Experiment No. 7
Title: Simulation of Cafeteria

Batch: B2 **Roll No.: 16010421059** **Experiment No.:7**

Aim: To Implement the model for Cafeteria using Extend Sim and estimate system performance.

Resources needed: Extend Sim 10.0.7

Theory

Problem Statement:
People arrive at a self-service cafeteria at the rate of one every 30 sec (Arrivals are Poisson distributed). 40% got to sandwich counter, where one worker makes a sandwich in approximately 60 sec. The rest go to the main counter; where one server spoons the prepared meal onto a plate in approximately 45 sec. All the customers must pay a single cashier, which takes approximately 25 sec., for all customers eating takes approximately 20 min. After eating 10% of the people go back for dessert, spending an additional 10 min (approx) altogether in the cafeteria. Simulate until 100 people have left the cafeteria, how many people are left in the cafeteria and what are they doing at the time the simulation ends. Except for the arrivals all the other data are exponentially distributed.

Model the problem as a queuing system.

Animate the model in 2D.

Run the simulation till 100 people have departed from the system.

Plot and verify the following results
- Length of the queue against the number of jobs exited from the system.
- Display how many people are in the system when the simulation ends and what they are doing.

Concepts:

Discrete Event Model
Simulating a system or process provides a quick and cost effective method for determining the impact, value and cost of change. Simulation models allow for time compression, are not disruptive of the existing system, and are more flexible than real systems. They also provide metrics for meaningful analysis and strategic planning.
Discrete event modelling is an integral part of Six Sigma, business engineering, risk analysis, capacity planning, throughput analysis and reliability engineering projects. The discrete event model is also useful for examining the effect of variations.

Conceptual Model assumptions:

The Cafeteria model represents a business operation where customer are given service. The assumptions for the model are:

• The model runs until 100 customers are exited from the system
• Arrival of the customer is Poisson distributed with mean 30.
• All other service times are exponentially distributed with the specified means
• The blocks come from the Item, Value, and Plotter libraries

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Procedure / Approach /Algorithm / Activity Diagram:
(Write the algorithm for the Autocorrelation test and follow the steps given below)
Steps:
Starting a model and setting simulation parameters

The following steps are typical when starting any discrete event model.

- ✓ *Open a new model worksheet*
- ✓ *Give the command Run > Simulation Setup. In the Setup tab enter the simulation parameters:*
  - o *Global time units: seconds*
- ✓ *If they aren't already open, open the Item, Plotter, and Value libraries*
- ✓ *Place an Executive block (Item library) on the top left corner of the model worksheet*
- ✓ *Open dialog of the Executive block ; control tab; select options;*
  - o *Stop Simulation: when count connector value>=;enter 100.*

The Executive block does event scheduling and manages discrete event simulations.
It must be present in every discrete event model.

Start small

In building any simulation model, start with a simple subset of the process and add detail until you arrive at a completed model that approximates the system that's being modelled.

The following table lists the blocks that will be added to the worksheet and their use in the model.

Except for the Plotter block from the Plotter library and random number block from value library, the blocks in the table are from the Item library.

Name (Label)	Block Function
Create block (customers)	Generates items or values, either randomly or on schedule. If used to generate items, it pushes them into the simulation and should be followed by a queue-type block.

Purpose in Cafeteria Model

Generates customers that arrive as per Poisson process

***Set* (Item > Properties)** Attaches user-assigned properties (attribute, priority, and quantity) to items passing through.

Purpose in Cafeteria Model

Set property as preference (sandwich or meal) and further dessert or no dessert

Queue block(Entry Line) Acts as a sorted queue or as a resource pool queue. As a

sorted queue, holds items in FIFO or LIFO order, or sorts items based on their attribute or priority.

Purpose in Cafeteria Model

Holds the customers and, when the server is available, releases one by one in first-in, first-out order.

***Select Item In* (Item > Routing)** Selects an input and outputs its item.

Purpose in Cafeteria Model

For merging the two inputs (customers coming from sandwich counter and meal counter towards) and output one (one cashier).

***Select Item Out* (Item > Routing)** Sends each item it gets to a selected O/P

Purpose in Cafeteria Model

Apply the routing rule 40% go to sandwich counter, others go to meal counter and the dessert routing rule 10% have dessert and others don't have.

Activity block Server) Processes one or more items simultaneously. Processing

time is a constant or is based on a distribution or an item's attribute.

Purpose in cafeteria Model

Serves the customers as per the service distribution i.e. exponentially distributed

Random Number block Generates the random numbers

Purpose in cafeteria Model

Outputs values to a Set block as per the look up table

Exit (Exit)	Removes items from the simulation and counts them as they leave.

Purpose in Cafeteria Model

Exits the customers from the model.

Plotter, Discrete Event

Purpose in Cafeteria Model

Reports the length of the waiting line and how many jobs has been processed.

- ✓ Starting at the right of the Executive block, place the blocks on the model worksheet in a line from left to right, based on their order in the table.
- ✓ Label the blocks as the system entities.

<u>Enter the dialog parameters and settings for each block</u>

<u>Make the connections</u>

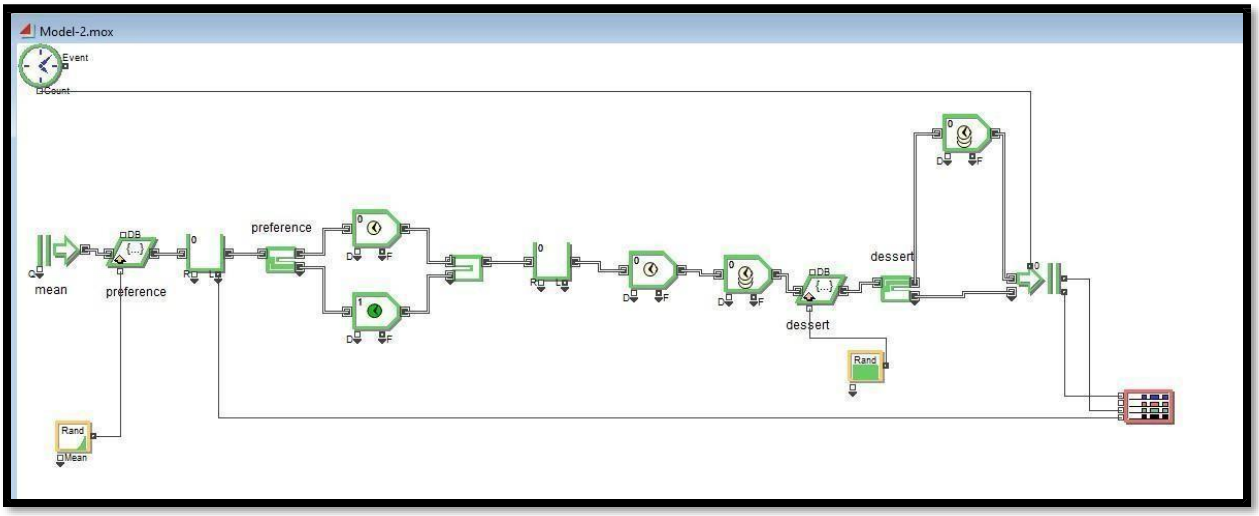
<u>Run the simulation</u>

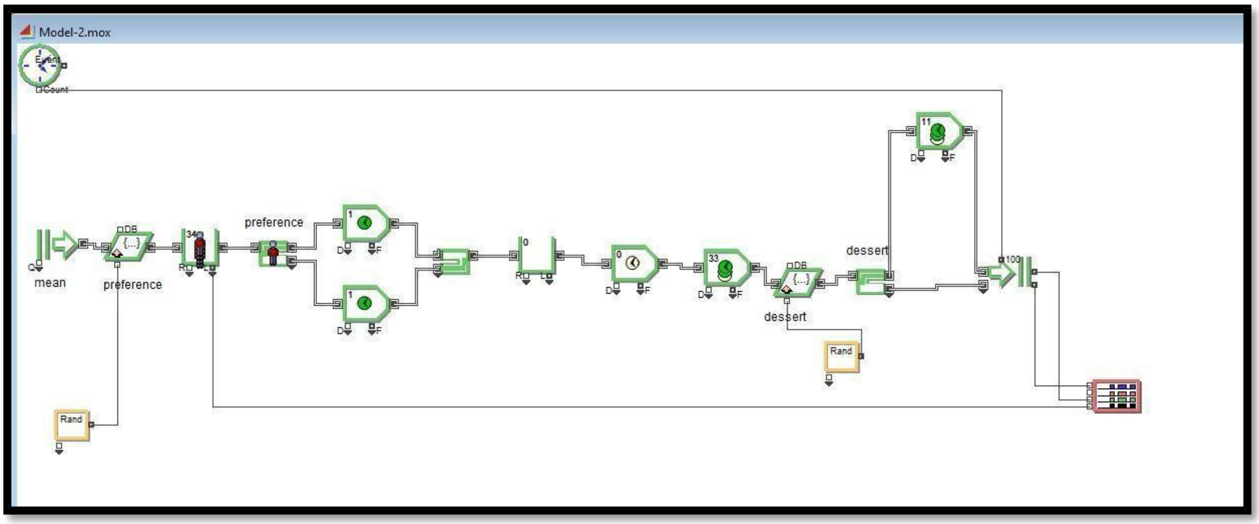
<u>Verify the results</u>

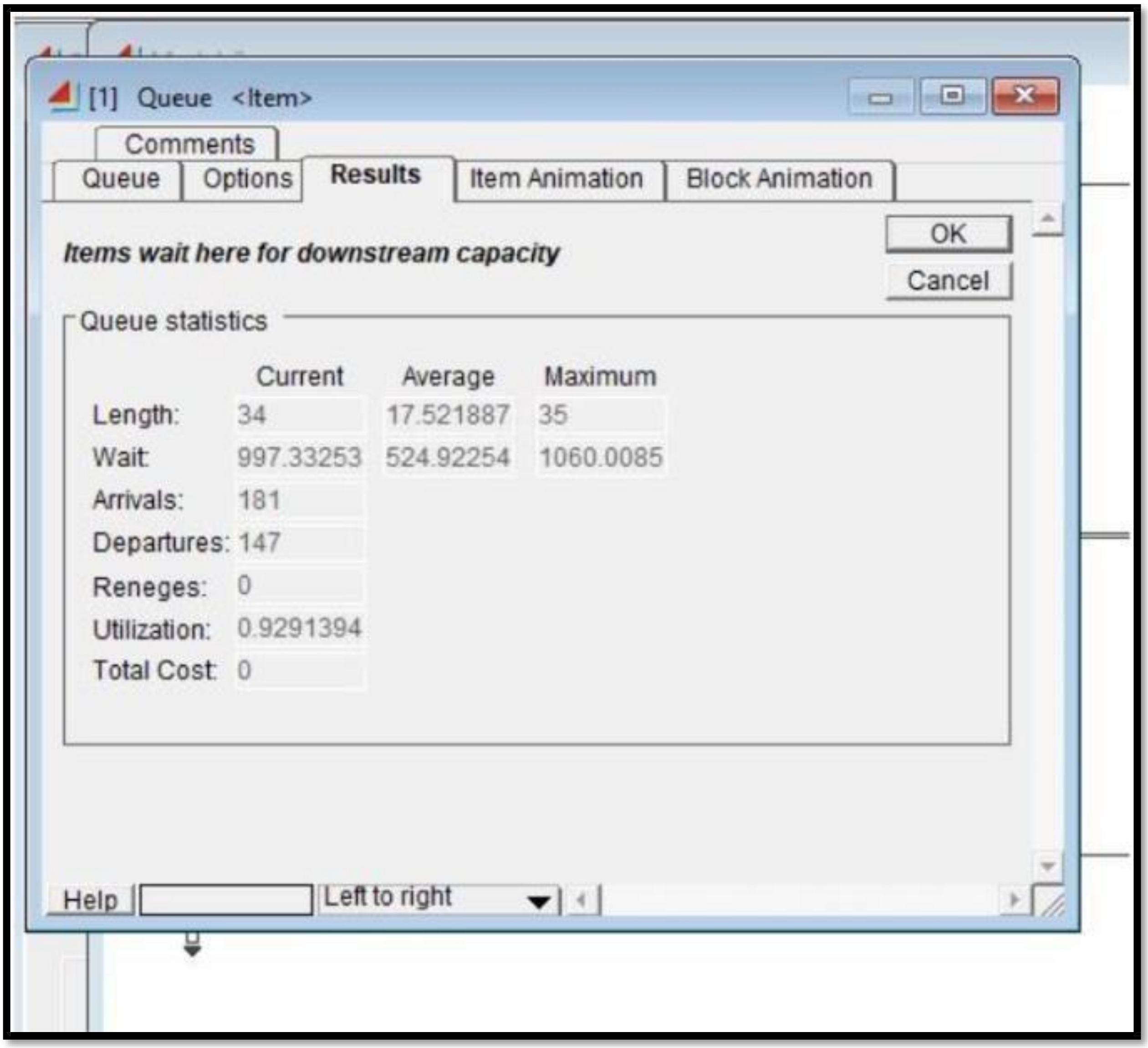
<u>Animate the model</u>

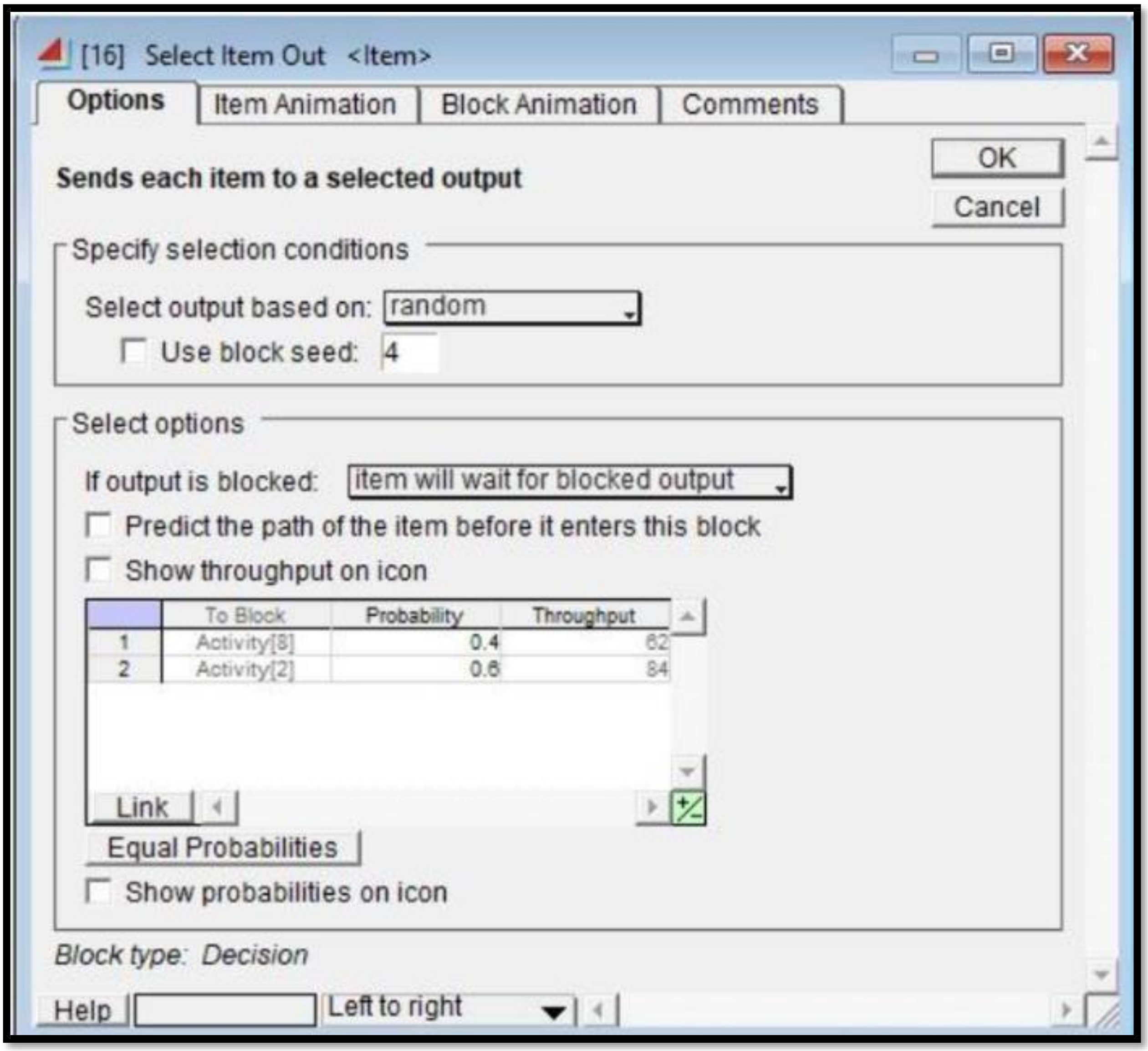
<u>Results: (Program printout with output)</u>

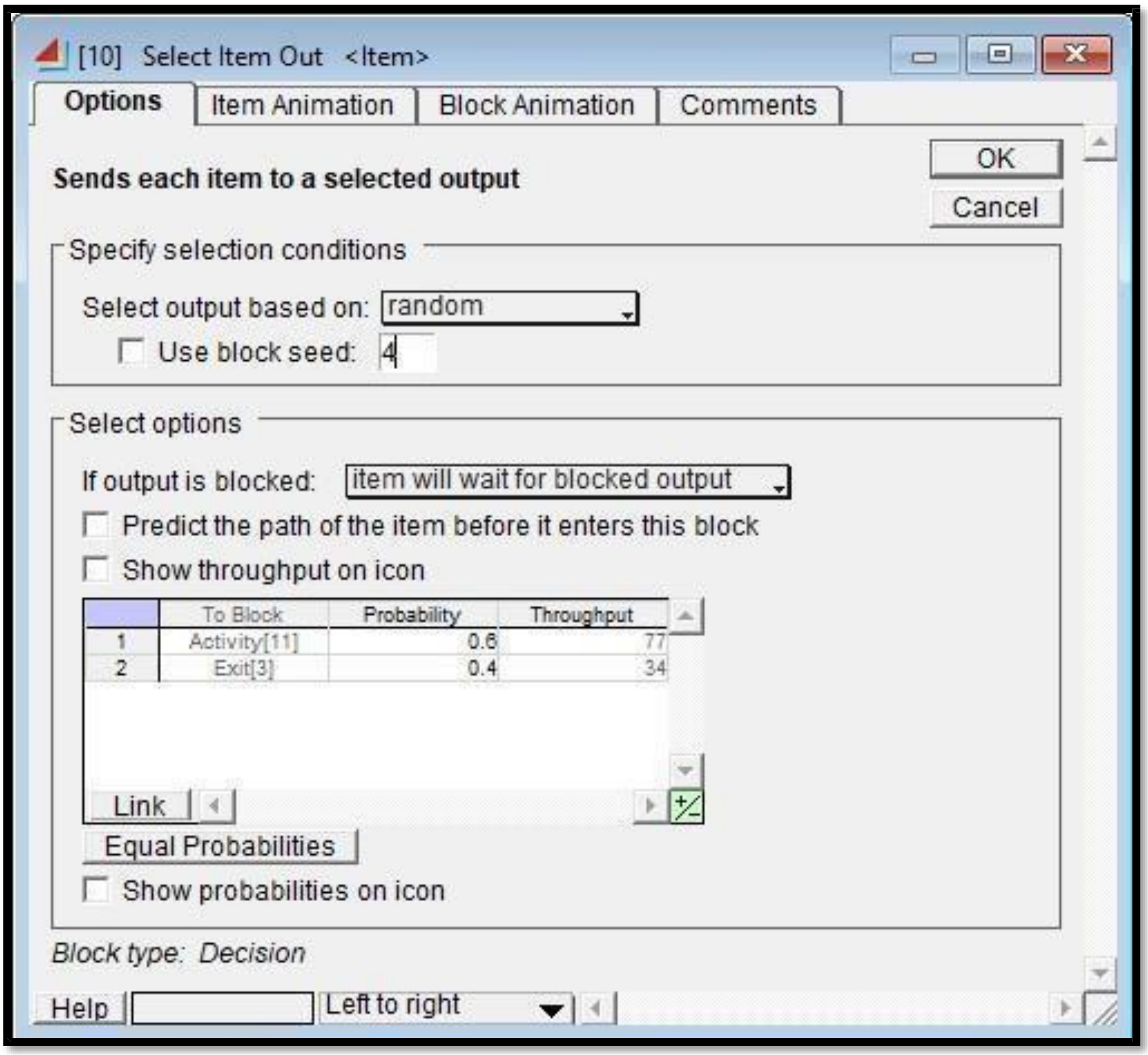
Program: *(Printed model developed in Extend Sim)*

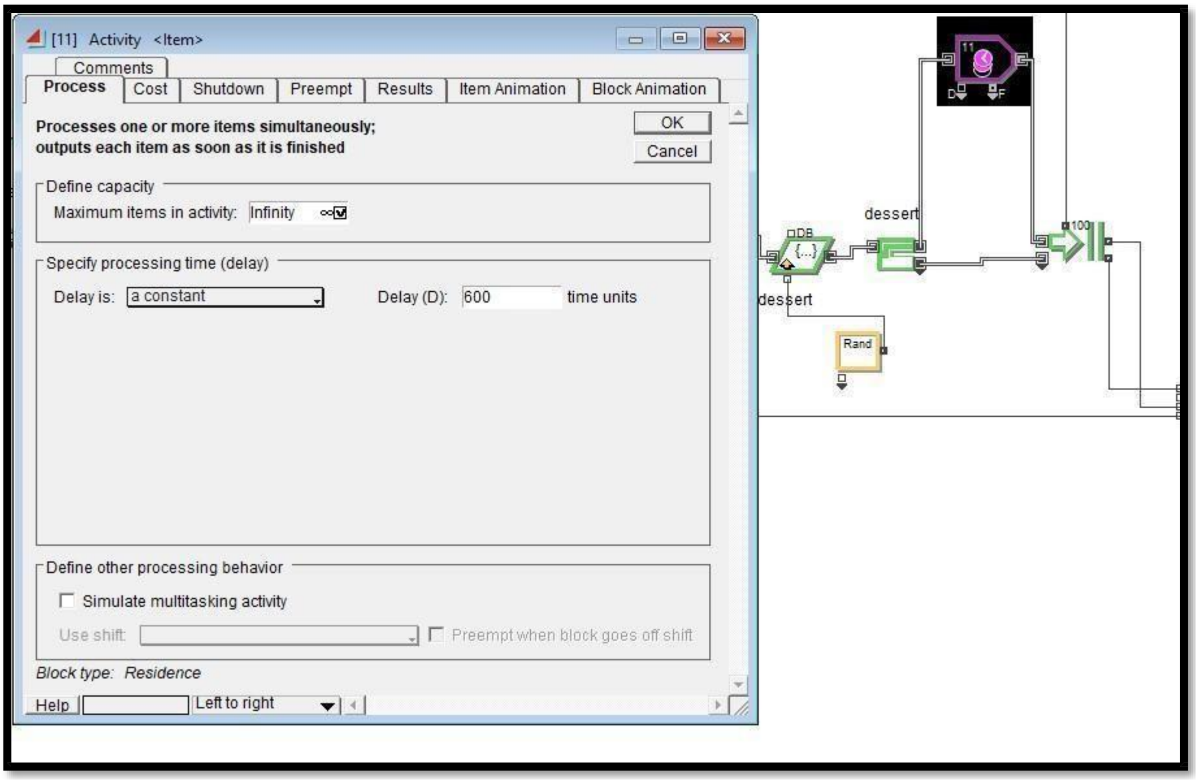




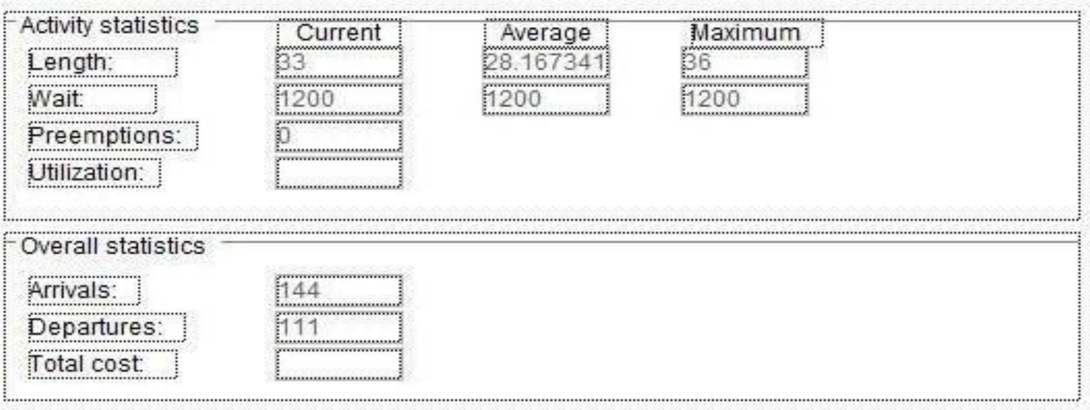

[1] Queue <Item>
Comments
Queue
Options
Results
Item Animation
Block Animation
OK
Cancel
Items wait here for downstream capacity
Queue statistics
Current
Average
Maximum
Length: 34 17.521887 35
Wait: 997.33253 524.92254 1060.0085
Arrivals: 181
Departures: 147
Reneges: 0
Utilization: 0.9291394
Total Cost: 0
Help
Left to right

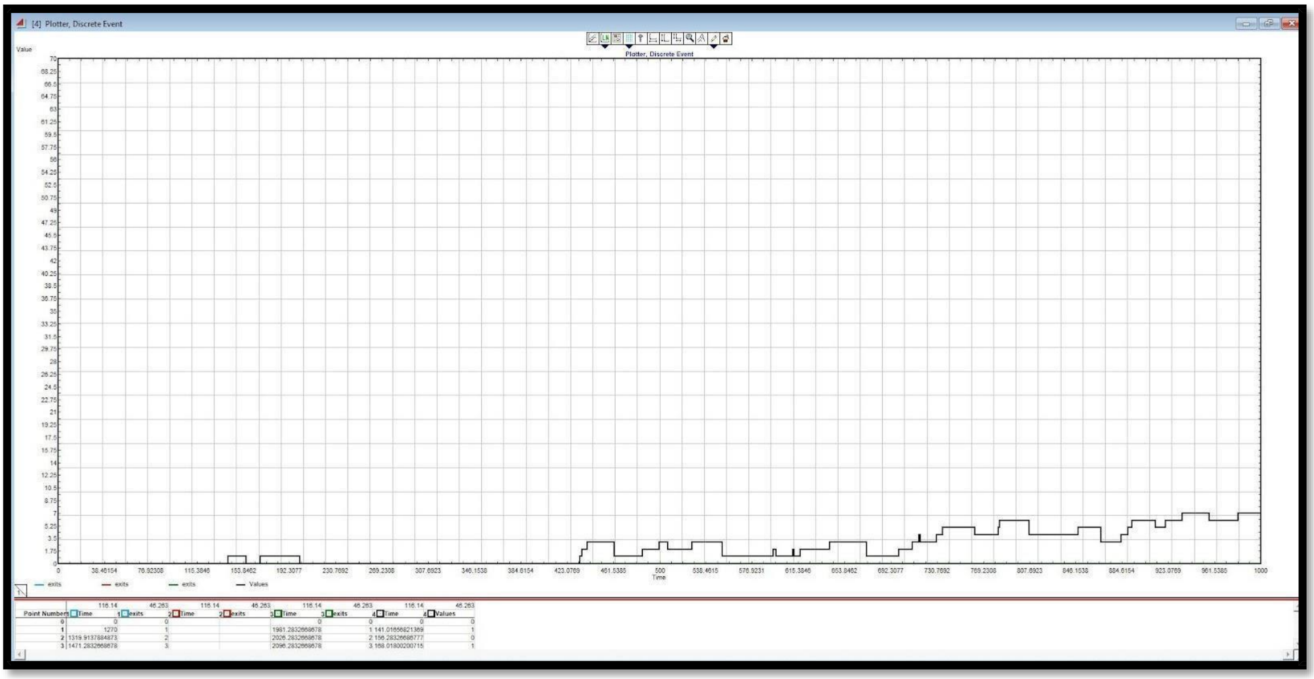

[16] Select Item Out <Item>
Options
Item Animation
Block Animation
Comments
OK
Cancel
Sends each item to a selected output
Specify selection conditions
Select output based on: random
Use block seed: 4
Select options
If output is blocked: item will wait for blocked output
Predict the path of the item before it enters this block
Show throughput on icon
To Block
Probability
Throughput
1 Activity[8] 0.4 62
2 Activity[2] 0.6 84
Link
Equal Probabilities
Show probabilities on icon
Block type: Decision
Help
Left to right


[10] Select Item Out <Item>
Options
Item Animation
Block Animation
Comments
OK
Cancel
Sends each item to a selected output
Specify selection conditions
Select output based on: random
Use block seed: 4
Select options
If output is blocked: item will wait for blocked output
Predict the path of the item before it enters this block
Show throughput on icon
To Block
Probability
Throughput
1 Activity[11] 0.6 77
2 Exit[3] 0.4 34
Link
Equal Probabilities
Show probabilities on icon
Block type: Decision
Help
Left to right


[11] Activity <Item>
Comments
Process
Cost
Shutdown
Preempt
Results
Item Animation
Block Animation
Processes one or more items simultaneously;
outputs each item as soon as it is finished
OK
Cancel
Define capacity
Maximum items in activity: Infinity
Specify processing time (delay)
Delay is: a constant
Delay (D): 600 time units
Define other processing behavior
Simulate multitasking activity
Use shift
Preempt when block goes off shift
Block type: Residence
Help
Left to right
dessert
dessert
Rand

Output: *(Printed results i.e. the plotter data)*





Questions:

1. List some features when selecting simulation software.

Ans. Features when selecting simulation software include:

- Modelling capabilities: Look for software that allows you to create complex models that accurately represent the system or process you want to simulate.
- Flexibility: The software should be flexible enough to adapt to various applications and scenarios, and it should support multiple types of simulations.
- Accuracy: Choose a software that has been validated and proven to produce accurate results.
- User-friendliness: The software should be easy to use and navigate, with a clear interface and intuitive controls.
- Integration: Look for software that can be easily integrated with other tools and applications that you use.

2. Give the physical basis for selecting distribution
(i) Poisson
(ii) Exponential
(iii) Normal

Ans.

(i) Poisson distribution: The Poisson distribution is used when modelling the number of occurrences of an event in a given time or space interval. This distribution is appropriate when the events are random and independent, and the average rate of occurrence is constant. For example, the number of customers arriving at a store in a given hour, the number of defects in a batch of products, or the number of earthquakes in a given region over a period of time can be modelled using a Poisson distribution.

(ii) Exponential distribution: The exponential distribution is used when modelling the time between two consecutive events in a Poisson process. It is often used to model waiting times, failure times, or other durations. The exponential distribution assumes that the rate of occurrence is constant and that events are independent. For example, the time between customer arrivals, the time between machine breakdowns, or the time between consecutive earthquakes can be modelled using an exponential distribution.

(iii) Normal distribution: The normal distribution is used when modelling continuous data that follow a bell-shaped curve. The normal distribution is commonly used in statistical analysis because many natural phenomena tend to follow this distribution. For example, the distribution of heights or weights of a population, or the distribution of test scores in a classroom can often be modelled using a normal distribution. The normal distribution is also important in control chart analysis and process capability studies.

3. What is the purpose of Output analysis?

Ans. The purpose of output analysis is to evaluate and understand the results generated by a simulation model. The simulation model can be used to represent a complex system or process, and output analysis helps to determine the behavior of the system and the impact of different scenarios or input values.

The main objectives of output analysis include:

- Validating the simulation model: Output analysis can help to verify that the simulation model accurately reflects the behavior of the real system or process being studied.

- Understanding the system behavior: Output analysis can help to identify the key performance indicators (KPIs) and evaluate how the system performs under different scenarios and input values.

- Identifying bottlenecks and improvement opportunities: Output analysis can help to pinpoint the factors that are limiting the performance of the system, and suggest areas for improvement.

Outcomes:

CO3. Analyze simulation results to reach an appropriate conclusion.

Conclusion: (Conclusion to be based on outcomes)

Implemented the model for Cafeteria using Extend Sim software and estimated its system performance. Modelled the cafeteria problem statement as a queuing system. Animated the model in 2D. Ran the simulation till 100 people departed from the system.

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of faculty in-charge with date

References:

Books/ Journals/ Websites:
Text Book:

Banks J., Carson J. S., Nelson B. L., and Nicol D. M., “Discrete Event System Simulation”, 3rd edition, Pearson Education, 2001.

Additional Web Resources:

• Extend sim Users Guide
•Real Queuing Examples:http://www2.uwindsor.ca/hlynka/qreal.html
This site contains excerpts from news articlesthat deal with aspects of waiting lines.
• ClearQ:http://clearq.com/This company produces “take-a-number” systems for service facilities (e.g., delis), but also provides performance information about the waiting line.
• Qmatic:http://us.q-matic.com/index.htmlThiscompany produces informational displays and other products to keep customers informed about waiting times.
• “Queuing Presentation” by Richard Larson, given at the Institute for Operations Research and the Management Sciences:http://caes.mit.edu/people/larson/MontrealINFORMS1/sld001.htm.

• The Queuing Theory
Tutor:http://www.dcs.ed.ac.uk/home/jeh/Simjava/queueing/mm1_q/mm1_q
.html
This site has two animated displays of waiting lines. The user can change arrival and service rates to see how performance is affected.
• Myron Hlynka's Queuing Page:http:www2.uwindsor.ca/hlynka/queue.html
This Web site contains information about waiting lines as well as links to other interesting sites.
• Queuing ToolPak:http://www.bus.ualberta.ca/aingolfsson/qtp/
The Queuing ToolPak is an Excel add-in that allows you to easily compute performance measures for a number of different waiting line models

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