

**Question 1:** Consider the example problem 4 (flow shop) in handout 2. Model the system using Station/Route and Branch blocks, and define and evaluate five different ranking rules (ordering entities in queue). We are trying to minimize “average time in system” and “average number of jobs in system.”

Using the parameters given in example problem four in handout two, five different models were created using Arena Simulations. In the simulation, A(1) is the arrival time of the entity, A(2) is the job type, and A(3) is the number of remaining total average process times. The five different ranking rules for the queues for models 1-5 are as follows, respectively: Last in first out, first in first out, lowest value next processing time first, lowest value of remaining processing time first served, highest value of remaining processing time first served. The simulation was runned for 100 replications and using the process analyzer, both the average time in the system and average number of jobs in the system were recorded and are as follows:

Ranking Rule	Average Time In System	Average # of Jobs
LIFO	261.412	71.148
FIFO	232.853	69.264
LVF (Next Processing Time)	232.273	56.264
LVF (Remaining Processing Time)	205.154	60.259
HVF (Remaining Processing Time)	329.021	80.408

There are a few things we can conclude based from the table above. To minimize the average time in the system, the queue ranking should follow the lowest value of remaining processing time first. To minimize the average number of jobs in the system, the queue ranking should follow the lowest average next processing time first. Depending on the preference of the user, weights can be placed for both the average time in the system and average number of jobs for each ranking rule to determine the best ranking rule to use for their operations.

**Question 2:** Consider the example problem 1 (job shop) in handout 3. Define five different ranking rules (ordering entities in queue) and evaluate them in “average time in system” and “average number of jobs in system.”

Using the parameters given in example problem one in handout three, five different models were created using Arena Simulations. In the simulation, A(1) is the arrival time of the entity, A(2) is the job type, and A(3) is the entity's index for station, A(4) is the number remaining operations left, A(5) is the remaining total expected average processing time. The five different ranking rules for the queues for models 1-5 are as follows, respectively: First in first out, last in first out, lowest value of remaining operations A(4) first, highest value of remaining operations A(4) first, lowest value of average processing time remaining A(5) first. The simulation was runned for 100 replications and using the process analyzer, both the average time in the system and average number of jobs in the system were recorded and are as follows:

Ranking Rule	Average Time In System	Average # of Jobs
FIFO	17.131	9.615
LIFO	17.258	10.119
LVF (Remaining operations Left)	17.447	10.858
HVF (Remaining operations left)	17.703	10.896
LVF (Average processing time)	18.359	11.013

There are a few things we can conclude based from the table above. To minimize the average time in the system, the queue ranking should be first in first out. To minimize the average number of jobs in the system, the queue ranking should also be first in first out.

**Question 3:** Consider the example problem 2 (open shop except inspection) in handout 3. Define three different queue selection rules (choosing a queue among those eligible) and evaluate them in “average time in system” and “average number of jobs in system.” Use FCFS for the ranking.

Using the parameters given in example problem four in handout two, three different models were created using Arena Simulations. In the simulation, A(1) is the arrival time of the entity, A(2) is the job type, and A(3) is the average remaining process time, A(4) - A(8) are the different stations the entities can travel to. The three different ranking rules for the ques for models 1-3 are as follows, respectively: first in first out by completing the stations tasks with smallest que length first, first in first out by completing the smallest total process remaining time first, first in first out by randomly picking any job type and checking for its uncompleted station tasks. The simulation was runned for 100 replications and using the process analyzer, both the average time in the system and average number of jobs in the system were recorded and are as follows:

Ranking Rule	Average Time In System	Average # of Jobs
FIFO (Smallest Que First	16.033	6.442
FIFO (Smallest total processing time First)	15.916	6.415
FIFO (Random)	18.246	7.321

There are a few things we can conclude based from the table above. To minimize the average time in the system and average number of jobs, the queue ranking should be first in first with having the shortest processing time served first.