

Simio Add-On Processes (Subway Model Revisited)

In this lab we will revisit the Simio model of the Subway® restaurant that was developed in *Lab 2* and use *Simio Add-On Processes* to extend our original model to include customer balking. We will also discuss an alternative method using add-on processes to implement type-dependent processing times. The system operates similar to a serial production line with five stages as shown in the figure below (the highlighted stations involve a human worker).



Customers enter and go to the first stage where they select the size and type of bread, meat, and cheese. The second stage is the oven where sandwiches get toasted (if ordered by the customer). The customer (and partially made sandwich) then go to the next stage to add veggies and condiments. Once the sandwich is made, the customer pays at the cash register, the cashier wraps the sandwich and puts it in a bag. Finally, customers go to the drink machine to get their drink and then they leave the system. Each stage has one server and we will assume infinite queues between stages.

During lunch rush, customers arrive according to a Poisson distribution with a rate of 32/hr. However, customers will balk if there are 6 people in the system (all stages). Processing times are all triangularly distributed with the following parameters (minutes):

Station	Bread & Meat	Oven	Veggies	Cashier	Drink
(Min, Mode, Max)	(1, 1.5, 2)	(0.5, 1, 1.5)	(1, 1.5, 2)	(0.5, 1, 1.5)	(0.5, 1, 1.5)

Based on the data collected from the restaurant, 70% of the customers want their sandwich toasted while the remaining 30% get cold subs. The current operating policy requires that FIFO (First In First Out) must be maintained throughout the system. Therefore, cold sandwiches should also wait in the queue for the oven (if there is one). In other words, the current policy does not allow a customer that wants a cold sandwich to pass a customer that is waiting for his/her sandwich to be toasted.

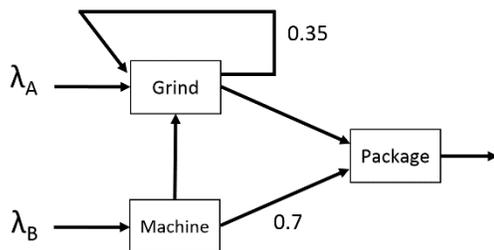
The manager of this restaurant has hired you to estimate the utilization of the servers, expected number of customers in the system, the time that customers spend in the system on average, percentage of customers that balk, and the average TIS per customer type.

The videos will guide you through:

1. Understanding how Simio processes work
2. Implementing the balking logic using add-on processes
3. Implementing type-dependent processing times on the oven using add-on processes
4. Using *State Assignments* to change object states
5. Defining “Responses” for the performance metrics

Assignments

1. Modify your simulation model of the current policy so that a new customer will balk with a probability of 0.6 if there are 4 or more customers in the first three stations. Explain how you implement this balking logic and provide snapshots of your add-on process and its steps. Evaluate the performance of the system with respect to the utilization of the servers, expected number of customers in the system, the time that customers spend in the system on average, percentage of customers that balk, and the average time in system per customer type.
2. Consider the following manufacturing system that processes two different part types (*A* and *B*). The arrival rates are 12 parts/hr for *A* and 20 parts/hr for *B* (both arrival processes are Poisson). Server processing times are triangularly distributed with parameters shown in the table below.



Processing Times (Minutes)			
	Machine	Grind	Package
Mean	2.5	2	1.5
Min	3.5	1	0.5
Max	1.5	3	2.5

Parts that are processed more than once on the Grind machine will have a higher priority at the Package station. On the other hand, parts that are routed back to the Grind machine more than three times are deemed “bad” and will be scrapped. Develop a Simio model of this manufacturing system and estimate at steady state the average time in system per part type, average time in system for all parts, and percentage of scrapped parts. Perform model verification (using animation and also comparison with queuing results). Use *State Assignments* so that entities will change colors as they leave each station, i.e., default green for type *A* and blue for type *B* after being created, red once processed on Machine, and black after leaving the Grind station (parts that are reworked on the Grind machine must maintain their original color). Justify your run configurations (run length, number of replications, and warm-up period) using the SMORE plots.

Submission Requirements

The deliverables for the lab include the following:

1. A single word document that includes the “solutions” to the assignment problems, i.e., tables/figures of simulation results, analysis of simulation outputs/recommendations, description of your verification analysis, etc. The report is the primary component of your submission that is graded and all other files (such as Excel or Simio models) are just supporting material so make sure your report document is complete by itself and do not simply refer the reader to other files in your submission.
2. All related Simio models developed as part of the assignments.

All of the files should be zipped together and submitted via Canvas. Make sure you do not submit any other file types such as “.rar”.

If you work in a team of 2, make sure that you both submit the exact same zip file and indicate the name of your partner as a comment.