

ME 635: Modelling and Simulation

Homework 3

Simulation models using Arena

09/26/2022

I pledge my honor that I have abided by the Stevens Honor System.

Submitted by,
Viral Panchal.

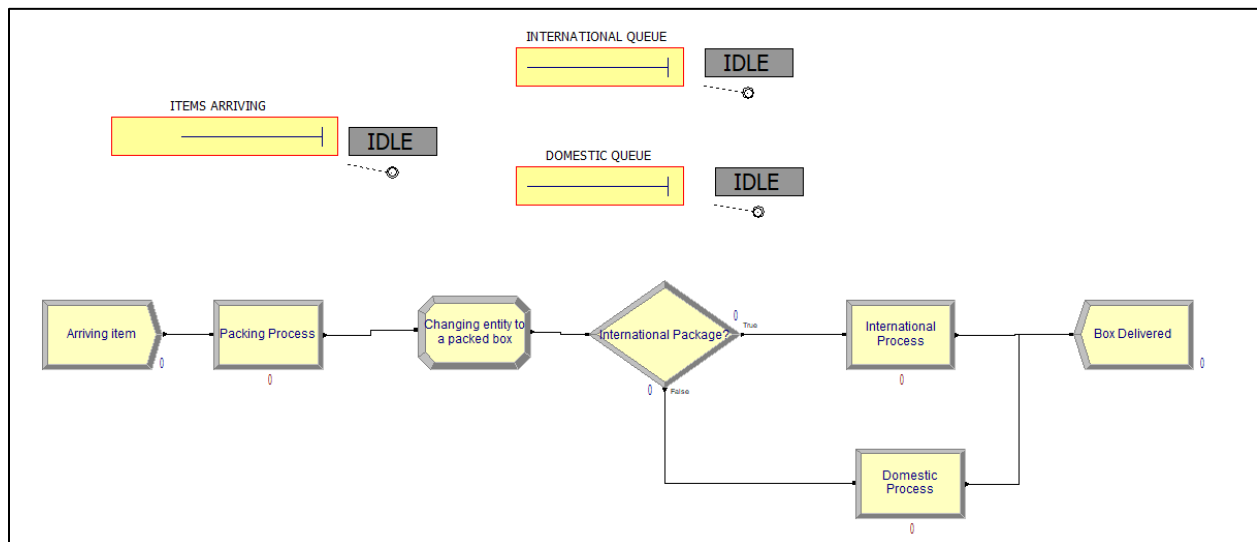
Q1)

Problem 1

Items arrive from an inventory-picking system according to an exponential interarrival distribution with mean 1.1 (all times are in minutes), with the first arrival at time 0. Upon arrival, the items are packed by one of four identical packers, with a single queue “feeding” all four packers. The packing time is TRIA(2.75, 3.3, 4.0). Packed boxes are then separated by type (each box has an independent probability of 0.2 of being international, and the rest are domestic), and sent to shipping. There is a single shipper for international packages and two shippers for domestic packages with a single queue feeding the two domestic shippers. The international shipping time is TRIA(2.2, 3.3, 4.8), and the domestic shipping time is TRIA(1.7, 2.0, 2.7). This packing system works three 8-hour shifts, 5 days a week. All the packers and shippers are given a 15-minute break 2 hours into their shift, a 30-minute lunch break 4 hours into their shift, and a second 15-minute break 6 hours into their shift; use the Wait Schedule Rule.

- Run the simulation for a single replication of 2 weeks (10 working days) to determine the average and maximum number of items or boxes in each of the three (Packing Queue Length, International Queue Length and Domestic Queue Length).

Model:



Parameters within each block:

A) Arriving Item – Create block 1

The 'Create' dialog box is used to configure an arriving item. It includes fields for Name, Entity Type, Time Between Arrivals (Type, Value, Units), Entities per Arrival, Max Arrivals, and First Creation. The 'Arriving item' is selected as the name, and 'Item' is the entity type. The time between arrivals is set to 1.1 minutes. The first creation is set to 0.0.

Name:	Entity Type:	
Arriving item	Item	
Time Between Arrivals		
Type:	Value:	Units:
Random (Expo)	1.1	Minutes
Entities per Arrival:	Max Arrivals:	First Creation:
1	Infinite	0.0

Buttons: OK, Cancel, Help

B) Packing Process – Process block 1

The 'Process' dialog box is used to configure a packing process. It includes fields for Name, Type, Logic (Action, Priority), Resources, Delay Type, Units, Allocation, Minimum, Value (Most Likely), Maximum, and a checkbox for Report Statistics. The 'Packing Process' is selected as the name, and 'Standard' is the type. The action is 'Seize Delay Release' with a priority of 'Medium(2)'. The resource is 'Resource Packers, 1'. The delay type is 'Triangular' with a minimum of 2.75, a most likely value of 3.3, and a maximum of 4.0. The 'Report Statistics' checkbox is checked.

Name:	Type:		
Packing Process	Standard		
Logic			
Action:	Priority:		
Seize Delay Release	Medium(2)		
Resources:			
Resource Packers, 1	Add...		
<End of list>	Edit...		
	Delete		
Delay Type:		Units:	Allocation:
Triangular	Minutes	Value Added	
Minimum:	Value: (Most Likely):	Maximum:	
2.75	3.3	4.0	

☒ Report Statistics

Buttons: OK, Cancel, Help

C) Changing entity to packed box – Assign block

The 'Assign' dialog box is used to configure an assign block. It includes fields for Name and Assignments. The 'Changing entity to a packed box' is selected as the name. The assignment is 'Entity Picture, Picture Box'.

Name:
Changing entity to a packed box
Assignments:
Entity Picture, Picture Box
<End of list>

Buttons: Add..., Edit..., Delete, OK, Cancel, Help

D) International package – Decide block

Decide ? X

Name: Type:

Percent True (0-100): %

OK Cancel Help

E) International Process – Process block 2

Process ? X

Name: Type:

Logic

Action: Priority:

Resources:

Resource, International Shipping, 1	Add... Edit... Delete
<End of list>	

Delay Type: Units: Allocation:

Minimum: Value: (Most Likely): Maximum:

☒ Report Statistics

OK Cancel Help

F) Domestic Process – Process block 3

Process ? X

Name: Type:

Logic

Action: Priority:

Resources:

Resource, Domestic Shipping, 1	Add... Edit... Delete
<End of list>	

Delay Type: Units: Allocation:

Minimum: Value: (Most Likely): Maximum:

☒ Report Statistics

OK Cancel Help

G) Box delivered – Dispose block

Dispose ? X

Name:

Box Delivered

☒ Record Entity Statistics

OK Cancel Help

H) Schedule spreadsheet

Schedule - Basic Process						
	Name	Type	Time Units	Scale Factor	File Name	Durations
1	Packing	Capacity	Quarterhours	1.0		7 rows
2	International	Capacity	Quarterhours	1.0		7 rows
3	Domestic	Capacity	Quarterhours	1.0		7 rows

Double-click here to add a new row.

Result:

Replications: 1

Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Value	Maximum Value
Domestic Process.Queue	9.0139	(Correlated)	0.00	44.5170
International Process.Queue	7.9474	1.25406	0.00	45.3249
Packing Process.Queue	8.2488	0.977990304	0.00	37.9266

Other

Number Waiting	Average	Half Width	Minimum Value	Maximum Value
Domestic Process.Queue	6.4772	(Correlated)	0.00	37.0000
International Process.Queue	1.4228	0.223791374	0.00	12.0000
Packing Process.Queue	7.4127	0.896054485	0.00	39.0000

[Q1_ViralPanchal_zipfile](#)

(The zip file has the arena models and pdf report generated)

Q2)

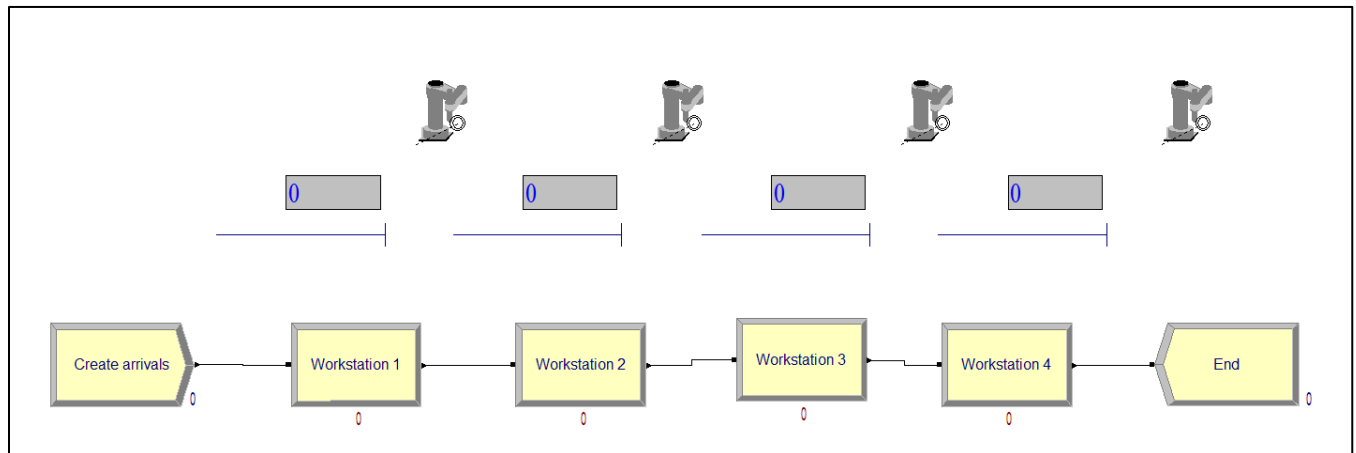
Problem 2

A production system consists of four serial automatic workstations. The first part arrives at time zero, and then (exactly) every 9.8 minutes thereafter. All transfer times are assumed to be zero and all processing times are constant. There are two types of failures: major and jams. The data for this system are given in the table (all times are in minutes). Use exponential distributions for the uptimes and uniform distributions for repair times (for instance, repairing jams at workstation 3 is UNIF(2.8, 4.2)).

- Run your simulation for a single replication of 10,000 minutes to determine the percent of time each resource spends in the failure state (Frequencies Report) and the ending status of each workstation queue (just read off the end-state of the simulation).

Workstation Number	Process Time	Major Failure Means		Jam Means	
		Uptimes	Repair	Uptimes	Repair
1	8.5	475	20, 30	47.6	2, 3
2	8.3	570	24, 36	57	2.4, 3.6
3	8.6	665	28, 42	66.5	2.8, 4.2
4	8.6	475	20, 30	47.5	2, 3

Model:



Parameters within each block:

A) Create arrivals – create block 1

Create ? X

Name: Entity Type:
Create arrivals Parts

Time Between Arrivals
Type: Value: Units:
Constant 9.8 Minutes

Entities per Arrival: Max Arrivals: First Creation:
1 Infinite 0.0

OK Cancel Help

B) Workstation 1 – Process block 1

Process ? X

Name: Type:
Workstation 1 Standard

Logic
Action: Priority:
Seize Delay Release Medium(2)

Resources:
Resource, Workstation 1 Machine, 1
<End of list>

Add...
Edit...
Delete

Delay Type: Units: Allocation:
Constant Minutes Value Added

Value:
8.5

☒ Report Statistics

OK Cancel Help

C) Workstation 2 – Process block 2

Process ? X

Name: Type:

Logic

Action: Priority:

Resources:

<End of list>

Add...
Edit...
Delete

Delay Type: Units: Allocation:

Value:

☒ Report Statistics

OK Cancel Help

D) Workstation 3 – Process block 3

Process ? X

Name: Type:

Logic

Action: Priority:

Resources:

<End of list>

Add...
Edit...
Delete

Delay Type: Units: Allocation:

Value:

☒ Report Statistics

OK Cancel Help

E) Workstation 4 – Process block 4

Process

Name: Type:

Logic

Action: Priority:

Resources:

<End of list>

Delay Type: Units: Allocation:

Value:

☒ Report Statistics

F) End - Dispose block

Dispose

Name:

☒ Record Entity Statistics

G) Failure spreadsheet

Failure - Advanced Process							
	Name	Type	Up Time	Up Time Units	Down Time	Down Time Units	Uptime in this State only
1	Major failure station 1	Time	EXPO(475)	Minutes	UNIF(20,30)	Minutes	
2	Jam station 1	Time	EXPO(47.6)	Minutes	UNIF(2,3)	Minutes	
3	Major failure station 2	Time	EXPO(570)	Minutes	UNIF(24,36)	Minutes	
4	Jam station 2	Time	EXPO(57)	Minutes	UNIF(2.4,3.6)	Minutes	
5	Major failure station 3	Time	EXPO(665)	Minutes	UNIF(28,42)	Minutes	
6	Jam station 3	Time	EXPO(66.5)	Minutes	UNIF(2.8,4.2)	Minutes	
7	Major failure station 4	Time	EXPO(475)	Minutes	UNIF(20,30)	Minutes	
8	Jam station 4	Time	EXPO(47.5)	Minutes	UNIF(2,3)	Minutes	

Double-click here to add a new row.

H) Statistics spreadsheet

Statistic - Advanced Process								
	Name	Type	Frequency Type	Resource Name	Collection Period	Report Label	Output File	Categories
1	Workstation 1 stats	Frequency	State	Workstation 1 Machine	Entire Replication	WorkStation 1 Stats		0 rows
2	Workstation 2 stats	Frequency	State	Workstation 2 Machine	Entire Replication	WorkStation 2 Stats		0 rows
3	Workstation 3 stats	Frequency	State	Workstation 3 Machine	Entire Replication	WorkStation 3 stats		0 rows
4	Workstation 4 stats	Frequency	State	Workstation 4 Machine	Entire Replication	WorkStation 4 stats		0 rows

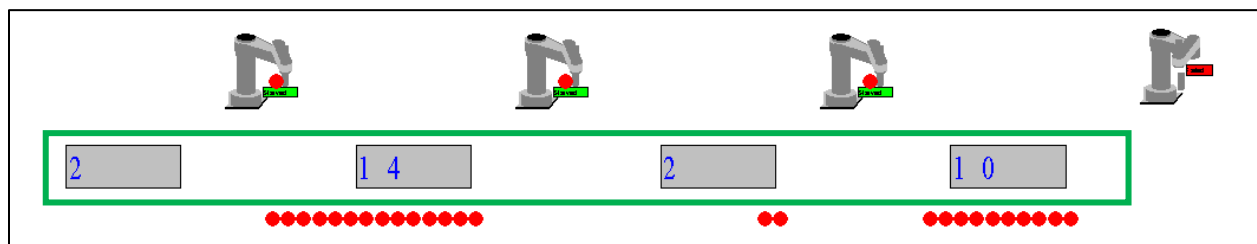
Double-click here to add a new row.

Result:

A) Percent time of each resource in failure state.

Unnamed Project					Replications: 1
Replication 1	Start Time:	0.00	Stop Time:	10,000.00	Time Units: Minutes
WorkStaion 1 Stats	Number Obs	Average Time	Standard Percent	Restricted Percent	
BUSY	634	13.6814	86.74	86.74	
FAILED	206	4.0156	8.27	8.27	
IDLE	440	1.1336	4.99	4.99	
WorkStation 2 Stats	Number Obs	Average Time	Standard Percent	Restricted Percent	
BUSY	434	19.2267	83.44	83.44	
FAILED	195	5.9606	11.62	11.62	
IDLE	252	1.9575	4.93	4.93	
Workstation 3 stats	Number Obs	Average Time	Standard Percent	Restricted Percent	
BUSY	202	42.6965	86.25	86.25	
FAILED	143	5.0861	7.27	7.27	
IDLE	75	8.6400	6.48	6.48	
Workstation 4 stats	Number Obs	Average Time	Standard Percent	Restricted Percent	
BUSY	242	35.2352	85.27	85.27	
FAILED	205	4.9544	10.16	10.16	
IDLE	54	8.4710	4.57	4.57	

B) Ending status.



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