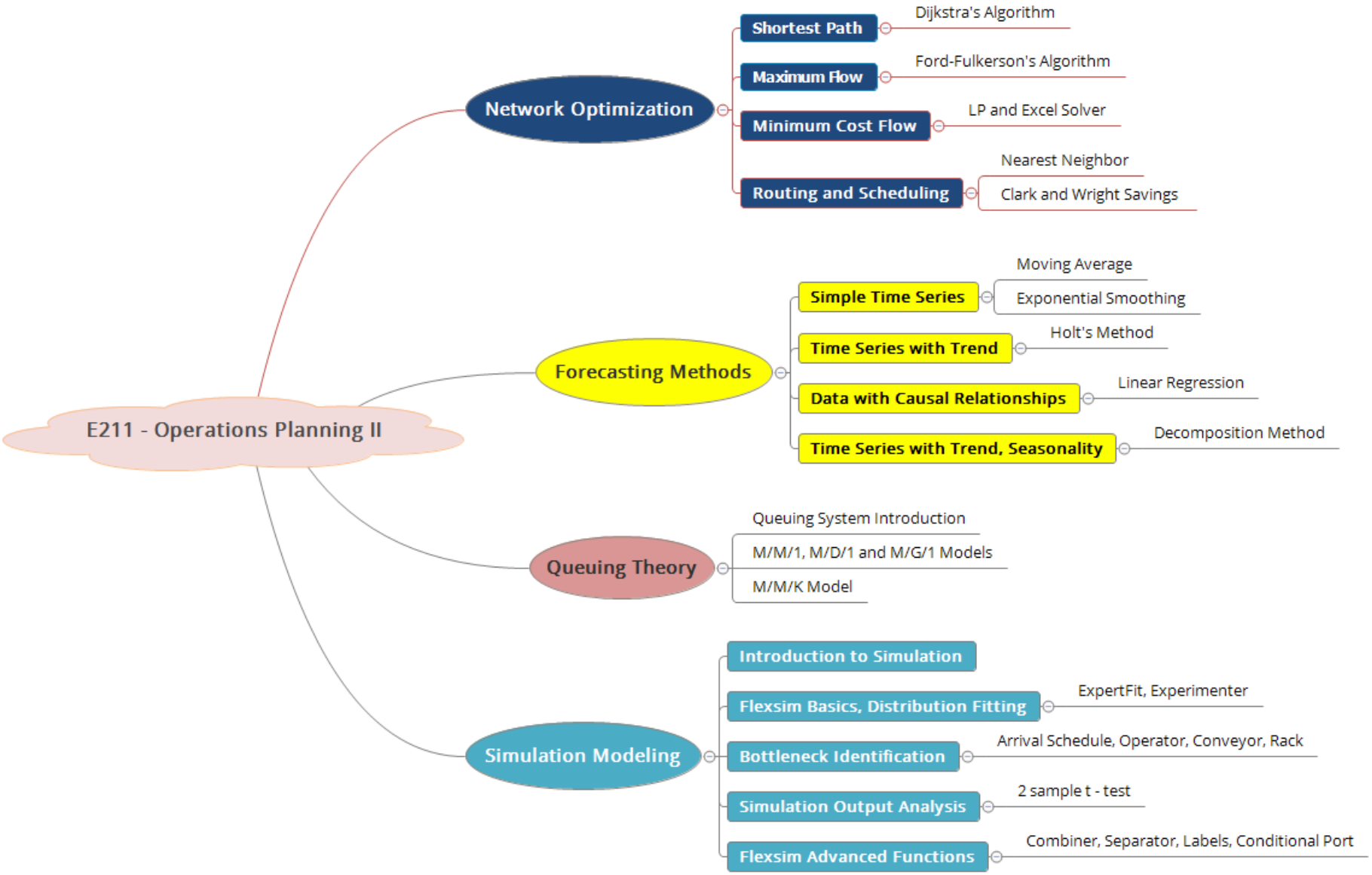
Problem 11

Is the Service Good?

E211 – Operations Planning II

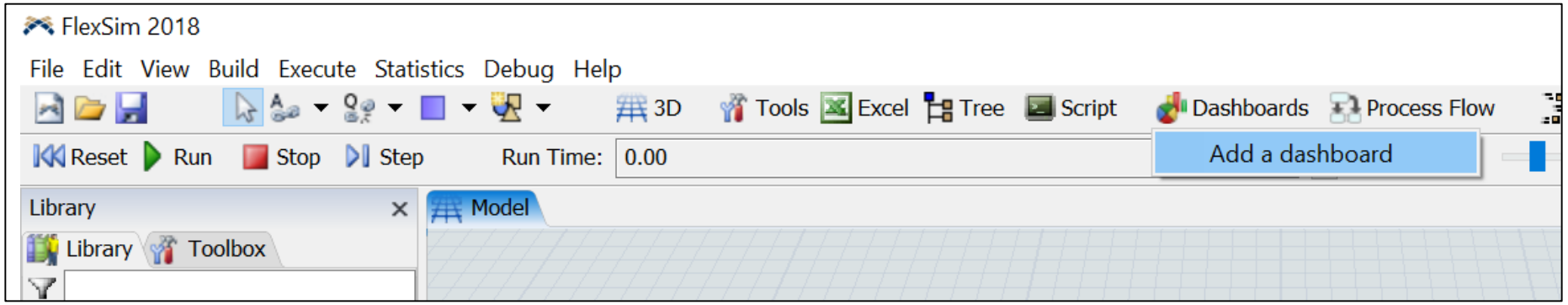
SCHOOL OF ENGINEERING

Module Coverage: E211 Topic Tree



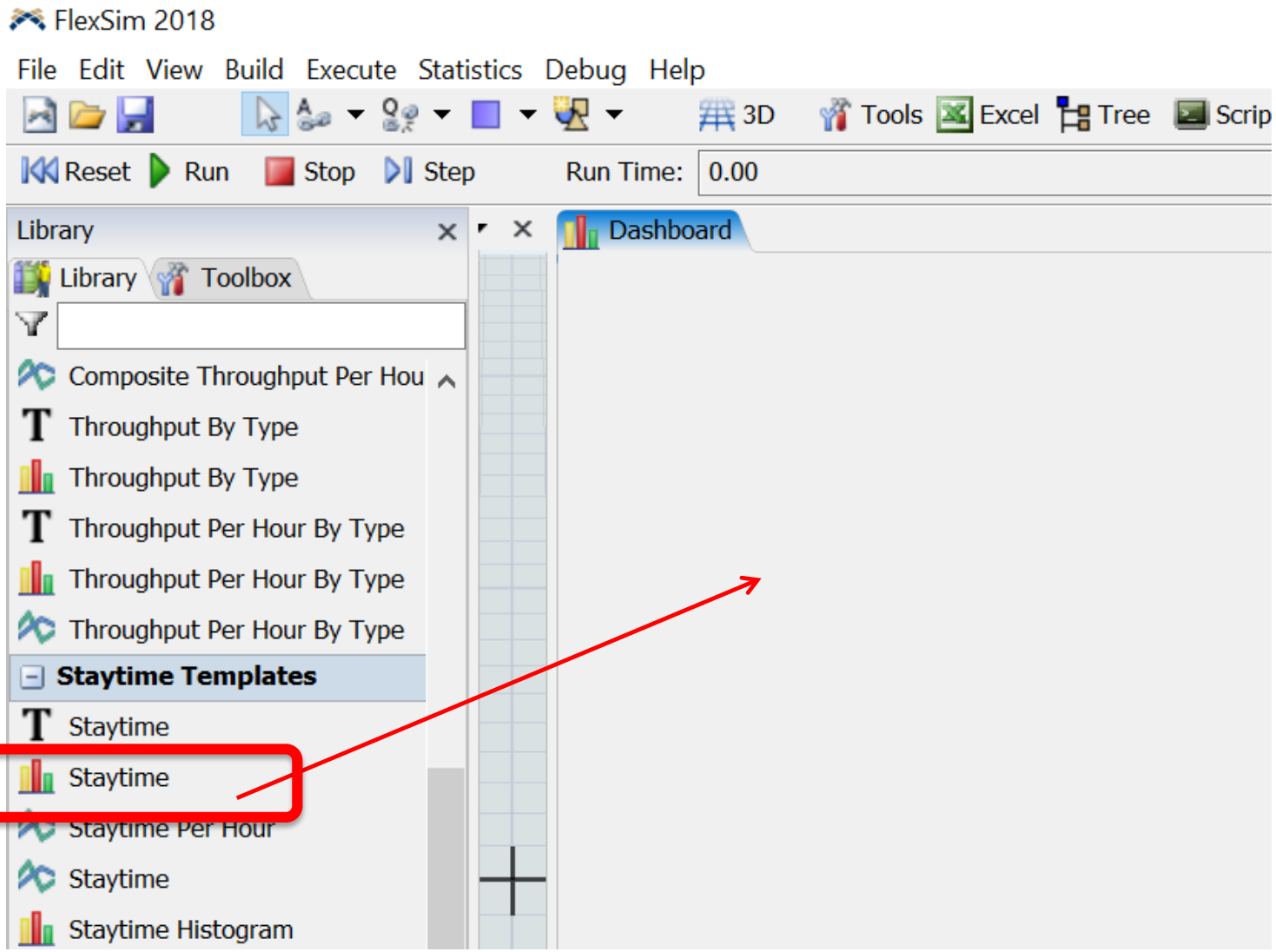
Exercise 4: Display the Simulation Output
Add Dashboard

- Click Dashboards on the toolbar>Add a Dashboard



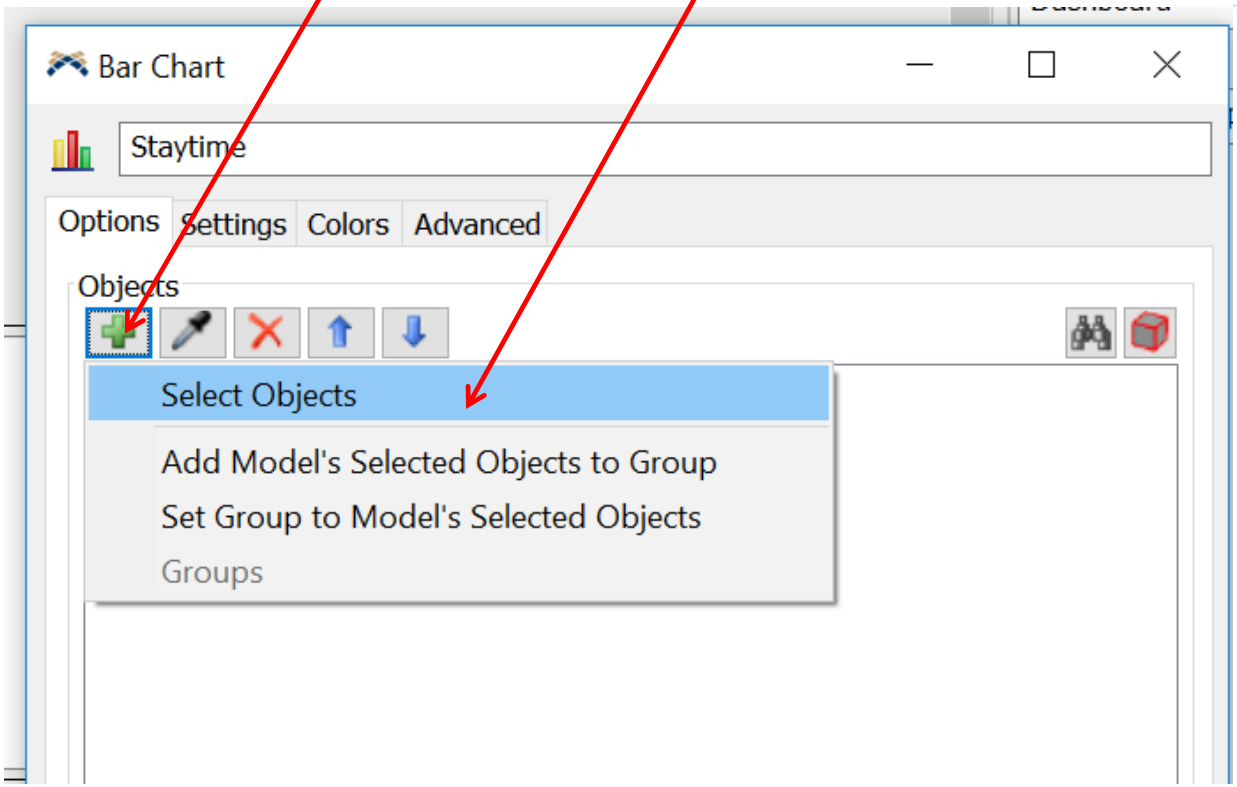
Exercise 4: Display the Simulation Output Dashboard-add statistic

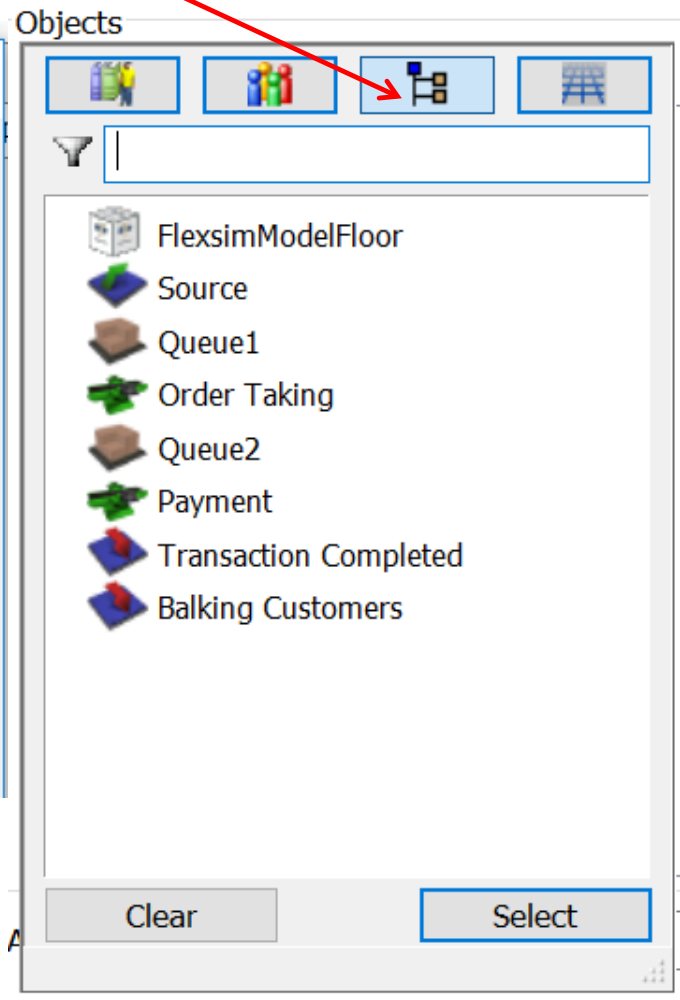
- Click and drag the statistic (from the library on the left) to the open space.



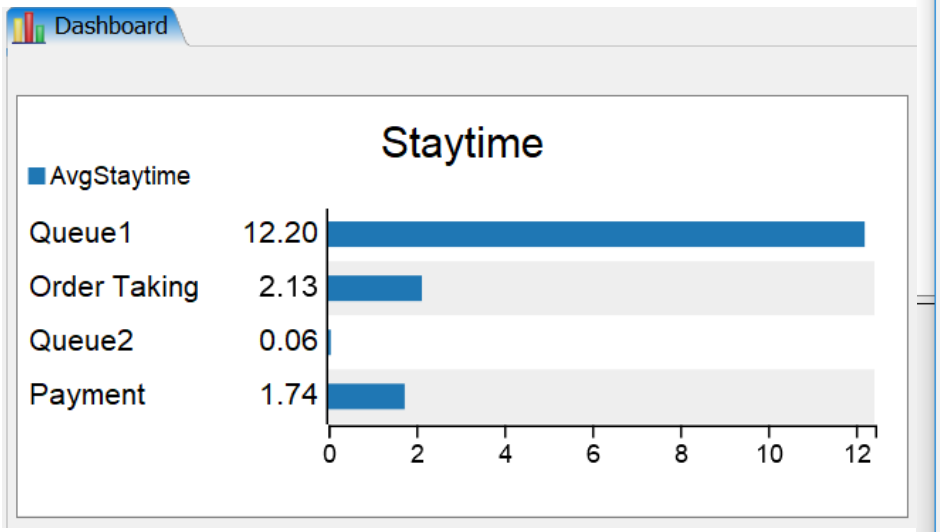
Exercise 4: Display the Simulation Output Dashboard-add objects

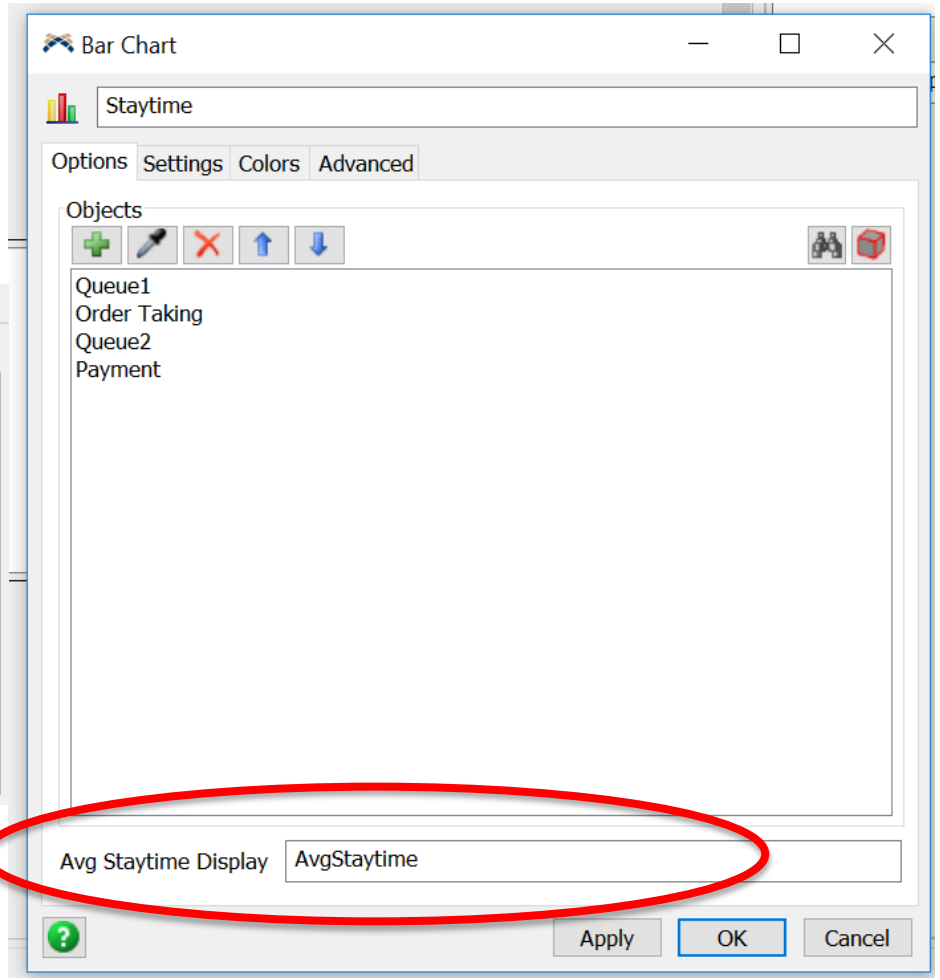
- Click “+”>Select Objects>Browse by tree, and select the object to show its statistics





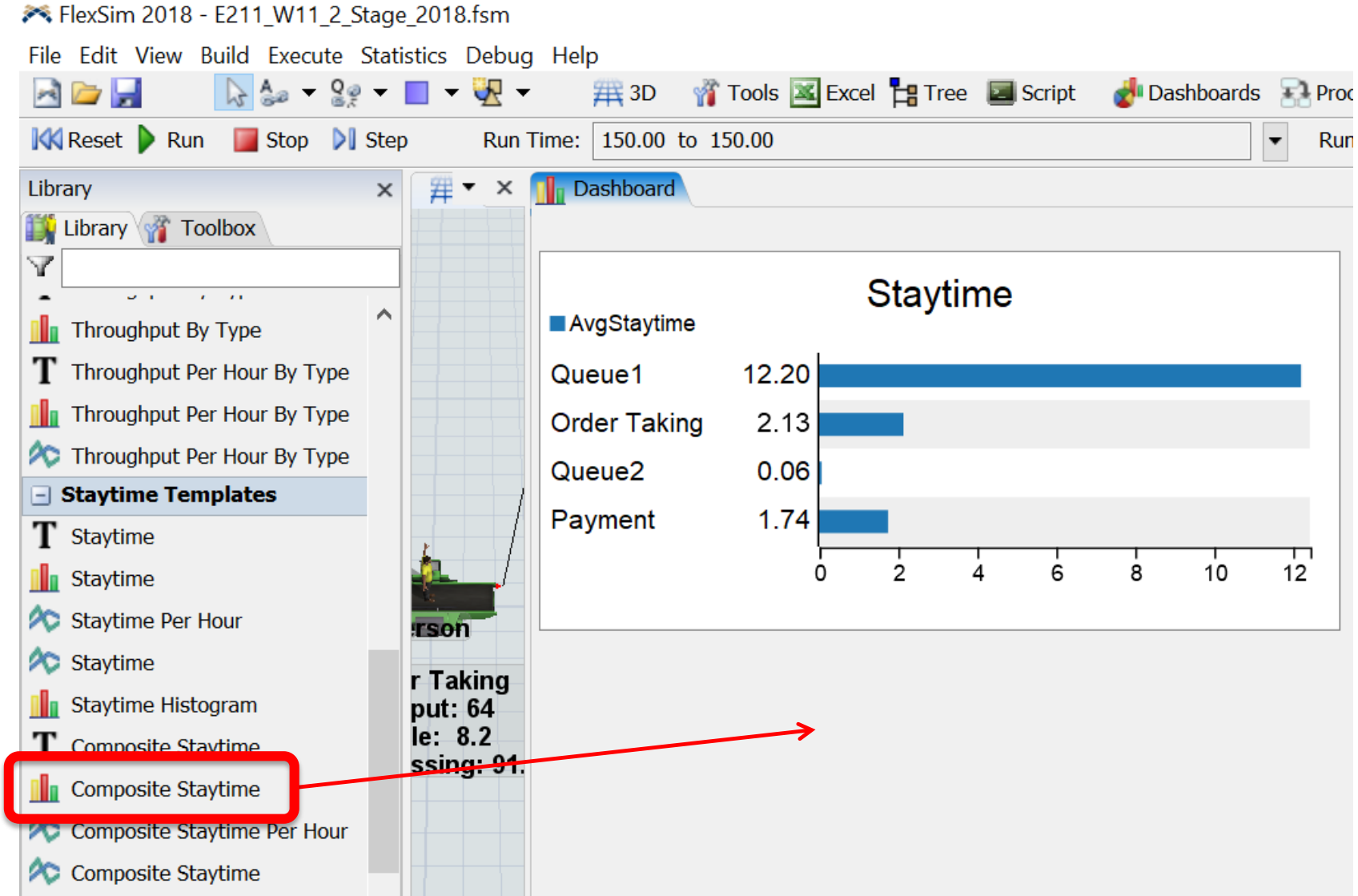
Exercise 4: Display the Simulation Output





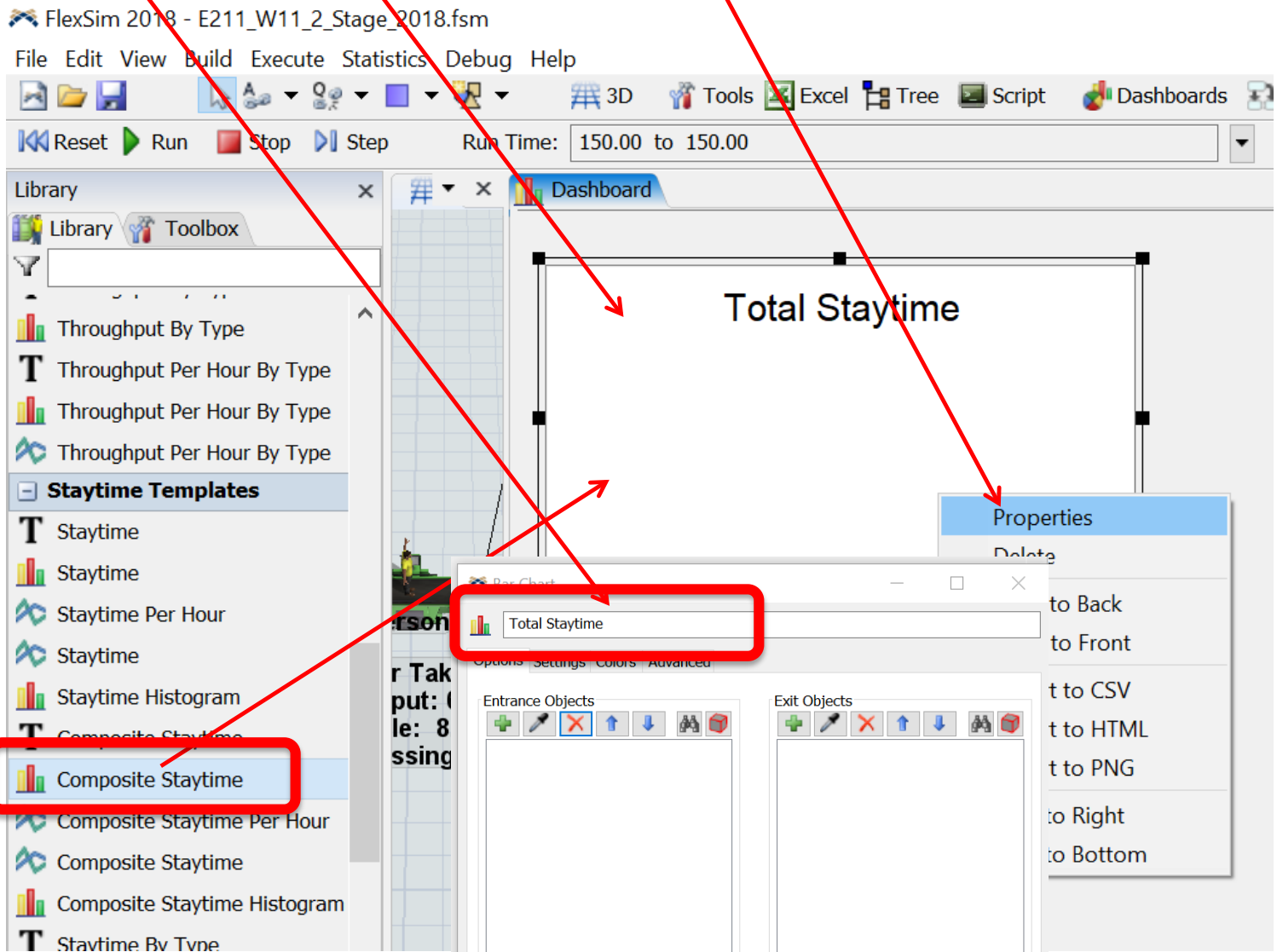
Exercise 5: Use Dashboard to Display a Customer's Total Stay Time in System

- Click and drag the statistic (Composite Staytime) from the library on the left to the open space.



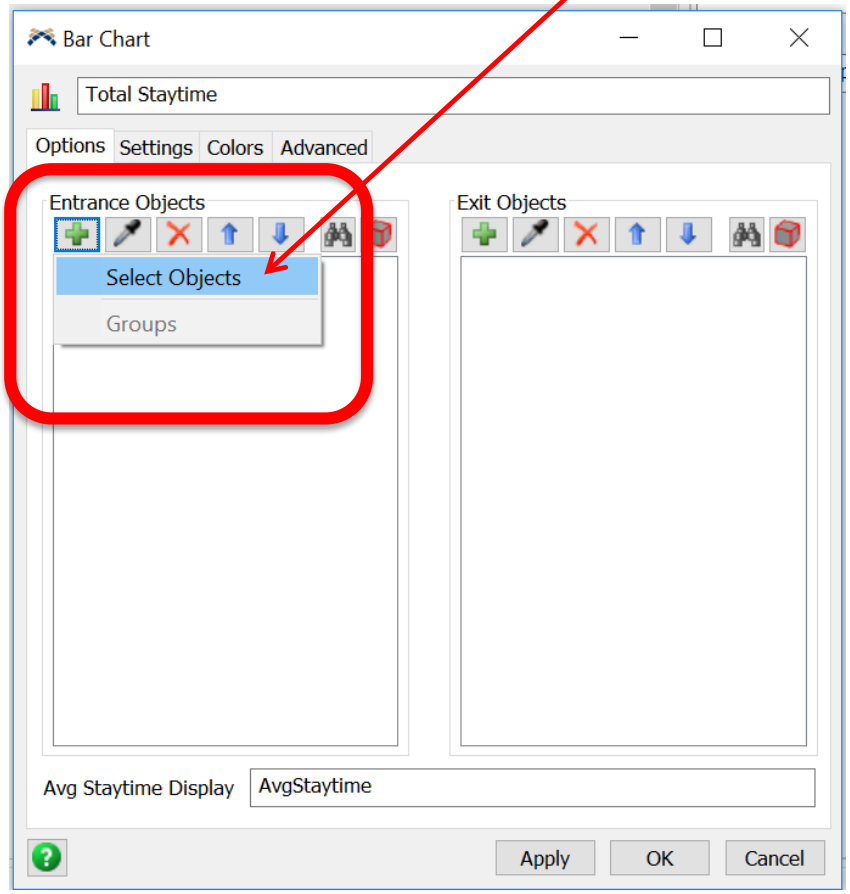
Exercise 5: Use Dashboard to Display a Customer's Total Stay Time in System

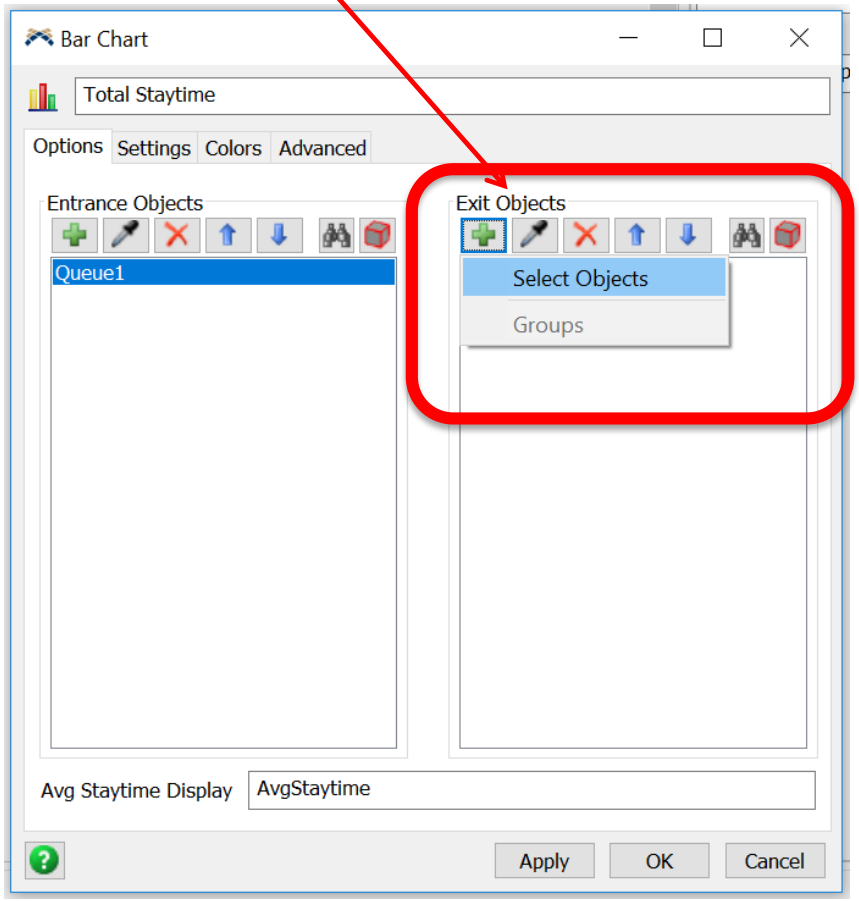
- Right click dashboard generated ->Select Properties->Name the dashboard 'Total Staytime'.



Exercise 5: Use Dashboard to Display a Customer's Total Stay Time in System

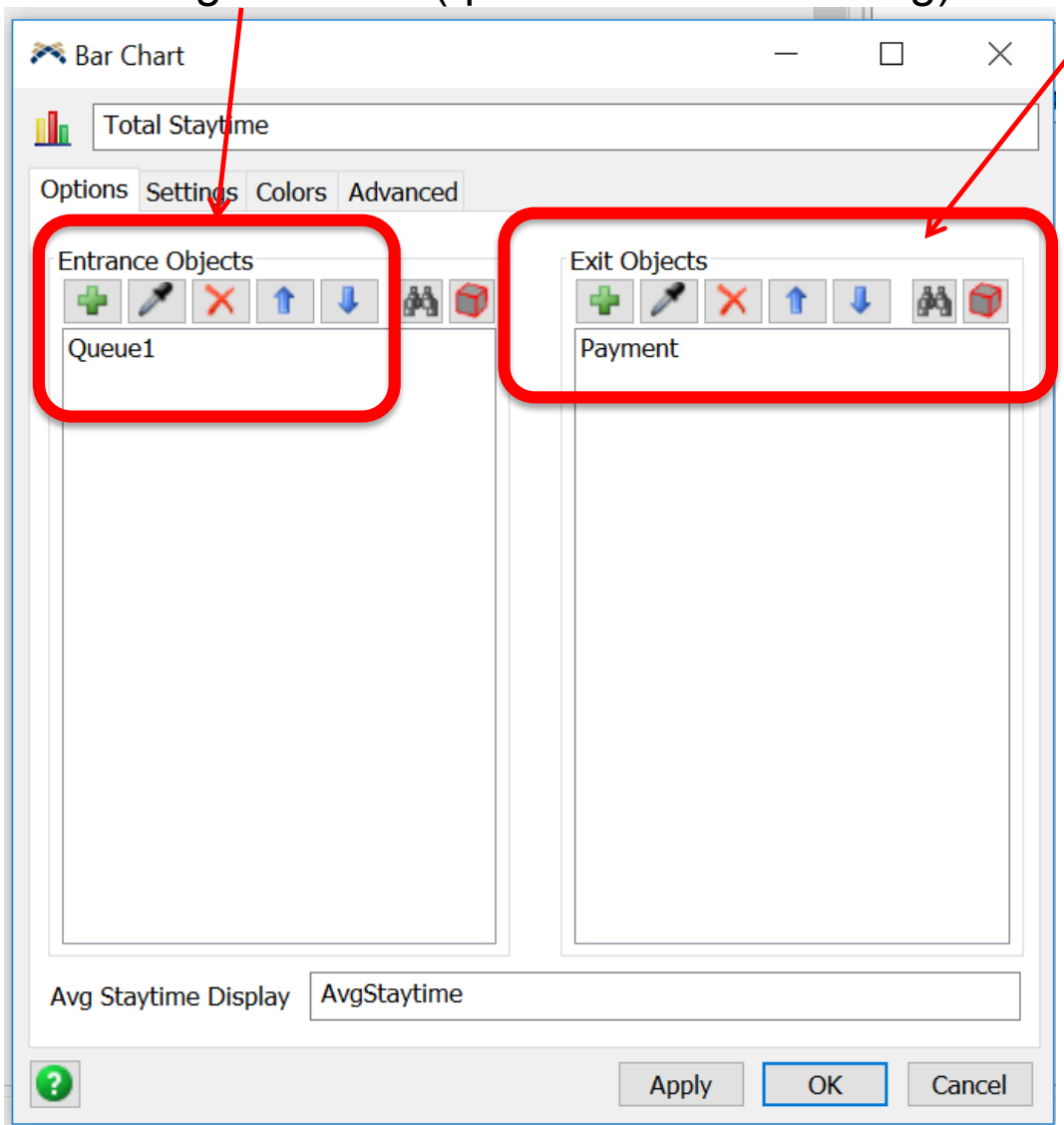
- Add and select the Entrance Objects and the Exit Objects to define a customer's total stay time in system.





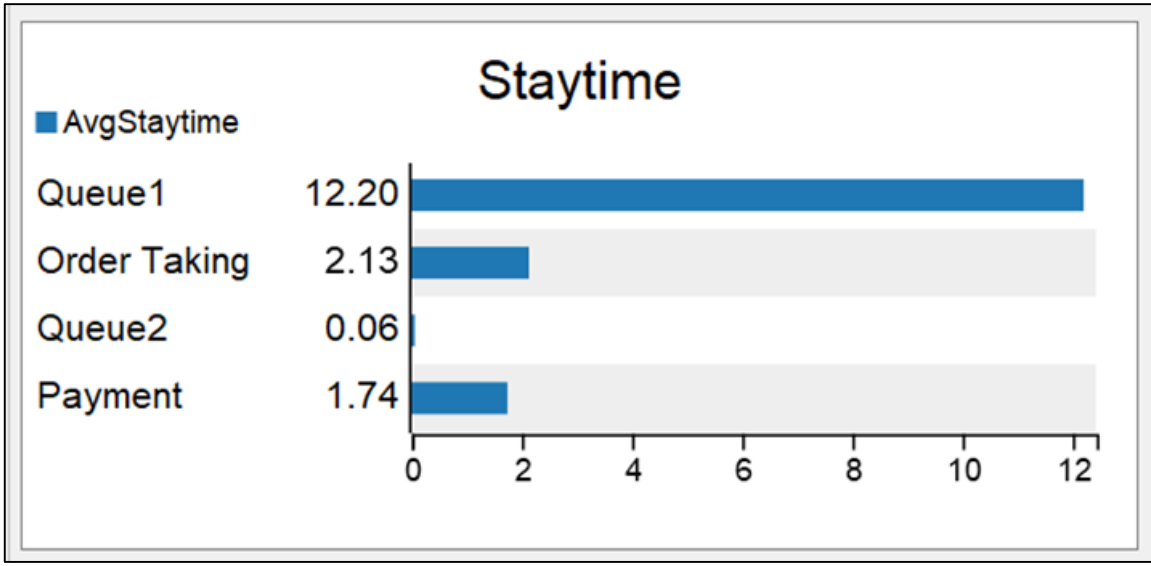
Exercise 5: Use Dashboard to Display a Customer's Total Stay Time in System

- A Customer's Total Stay Time in System is defined as: the average time (of customers) from entering Queue 1 (queue for Order Taking) till exiting Payment.

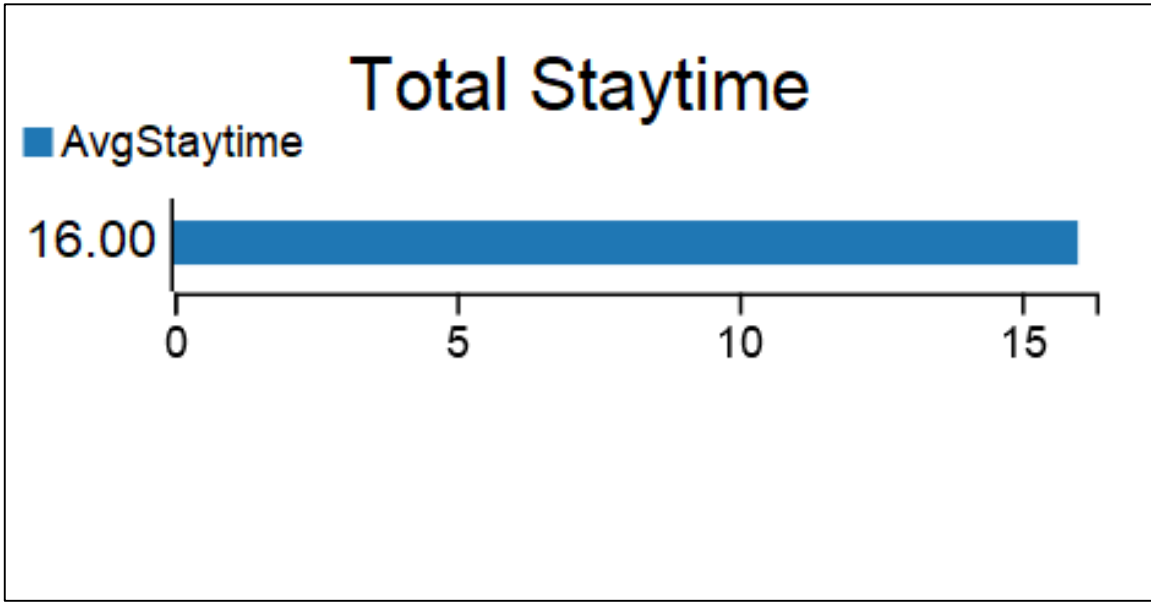


Exercise 5: Use Dashboard to Display a Customer's Total Stay Time in System

Stay time at each object of the system.

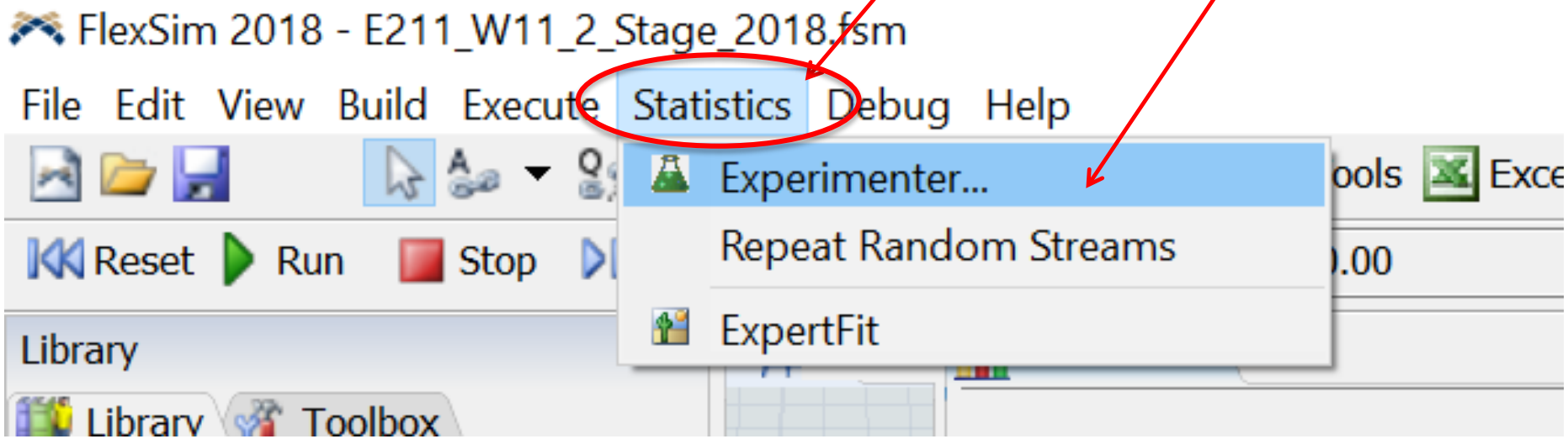


Total stay time in system.



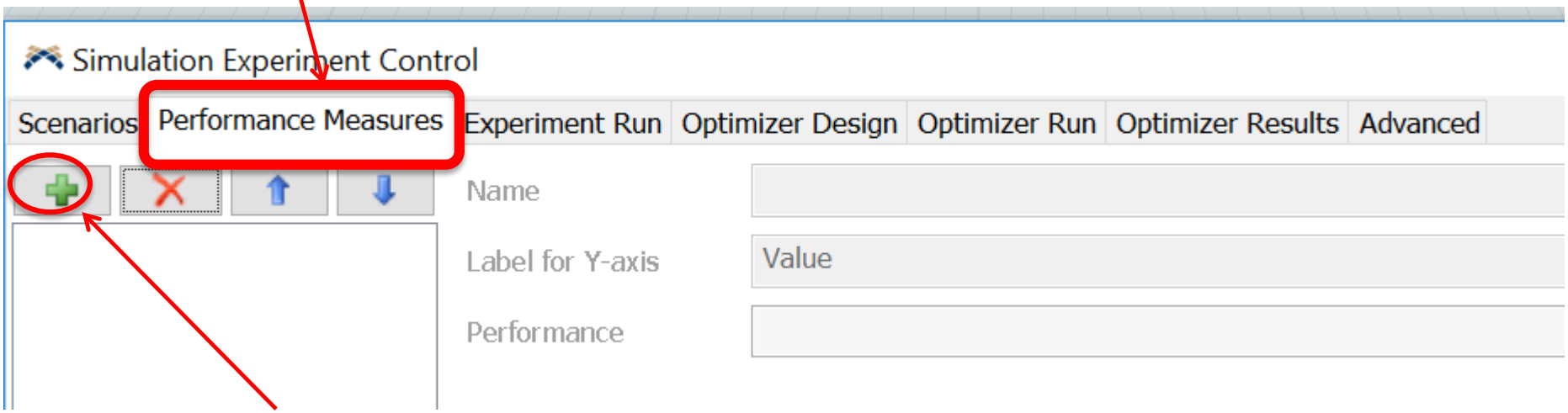
Exercise 6: Use Experimenter to Generate Multiple Runs – Add an Experimenter

- To add an Experimenter, click Statistics->Experimenter



Exercise 6: Use Experimenter to Generate Multiple Runs – Add a "Standard Performance Measure"

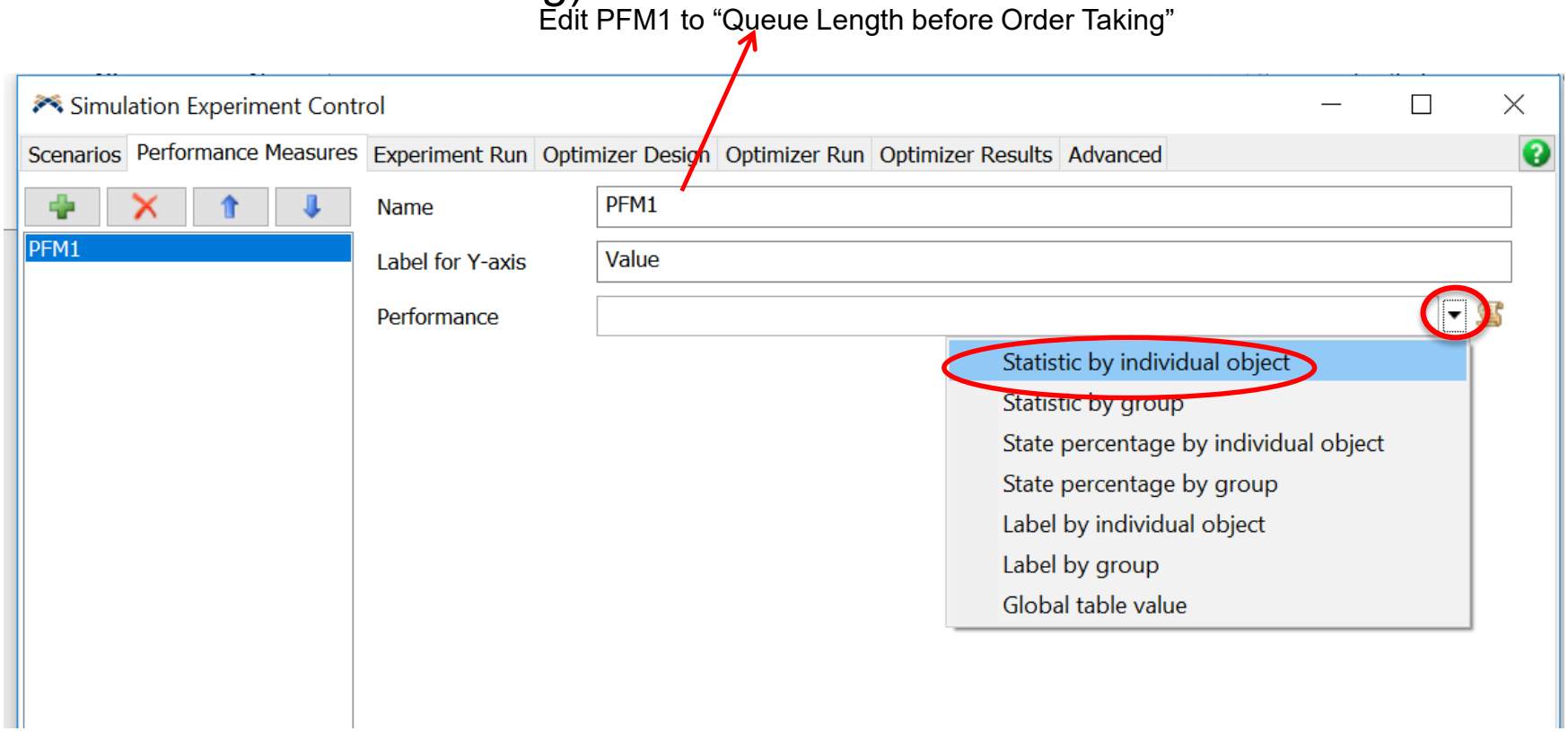
- To add a performance measure (Example-Queue Length before Order Taking): click Performance Measures, then click "+"



Add "Standard Performance Measure"

Exercise 6: Use Experimenter to Generate Multiple Runs – Add a “Standard Performance Measure”

- To add a performance measure (Example-Queue Length before Order Taking):



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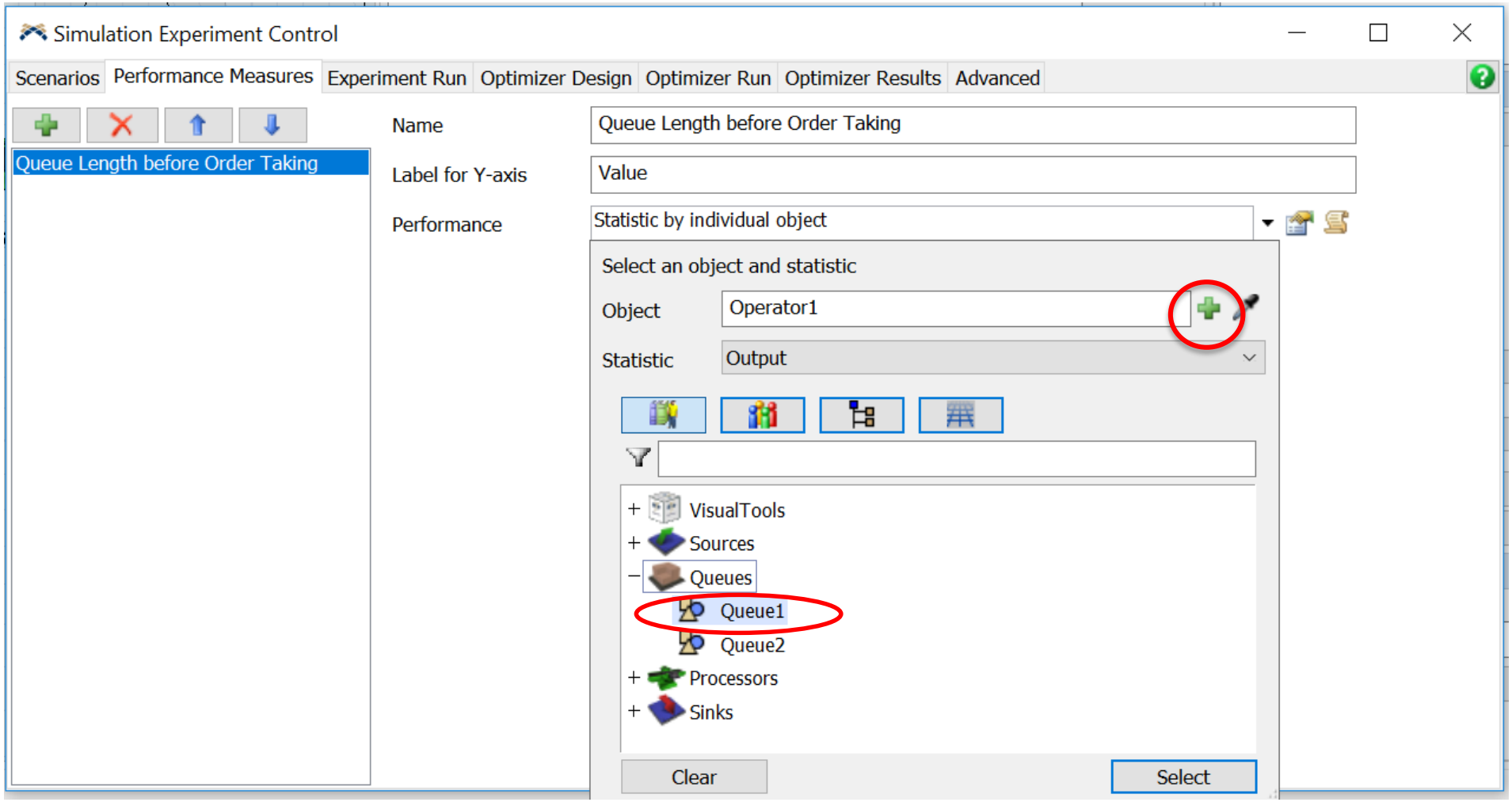

Exercise 6: Use Experimenter to Generate Multiple Runs – Add a "Standard Performance Measure"

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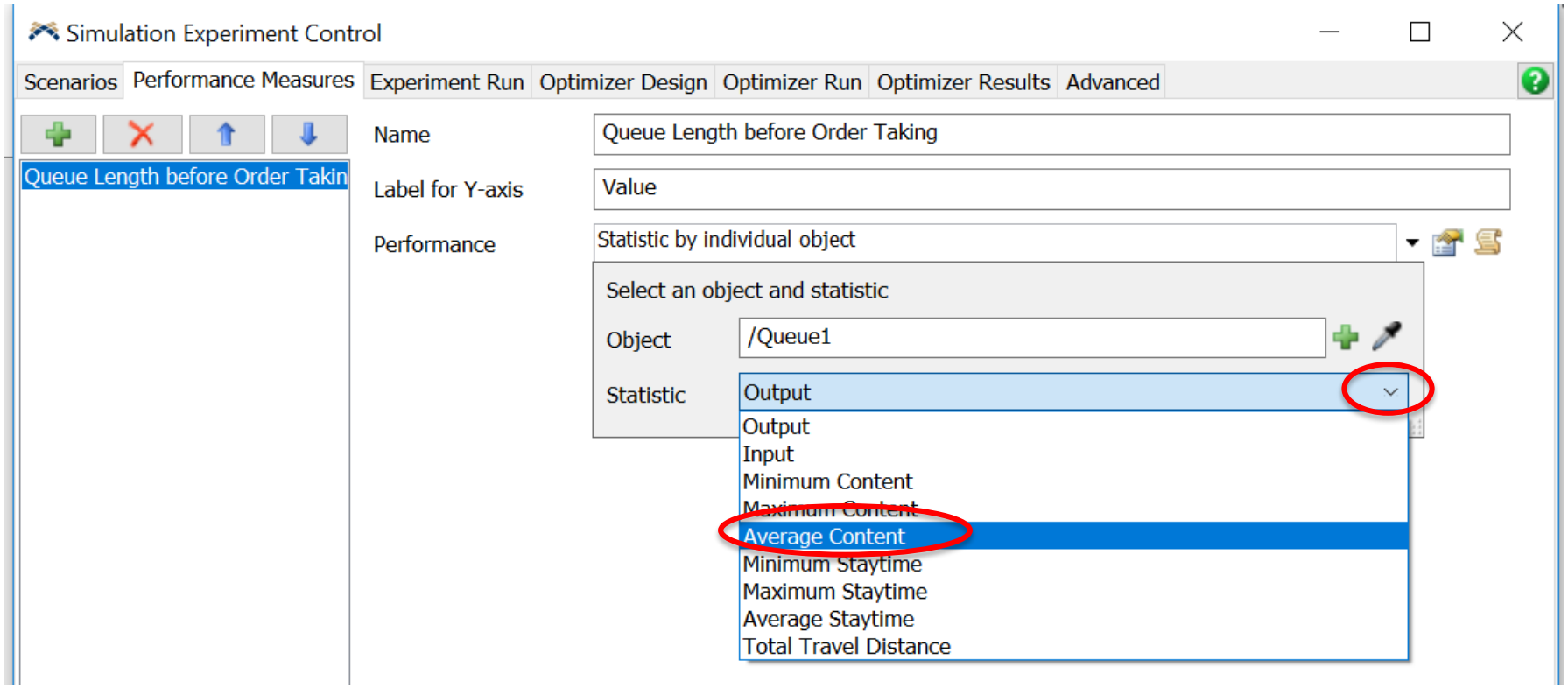
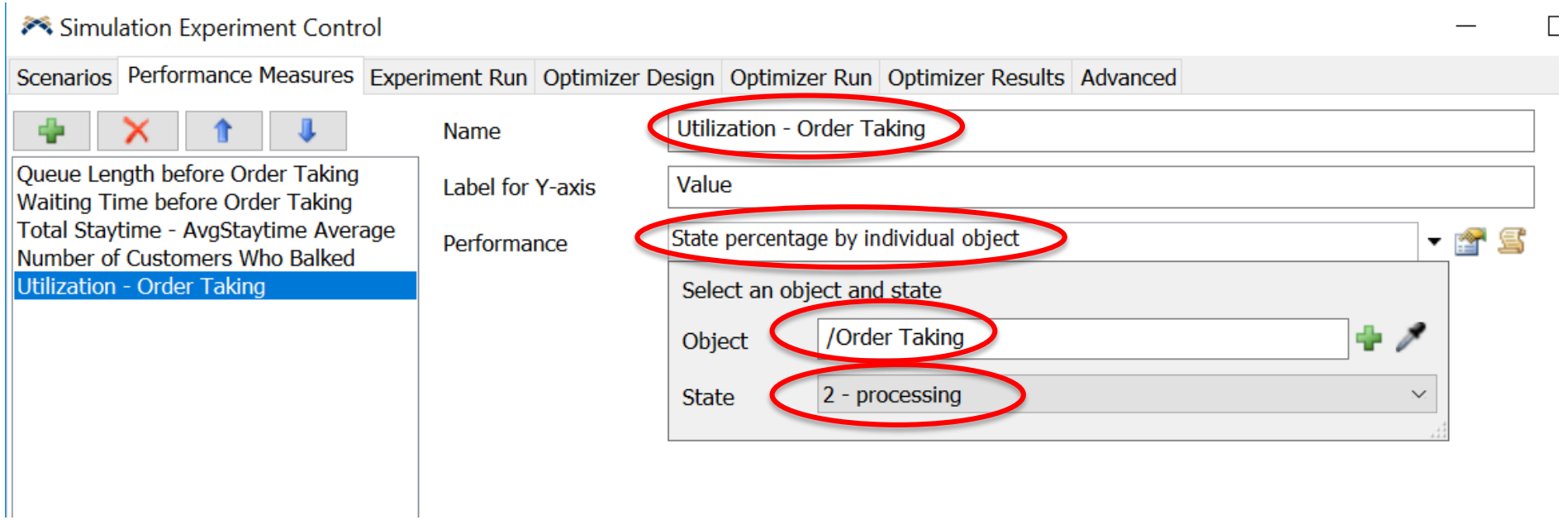


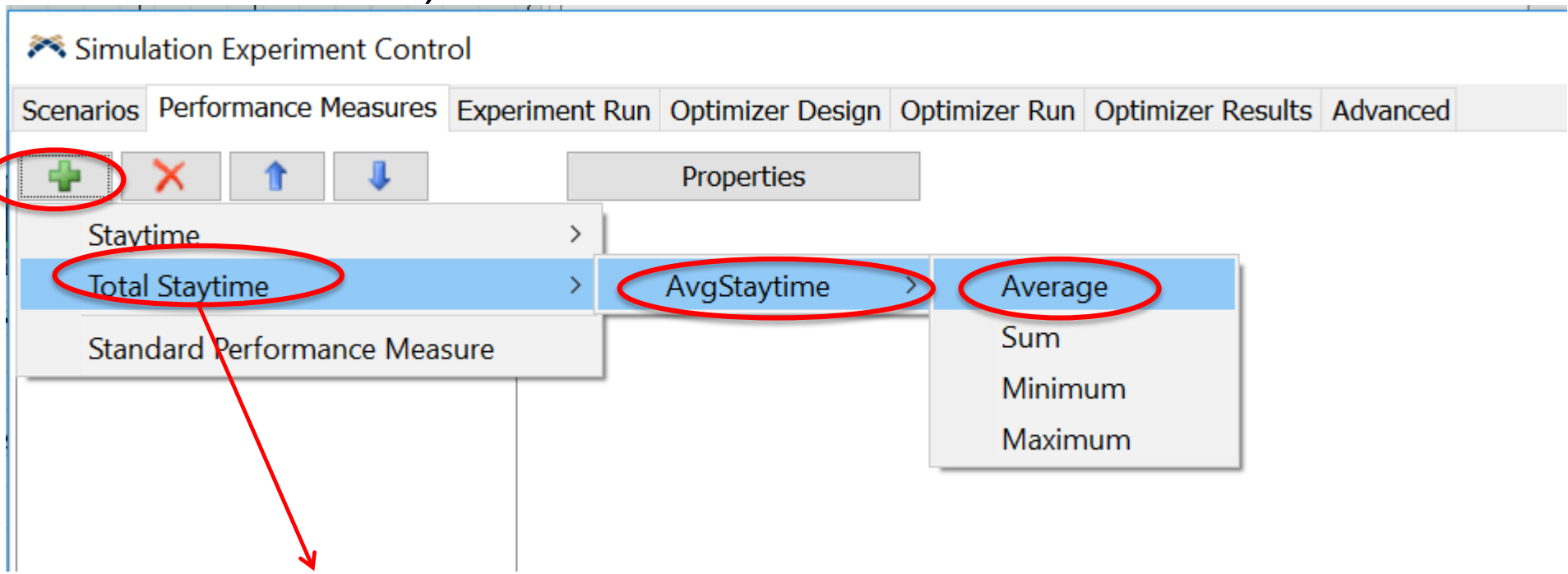
Exercise 6: Use Experimenter to Generate Multiple Runs – Add a "Standard Performance Measure"

- To add a performance measure (Utilization rate of Order Taking counter):



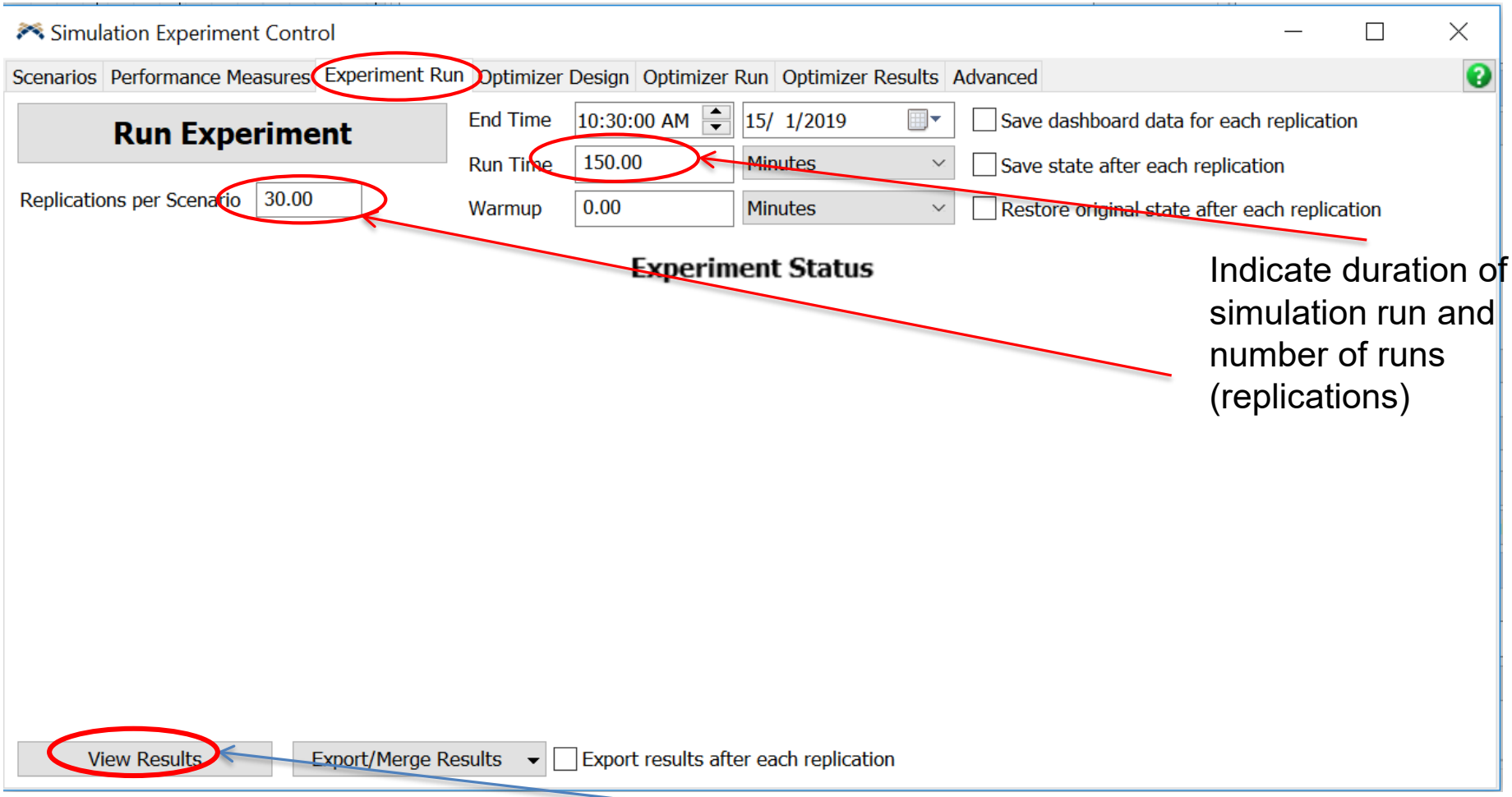
Exercise 6: Use Experimenter to Generate Multiple Runs – Add Total Stay Time in System

- To add a performance measure defined **in the dashboard**: Total stay time in system (average of all customers)



Already defined in the dashboard

Exercise 6: Use Experimenter to Generate Multiple Runs – Set up for the "Experiment Run"

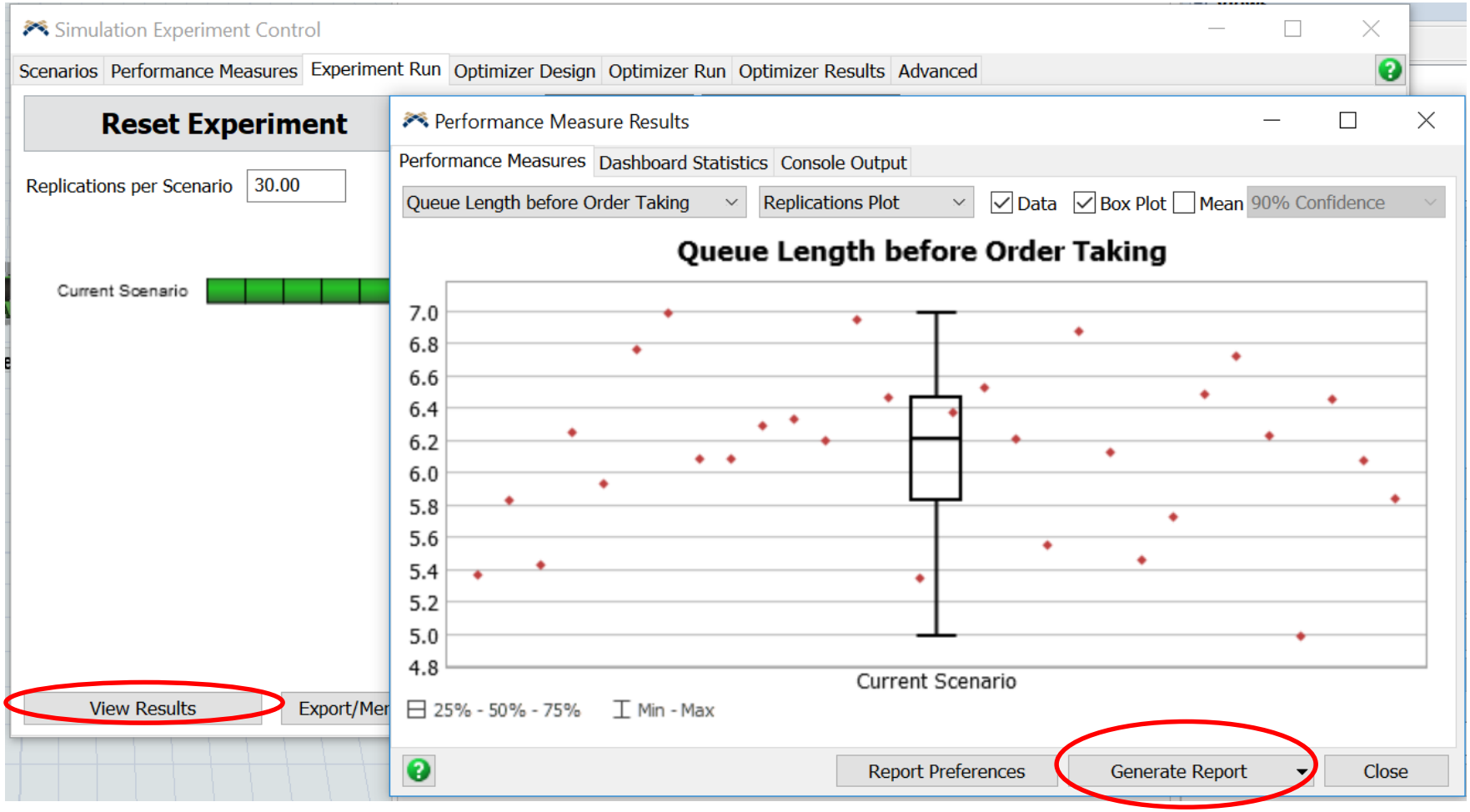


Indicate duration of simulation run and number of runs (replications)

Click to view results after experiment runs are completed

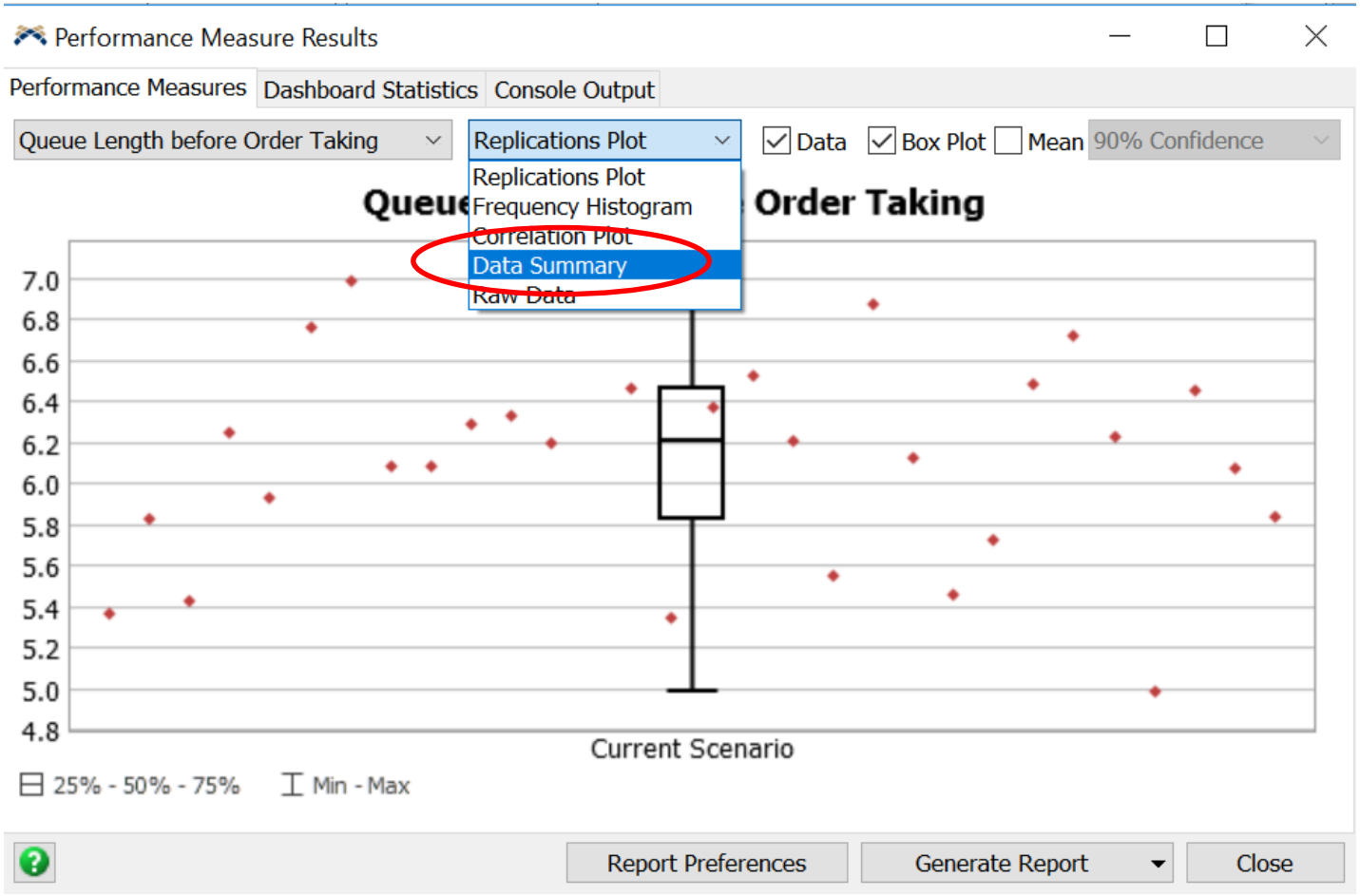
Exercise 6: Use Experimenter to Generate Multiple Runs - View Results and Generate Report

- After Running the Experimenter, View Results and Generate Report.



Exercise 6: Use Experimenter to Generate Multiple Runs - View Results and Generate Report

- Obtain data summary of the performance measures.



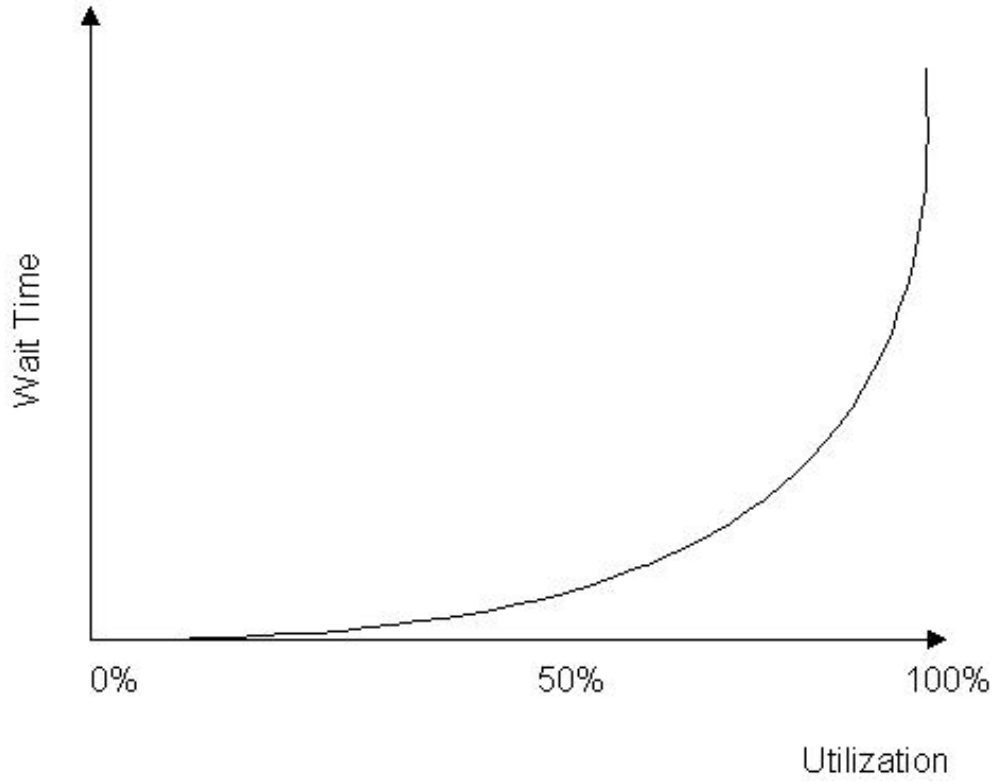
Exercise 6: Use Experimenter to Generate Multiple Runs - Summary of Performance Measures

Performance Measure	Mean	90% Confidence Interval of Mean	Range
Queue Length before Order Taking	6.13	5.97 – 6.29	4.99 – 6.98
Waiting Time before Order Taking (min)	12.92	12.57 – 13.28	9.97 – 15.03
Total Staytime - Average Stay Time (min)	16.23	15.85 – 16.61	13.00 – 18.00
Number of Customers Who Balked	26.20	23.00 – 29.50	9.00 – 50.00
Utilization – Order Taking (%)	98.29	97.76 – 98.82	91.82 – 99.90
Utilization – Payment (%)	73.29	72.47 – 74.11	69.16 – 78.95

Problem 11
Suggested Solution
(for the 4 stage service system)

Waiting Time Vs Utilization

- In a service system e.g. clinic, bank, post office, the busier the server, the longer is the waiting time. What causes this phenomenon?



General Concepts of “Queuing Theory”

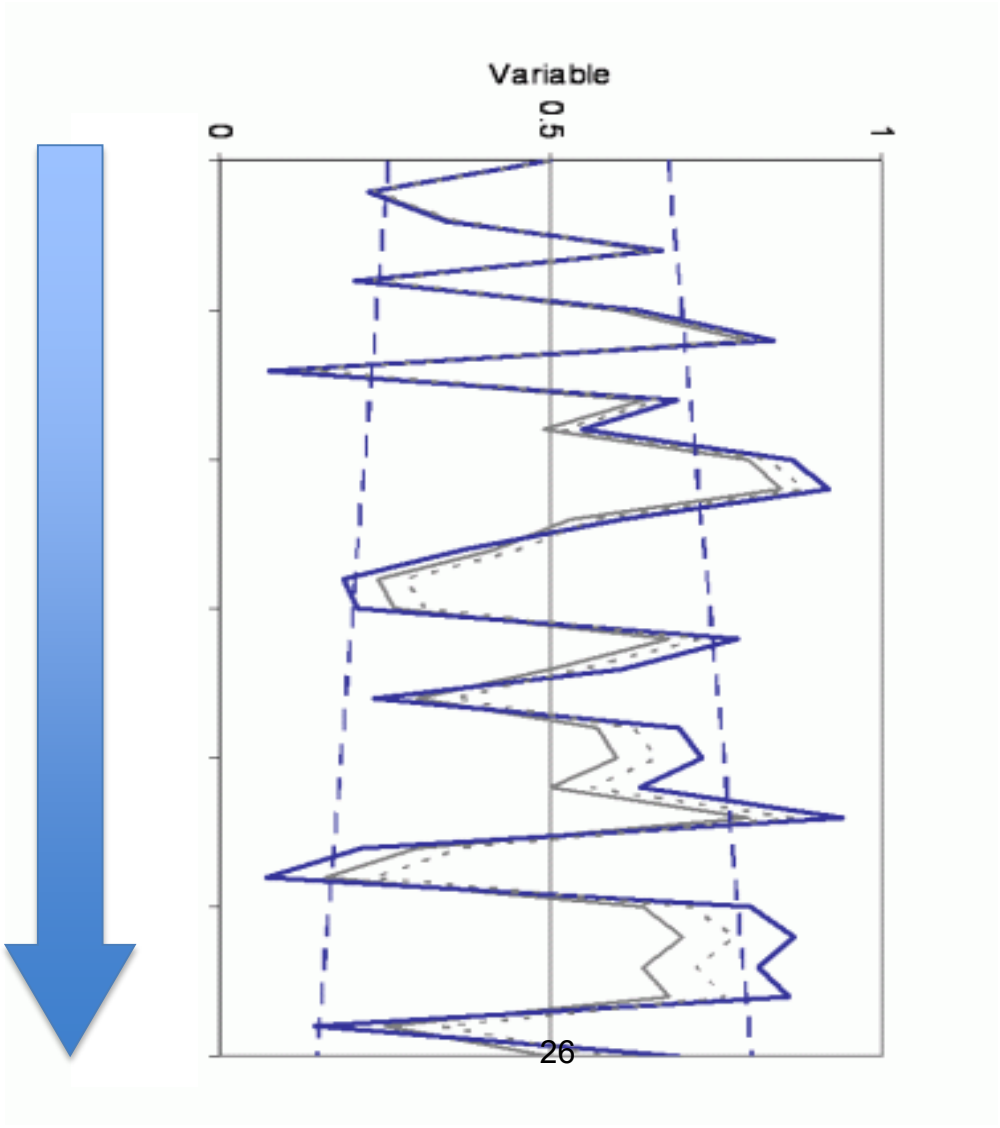
- Waiting time is caused by variability in customer arrivals and service times, and/or not enough service capacity.

- Every service system contains waiting time. As the customer arrival rate increases, load (utilization) of the system will increase and average waiting time will increase in a non-linear fashion.

- Totally eliminating waiting time is impossible due to uncertainties in the system. A good system should be designed such that the cost of waiting times is minimized.

Variability Propagates through System

Total system variability



Negative Influence of Variability

- Large variability in system together with inadequate capacity results in:
  - ✓ Long waiting times
  - ✓ Large number in queue
  - ✓ Increased total time in system
  - ✓ Under-utilized capacity
  - ✓ Reduced customer service (unhappy, balking customers)

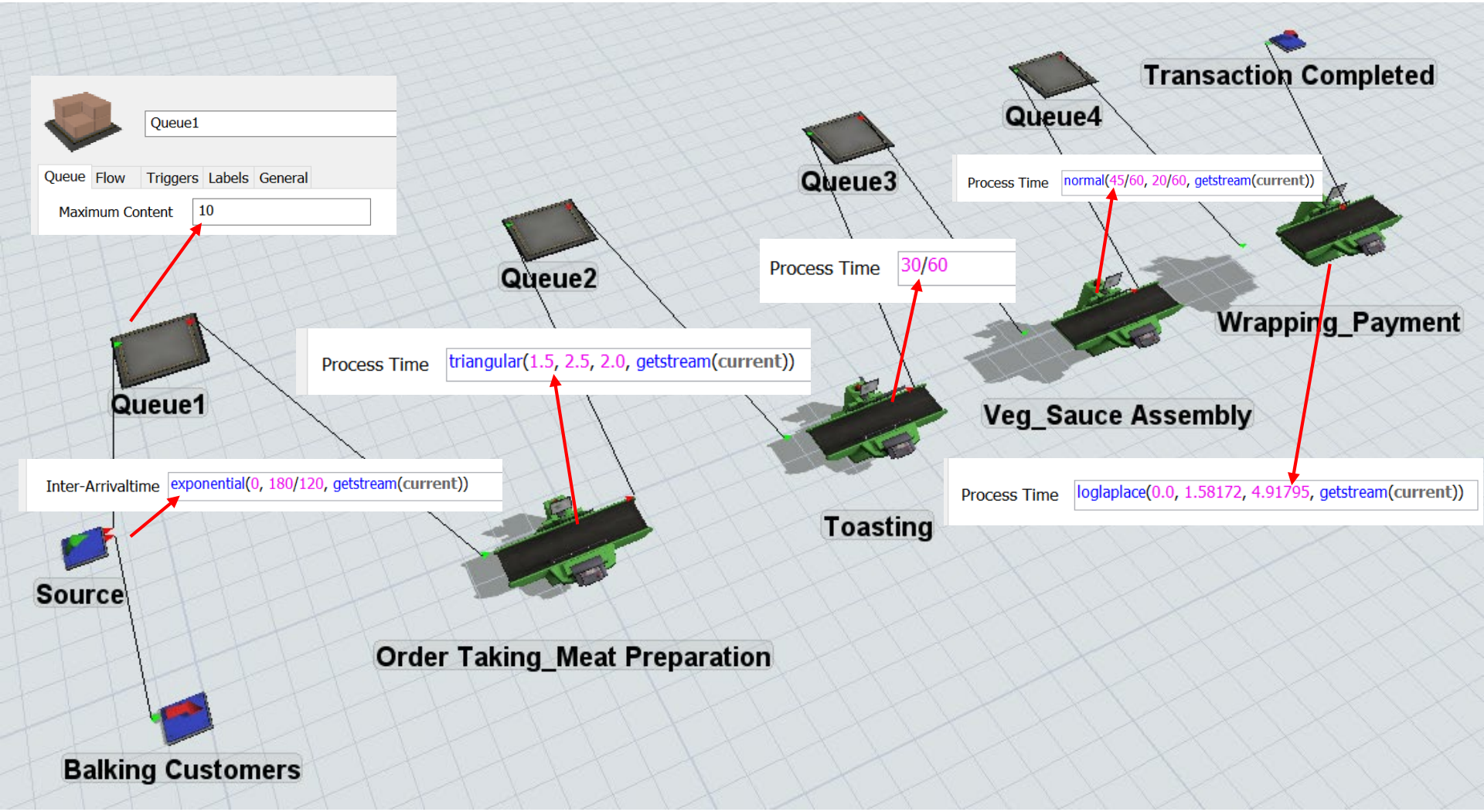
- Systems with variability must be buffered by some combination of:
  - ✓ Inventory (e.g. pre-order → preparation)
  - ✓ Capacity (e.g. additional manpower, space)
  - ✓ Time (e.g. managing waiting time expectation)

- Simulation is an appropriate tool to study systems with large and propagating variability

Performance Measures

- Number of customers who left without joining queue – unhappy customers who balk (lost revenue)
  - ✓ What is the acceptable queue length?
- Time in queue
  - ✓ What is the acceptable waiting time before ordering?
- Total time in the system
  - ✓ What is the acceptable ‘time in system’ for the customer before he gets his food?
- Utilization
  - ✓ What is the desired average utilization of staff?

Exercise 7: The Simulation Model



Exercise 7: Fit Distribution to Data for “Wrapping and Payment”

Automated-Fitting Results

Relative Evaluation of Candidate Models

Model	Relative Score	Parameters	
1 - Log-Laplace	91.13	Location	0.00000
		Scale	1.58172
		Shape	4.91795
2 - Log-Laplace(E)	89.52	Location	2.74419 e -4
		Scale	1.58145
		Shape	4.91707
3 - Log-Logistic	84.68	Location	0.00000
		Scale	1.54725
		Shape	6.66102

32 models are defined with scores between 0.81 and 91.13

Absolute Evaluation of Model 1 - Log-Laplace

Evaluation: Good

Suggestion: Additional evaluations using Comparisons Tab might be informative.
See Help for more information.

Log-Laplace distribution best represents Wrapping and Payment timings.

Parameters of the recommended distribution.

Anderson-Darling Test

Anderson-Darling Test with Model 1 - Log-Laplace

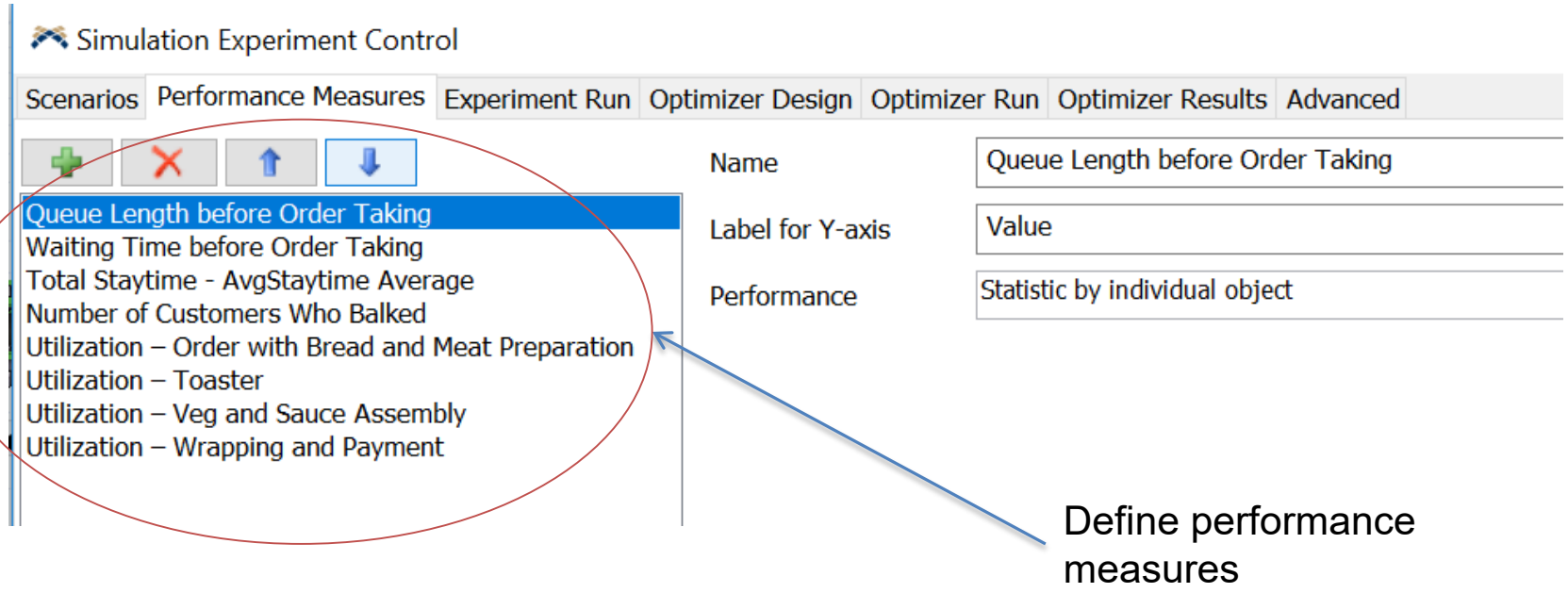
Sample size 20
Test statistic 0.30001

Note: The following critical values are exact.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.200	0.150	0.100	0.050	0.010
20	0.592	0.658	0.758	0.919	1.264
Reject?	No				

Goodness-of-fit test indicates that there is no strong evidence to reject the null hypothesis: The data set follows Log-Laplace Distribution with the given parameters.

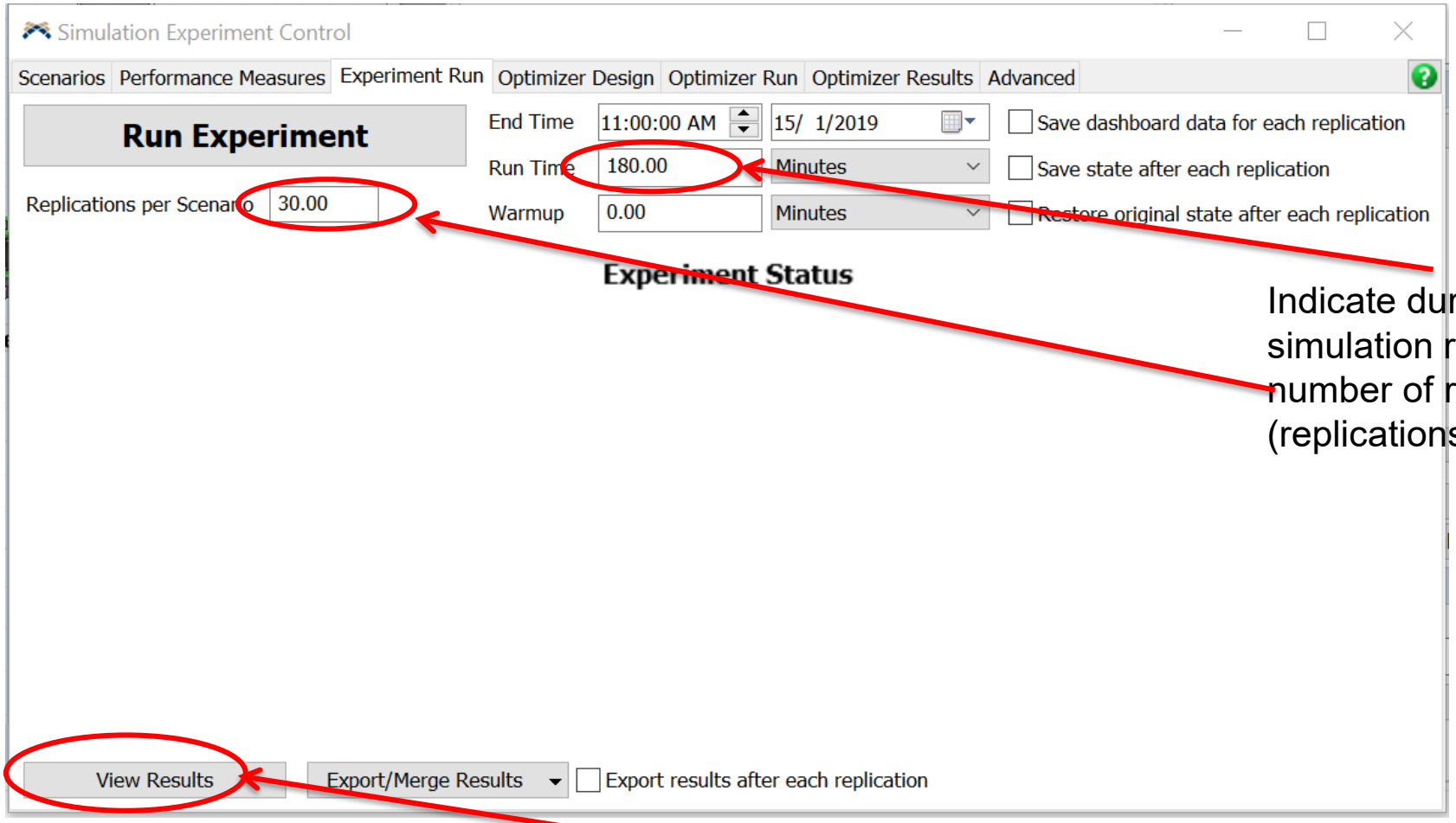
Exercise 7: Using Experimenter to Set Up Multiple Runs



Watch the e-learning video in the link below for a demonstration on how to set up Experimenter to collect performance measures.

https://drive.google.com/file/d/0B9sGwZfXz0MkcVBVcm91Y1I1c3M/view?usp=sharing

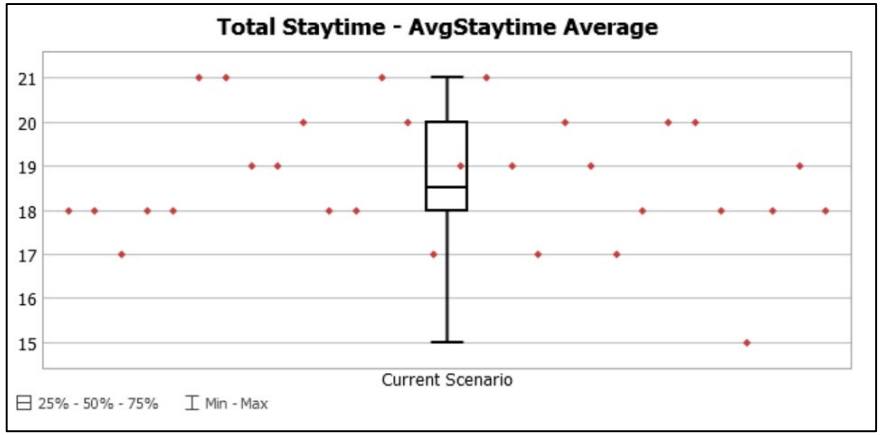
Exercise 7: Using Experimenter to Set Up Multiple Runs



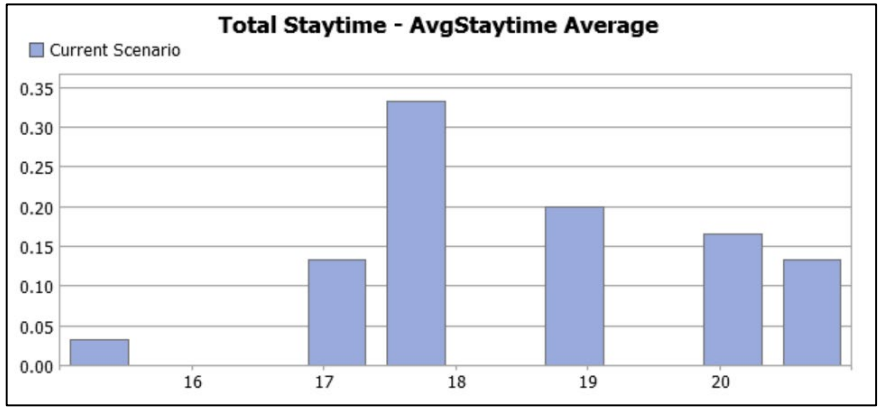
Indicate duration of simulation run and number of runs (replications)

Click to view results after experiment runs are completed

Exercise 7: Example of Simulation Output – Replication Results for Time in System



Individual replication outputs shown in scatterplot



Frequency graph

90% confidence interval of mean time in system

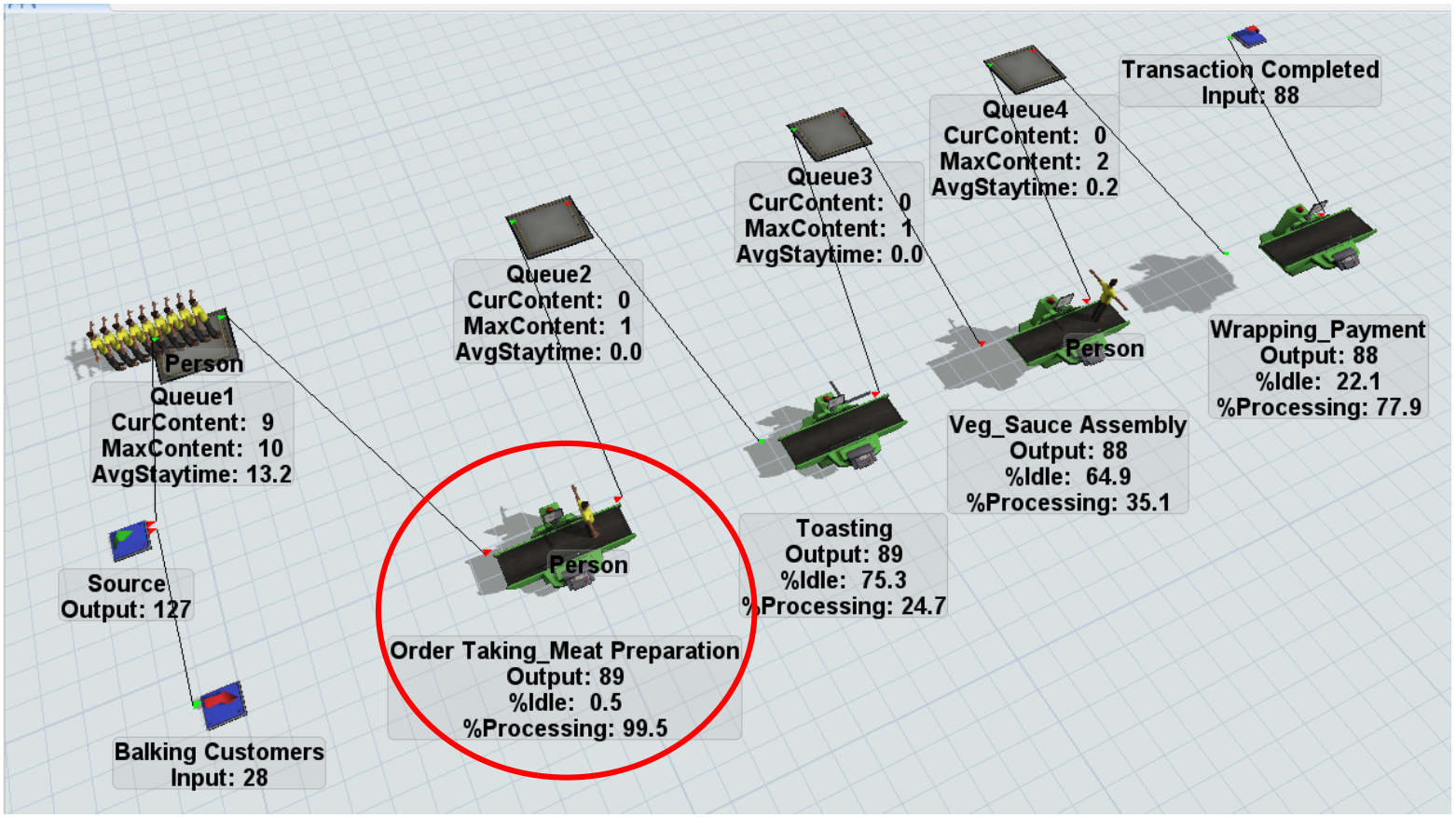
Total Staytime - AvgStaytime Average

	Mean (90% Confidence)			Sample Std Dev	Min	Max
Current Scenario	18.25	< 18.70	< 19.15	1.44	15.00	21.00

Exercise 7: Summary of Performance Measures of Existing System Based on 30 Replications

Performance Measure	Mean	90% Confidence Interval of Mean	Range
Queue Length before Order Taking	7.42	7.21 – 7.63	5.93 – 8.71
Waiting Time before Order Taking (min)	14.17	13.77 – 14.57	11.19 – 16.62
Total Staytime - Average Stay Time (min)	18.70	18.25 – 19.15	15.00 – 21.00
Number of Customers Who Balked	22.90	19.60 – 26.20	2.00 – 49.00
Utilization – Order with Bread and Meat Preparation (%)	98.38	97.89 – 98.86	93.15 - 99.92
Utilization – Toaster (%)	24.38	24.24 - 24.52	23.06 - 25.00
Utilization – Veg and Sauce Assembly (%)	36.59	35.93 – 37.24	32.39 – 40.66
Utilization – Wrapping and Payment (%)	79.55	78.62 – 80.47	72.51 – 86.49

Bottleneck of the 4-stage Service Process



From running the simulation model, we observe that “Order Taking_Meat Preparation” is the **bottleneck** of the 4-stage service process.

- A long queue in front of this bottleneck process
- Utilization rate of this processor (%Processing: 99.5) is the highest among all processors.

How to Improve Customer Service Level?

To reduce customer balking, first determine the acceptable queue length and waiting time by conducting customer survey.

Suggestions to improve service level:

- Assign one more staff for the order taking stage. This will reduce queue length and waiting time.

- Modify work processes such that less busy staff help out their busier colleagues. E.g. cashier to assist the simple food preparation at order taking stage. This will reduce overall time in system.

- Introduce new order process. E.g. allow self service order and payment to reduce queue length. See: http://www.youtube.com/watch?v=vf8JQSB8-so

Learning Objectives

- Construct a simulation model for a multi-stage service system.
- Generate performance measures of service system including waiting time, time in system and queue length from simulation model.
- Discuss measures to improve service system performance bearing in mind inherent variability and cost implications for service systems.

Overview of E211 Operations Planning II Module