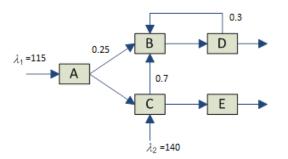# User-defined Statistics

In this lab, we learn how to use user-defined statistics (*Tally*, *State*, and *Output* statistics) to evaluate performance metrics that are not built-in in Simio. We will consider the following queueing network for the video part of the lab as well as the assignment:

	Station				
	A	**B**	**C**	**D**	**E**
# servers (*c*)	1	3	1	4	1
Service rate (μ)	150	120	240	80	80

There are two part types in this system. Both arrival processes are Poisson and all service times are exponentially distributed. Also, the arrival rates and service rates are expressed in entities/hour. Parts that are processed more than 2 times on Station D are considered to be of "low quality" and will be sold at a scrap price that is lower than the unit production cost. The amount of loss is $25 and $38 for each scrapped part of type 1 and 2, respectively.

We know that Simio automatically reports common performance metrics such as the expected number of each part type in the system, the expected time in system (overall and per part type), number in station, time in station, time and number in queue, and utilization for each station. However, here, we are interested in the following performance measures that are not built-in in Simio which necessitates the use of user-defined statistics:

- Total number in system (overall NIS)
- The average time an entity spends between Station B and D from its arrival into Station B until it leaves the system
- Number of type 1 parts in the queue for Station D
- Total loss due to selling at scrap price

The videos will guide you through:

1. Understanding different types of performance measures (*Observational* vs. *Time-persistent*)
2. Learning how to code user-defined *Tally*, *State*, and *Output* statistics in Simio

Assignments

Implement the following user-defined statistics in your Simio model of the queueing network:

1. ***Time between Station B and D (revisited):*** In the current model, we overwrite the arrival time at Station B every time the entity arrives at the station and thus what the current user-defined statistic reports is the duration of time from the *last* arrival into Station B until the time the entity leaves the system (which can be a valid statistic depending on the interpretation of the performance metric). Now suppose we are interested in the time between stations B and D from the perspective of the parts. In other words, we would like to know the duration of time an entity spends between B and D from its *first* arrival at B until it leaves the system. Add a new user-defined statistic to measure this alternative interpretation of the metric (**DO NOT** modify the existing user-defined statistic – start from scratch).

2. ***Total time in queue at Station D:*** While Simio automatically reports the average time in queue for a server object, what the built-in statistic measures is the expected time in queue per visit (i.e., any time an entity visits the station). Suppose we would like to measure the total time on average that an entity spends in the queue for Station D from the perspective of individual parts. In other words, we are interested in estimating the average accumulated time an entity spends in the queue at D over all of its visits to the station.

3. ***Closing time and over time cost:*** Suppose the system operates for 16 hours from 8:00 AM to 12:00 AM such that new parts are allowed into the system until midnight but the facility closes when all of the work-in-progress are finished (run ends with an empty system). Assume a $450 cost per hour of over time. Define a statistic that measures the total over time cost.

Run an experiment with all of the seven statistics covered in the videos and the assignment defined as *Responses* in your experiment table. Use the resulting SMORE plots to justify the number of replications and include the SMORE plots in your report document. You should also include a clear description of how you "coded" each of the above three user-defined statistics in your Simio model along with snapshots of different components/steps.

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., screenshots of your simulation models and their different components, tables/figures of simulation results (such as SMORE plots), analysis of simulation outputs/recommendations, description of your verification analysis (if applicable), 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.