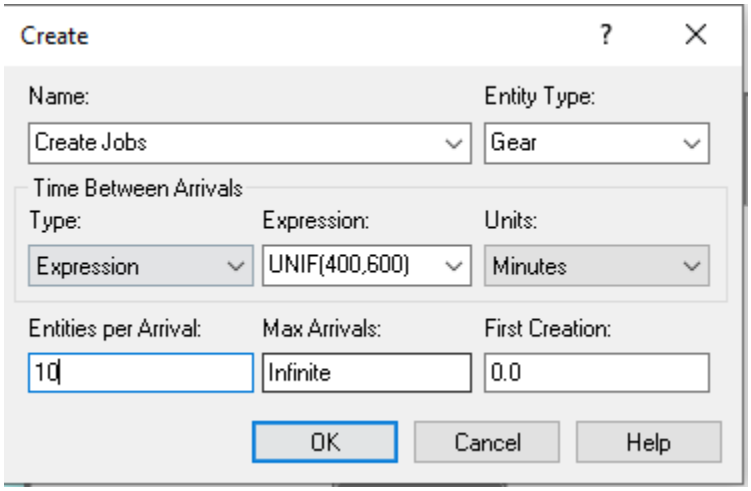


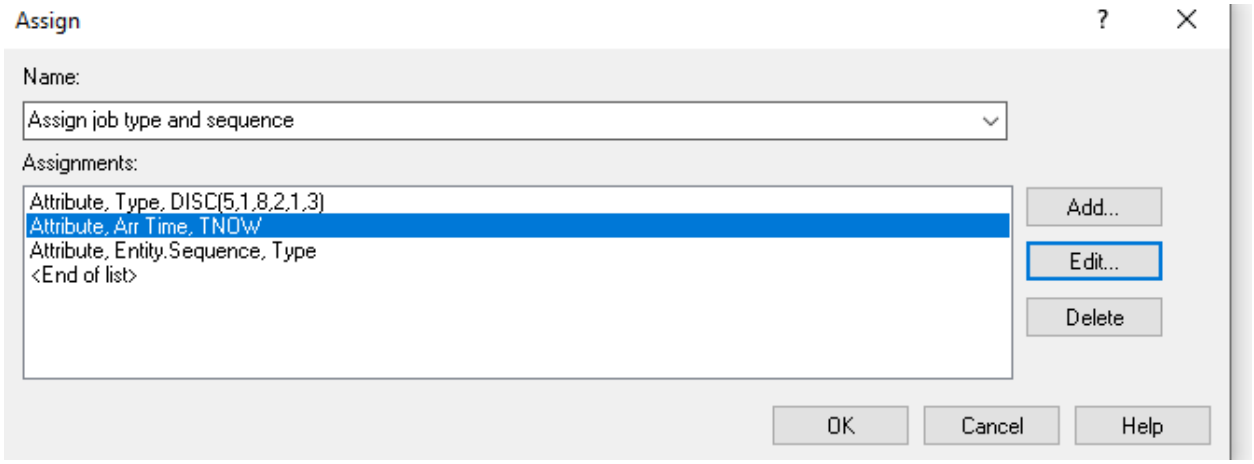
Arena Model for the Gear Manufacturing Job Shop Problem

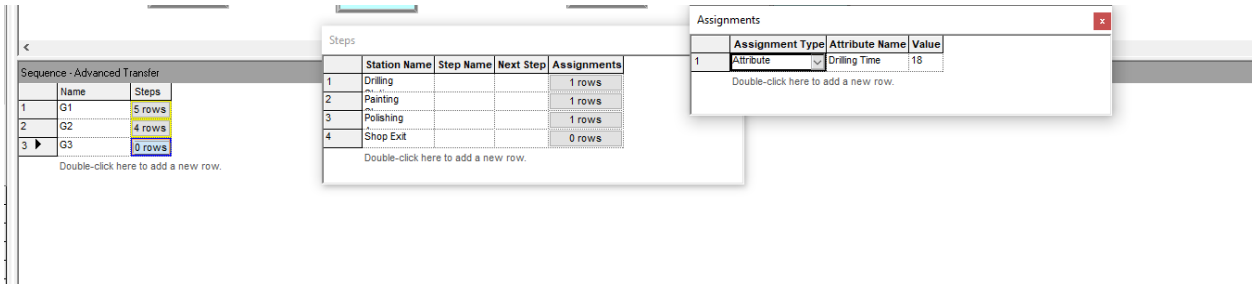


Gear entities are created in the Create module, called Create Jobs.The field labeled "Entities per Arrival" specifies that batches of 10 gear jobs arrive together, while the "Time Between Arrivals" section indicates that the time between batches is randomly distributed between 400 and 600 minutes. After arriving, each gear job is treated as an individual entity.

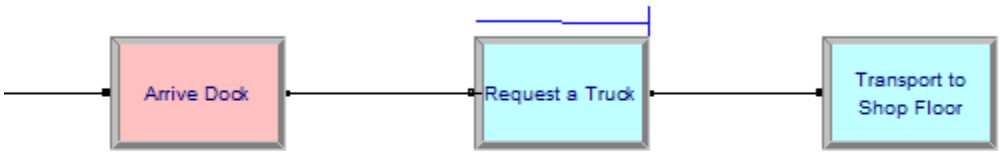


After an incoming gear entity arrives, it moves on to the Assign module, which is named Assign Job Type and Sequence. In this module, a gear entity is given a specific type by being randomly selected from a predetermined distribution. The resulting type code (either 1, 2, or 3) is then saved as the entity's Type attribute. Additionally, the module assigns the current simulation time (Tnow) to the entity's ArrTime attribute, which will be used later to calculate the entity's flow time.



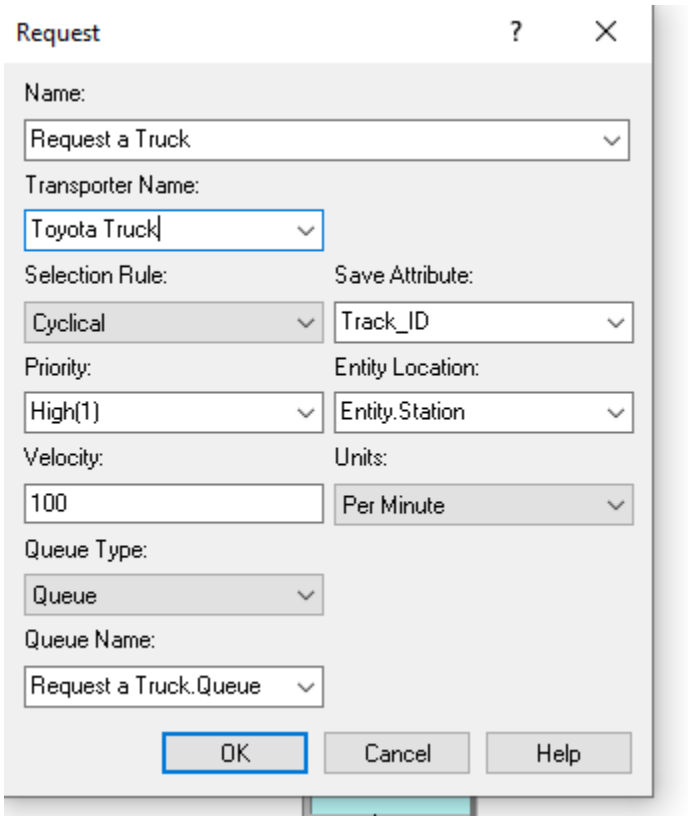


The Sequence module's dialog spreadsheet (located at the bottom of Figure), the Steps dialog spreadsheet (which is used to specify operations steps for G1 gears and is located in the middle of the figure), and the Steps Assignment spreadsheet (which is located at the top of the figure and is used to specify the amount of time for milling type G1 gears) are all displayed in the figure.

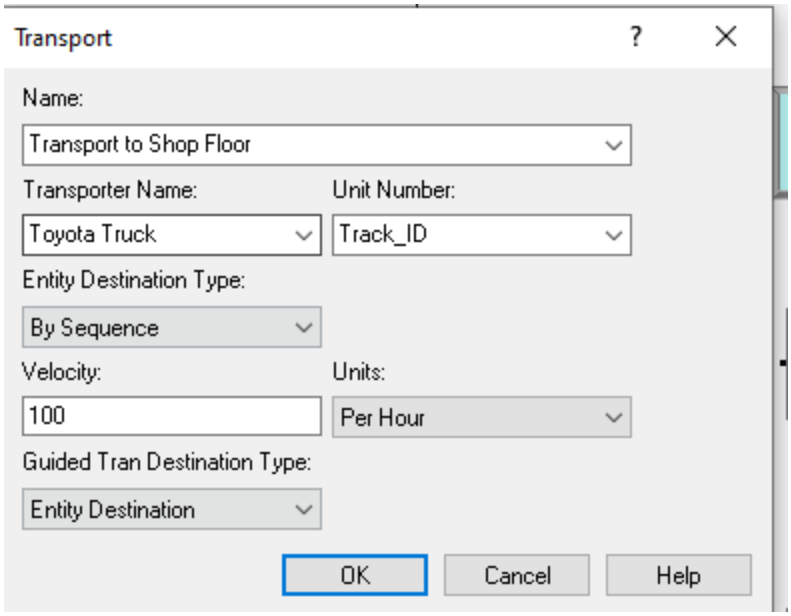


Since requesting transporters from multiple locations can create contention for resources, the Priority field allows the modeler to assign a priority to requests issued at multiple Request modules. In this case, a high priority is assigned to clear the arrival dock as quickly as possible.

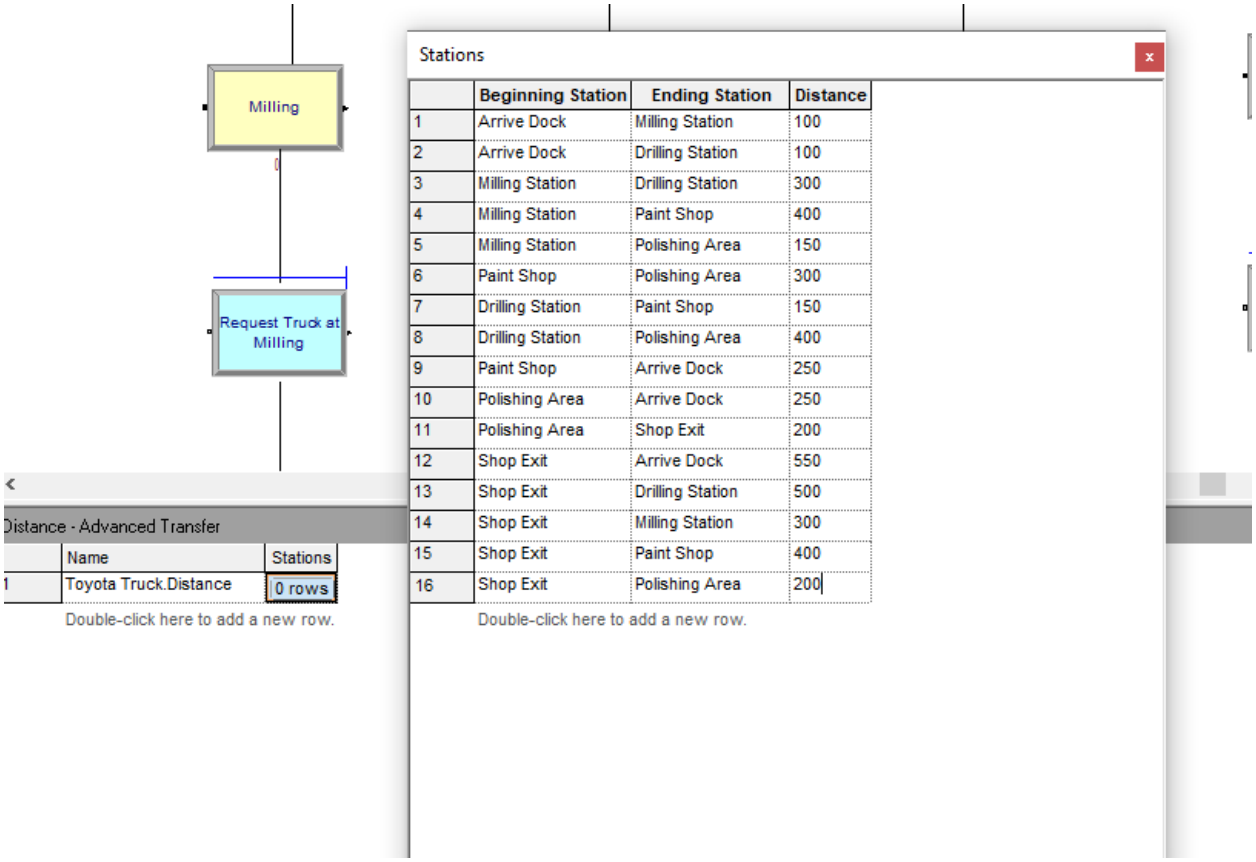
The Entity Location field indicates the location of the requesting entity, and the Velocity field specifies the transporter's velocity, which is set to 100 feet per minute. Finally, gear entities requesting transportation at the same Request module are instructed to wait in the queue called a Truck.Queue until a transporter becomes available.

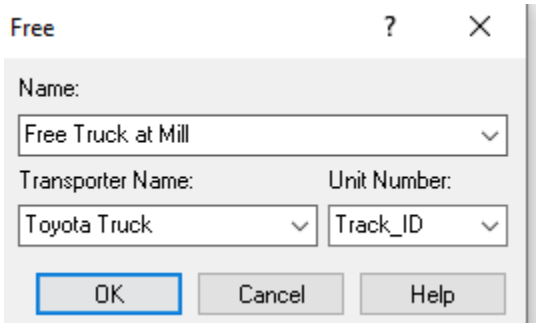


Once a gear entity has taken hold of a truck, it proceeds to a module called "Transport to Shop Floor". In this module, there is a dialog box displayed in Figure . The fields "Transporter Name" and "Unit Number" indicate the type and ID of the selected transporter, which in this case is the truck whose ID is stored in the "Truck_ID" attribute of the requesting gear entity. The destination for the gear entity and transporter is specified in the "Entity Destination Type" field as "By Sequence", meaning that the destination is determined by the gear entity's sequence number. Alternatively, the field can specify a station module name using the "Station" option or an attribute or expression. The gear entity and transporter move together at a velocity of 100 feet per minute, as specified in the "Velocity" field. Note that the velocity may vary depending on the type of trip, so an empty truck and a loaded one may move at different velocities.



The paragraph describes how the distances between different facilities are specified, and it mentions two dialog spreadsheets. Next Figure shows the Distance module dialog spreadsheet on the left and a corresponding Stations dialog spreadsheet on the right. The Stations spreadsheet pops up when a button under the Stations column in the Distance spreadsheet is clicked.


Milling
Request Truck at Milling
Stations
Beginning Station
Ending Station
Distance
1 Arrive Dock Milling Station 100
2 Arrive Dock Drilling Station 100
3 Milling Station Drilling Station 300
4 Milling Station Paint Shop 400
5 Milling Station Polishing Area 150
6 Paint Shop Polishing Area 300
7 Drilling Station Paint Shop 150
8 Drilling Station Polishing Area 400
9 Paint Shop Arrive Dock 250
10 Polishing Area Arrive Dock 250
11 Polishing Area Shop Exit 200
12 Shop Exit Arrive Dock 550
13 Shop Exit Drilling Station 500
14 Shop Exit Milling Station 300
15 Shop Exit Paint Shop 400
16 Shop Exit Polishing Area 200
Double-click here to add a new row.
Distance - Advanced Transfer
Name
Stations
Toyota Truck.Distance
0 rows
Double-click here to add a new row.


Free
Name:
Free Truck at Mill
Transporter Name:
Unit Number:
Toyota Truck
Track_ID
OK
Cancel
Help

Resource - Basic Process

	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics
1	Milling Machine	Fixed Capacity	4	0.0	0.0	0.0		0 rows	☑
2	Drilling Machine	Fixed Capacity	3	0.0	0.0	0.0		0 rows	☑
3	Painting Section	Fixed Capacity	2	0.0	0.0	0.0		0 rows	☑
4	Polishing Section	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑

Double-click here to add a new row.

Process

Name: Milling

Type: Standard

Logic

Action: Seize Delay Release

Priority: Medium(2)

Resources:

Resource, Milling Machine, 1
<End of list>

Add...
Edit...
Delete

Delay Type: Expression

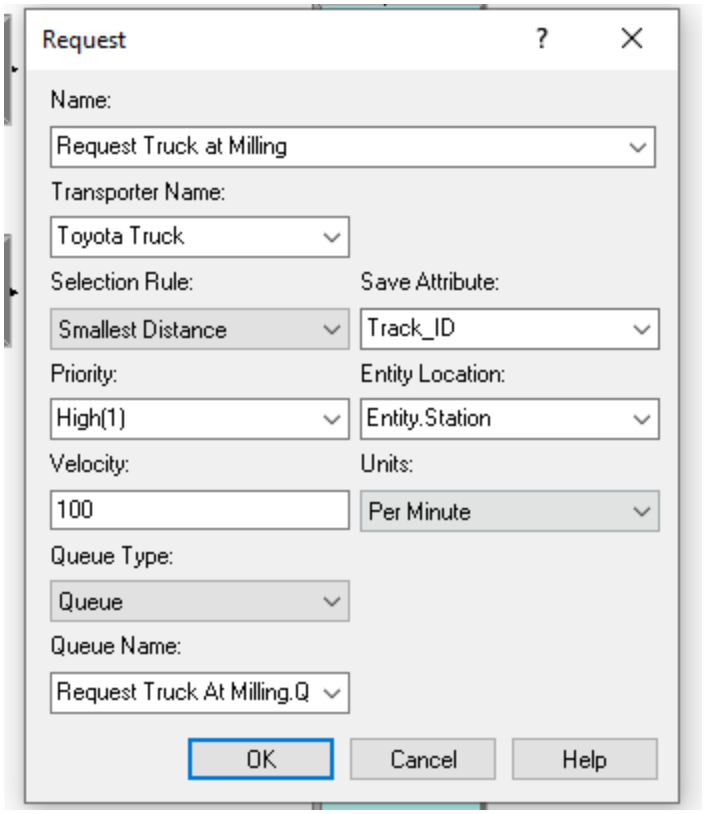
Units: Minutes

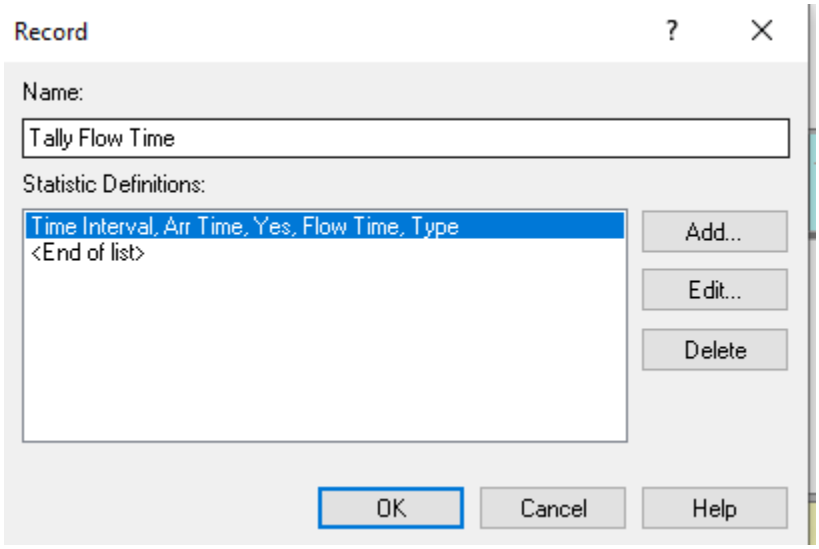
Allocation: Value Added

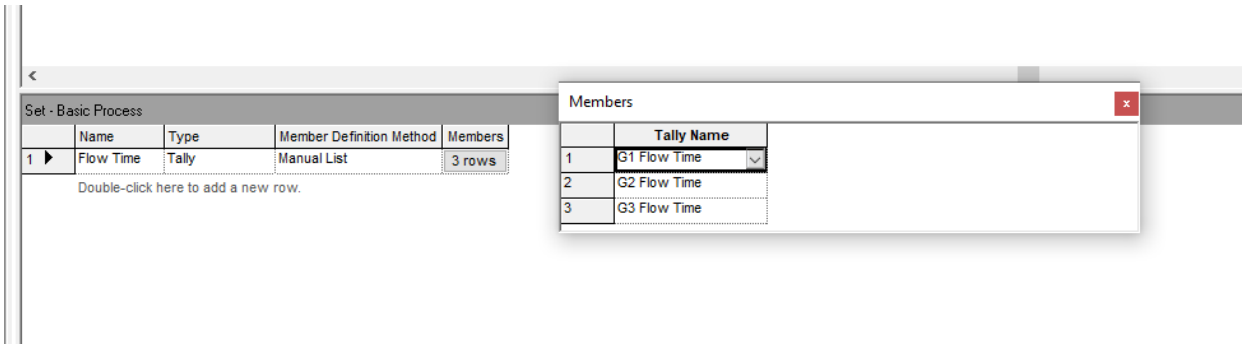
Expression: Milling Time

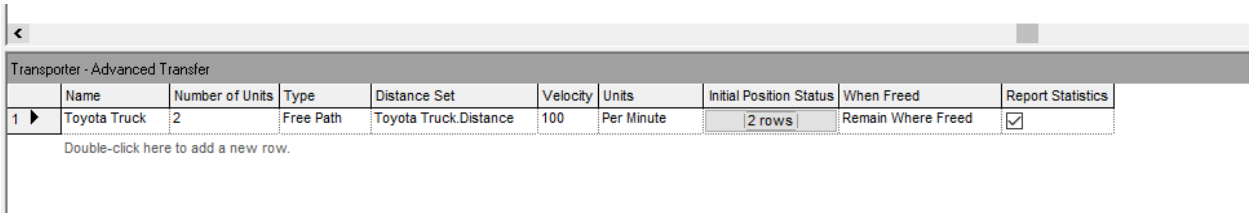
☑ Report Statistics

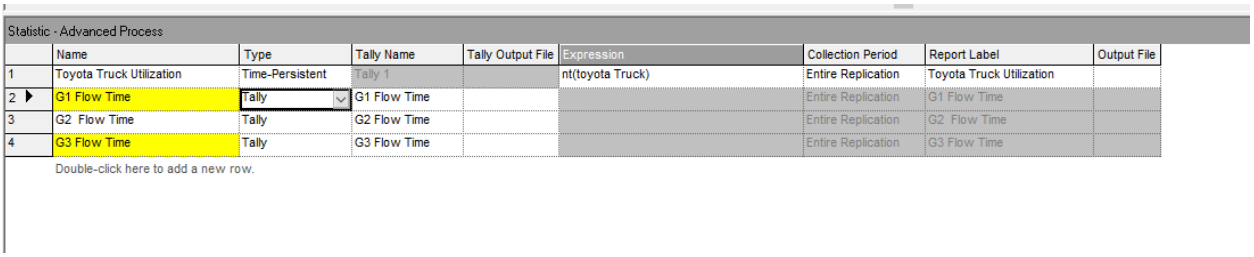
OK Cancel Help


Request
Name:
Request Truck at Milling
Transporter Name:
Toyota Truck
Selection Rule:
Smallest Distance
Save Attribute:
Track_ID
Priority:
High(1)
Entity Location:
Entity.Station
Velocity:
100
Units:
Per Minute
Queue Type:
Queue
Queue Name:
Request Truck At Milling.Q
OK
Cancel
Help


Record
Name:
Tally Flow Time
Statistic Definitions:
Time Interval, Arr Time, Yes, Flow Time, Type
<End of list>
Add...
Edit...
Delete
OK
Cancel
Help

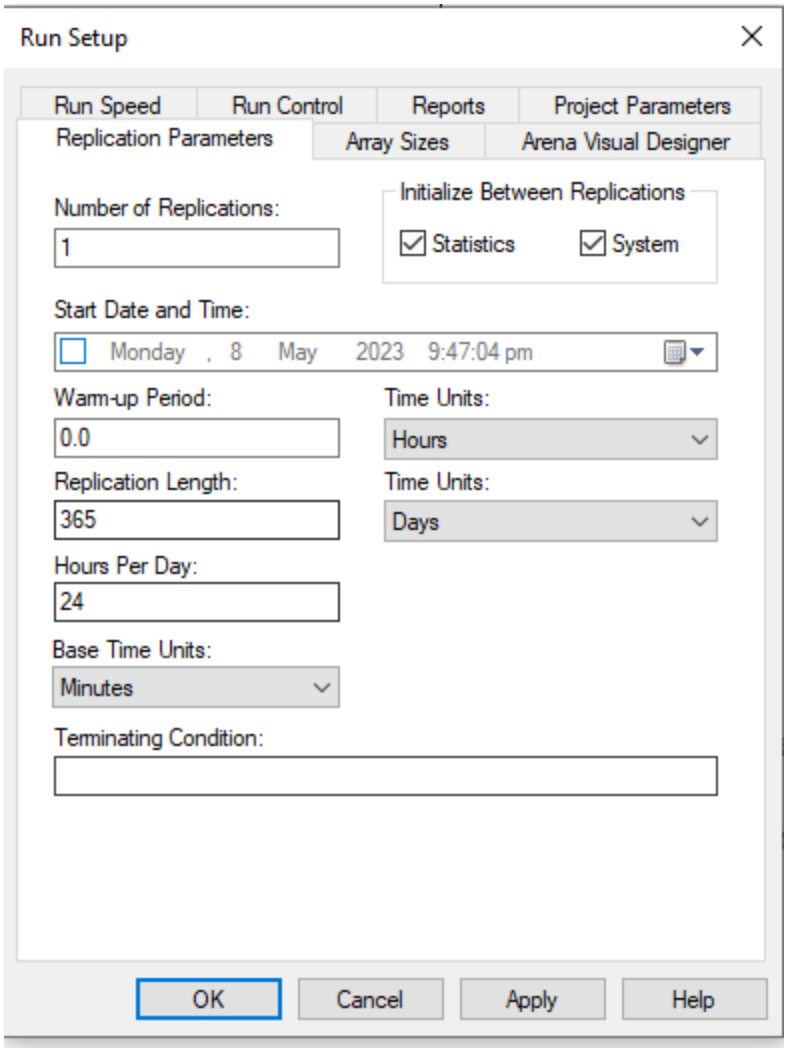






SIMULATION

The simulation of the ARENA job shop model spanned over a year, during which various parameters such as Replication Length and Hours Per Day were defined in the Run Setup. The corresponding setup is displayed in Figure 3.20. The simulation allowed for the observation of entities (represented as gears) as they moved through different facilities, waited for processing, and transferred between machines. It is assumed that the plant operates 24 hours a day, with three shifts of eight hours each. Upon completion of the simulation, a report will be automatically generated. This report can be used to determine Gear flow times (by type), Gear delays at operation locations, Machine utilizations, and other relevant information.


Run Setup
Run Speed
Run Control
Reports
Project Parameters
Replication Parameters
Array Sizes
Arena Visual Designer
Number of Replications:
1
Initialize Between Replications
Statistics
System
Start Date and Time:
Monday , 8 May 2023 9:47:04 pm
Warm-up Period:
0.0
Time Units:
Hours
Replication Length:
365
Time Units:
Days
Hours Per Day:
24
Base Time Units:
Minutes
Terminating Condition:
OK
Cancel
Apply
Help

RESULTS

Key Performance Indicators

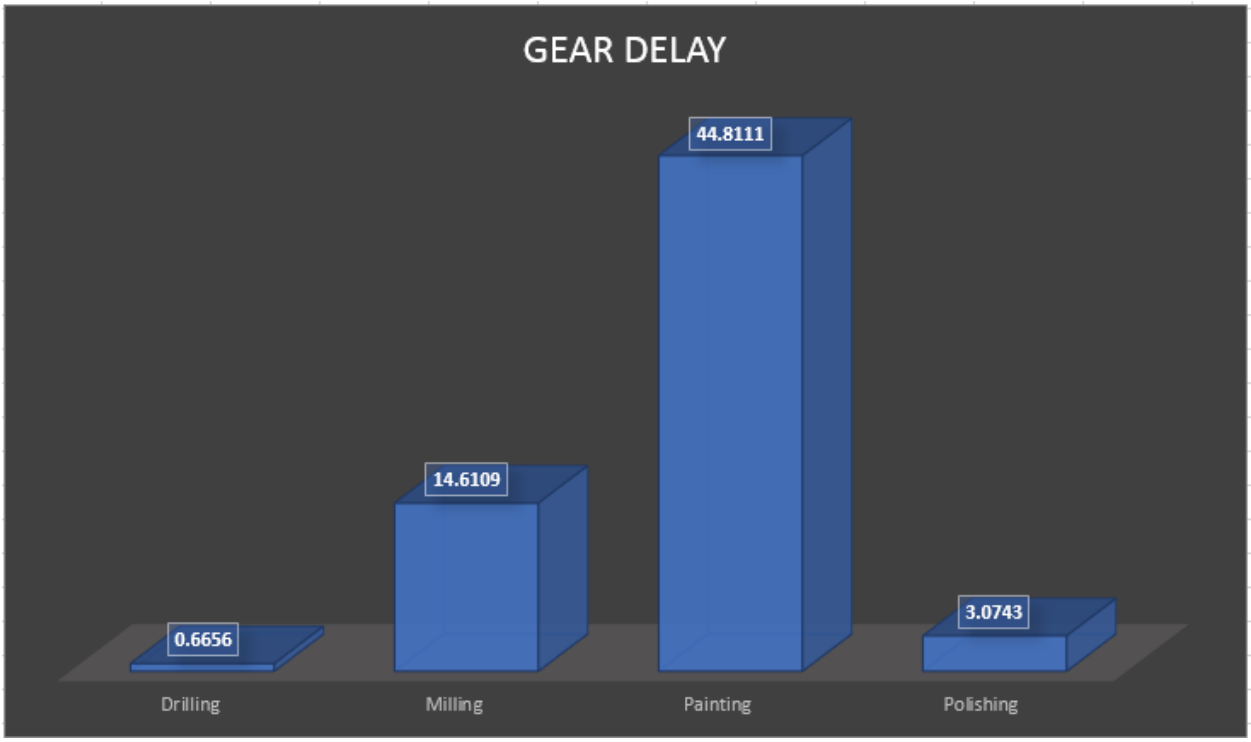
System

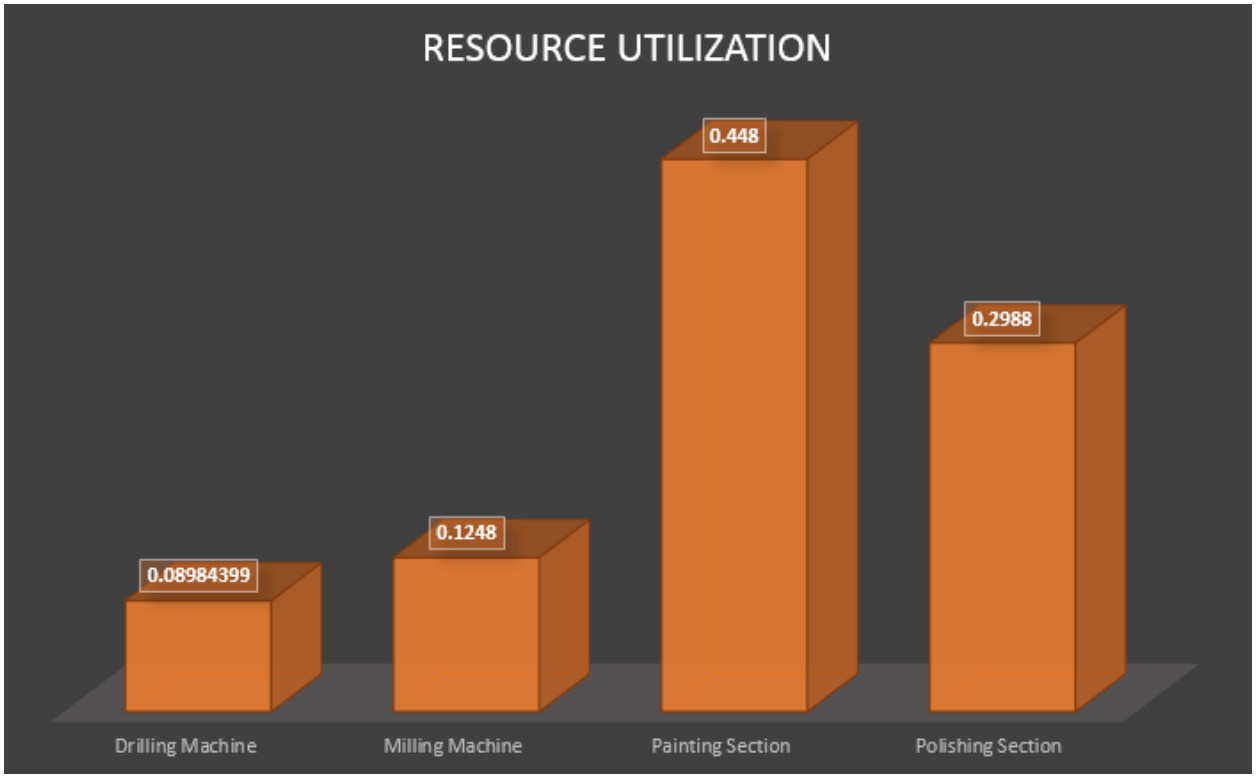
	Average
Number Out	10,470

Wait Time Per Entity	Average	Half Width	Minimum Value	Maximum Value
Drilling	0.6656	0.058478552	0.00	16.0000
Milling	14.6109	0.283086009	0.00	62.0000
Painting	44.8111	0.502319726	0.00	156.50
Polishing	3.0743	0.087881937	0.00	15.0000

Usage

Instantaneous Utilization	Average	Half Width	Minimum Value	Maximum Value
Drilling Machine	0.08984399	0.001432065	0.00	1.0000
Milling Machine	0.1248	0.001909548	0.00	1.0000
Painting Section	0.4480	0.004240685	0.00	1.0000
Polishing Section	0.2988	0.002281493	0.00	1.0000




RESOURCE UTILIZATION
0.08984399
0.1248
0.448
0.2988
Drilling Machine
Milling Machine
Painting Section
Polishing Section