

1- *Press operation.* The press department of an automobile manufacturing facility runs two main operations, each with its own press machine: front-plate press operation and rear-plate press operation. These operations can be performed in any order, but both have to be performed for each arriving plate. Plates (jobs) arrive randomly and their interarrival times are exponentially distributed with mean 5 minutes. The service time in the front-plate press operation is distributed iid Unif(1, 5) minutes, and in the rear-plate press operation it is distributed iid Unif(2, 6) minutes. A plate joins the queue of the press operation with the least number of plates waiting at that time (since there is no sequencing requirement), and on completion joins the queue of the other press operation after which it departs from the system. Finally, the press department is a three-shift facility running 24 hours a day.

a. Develop an Arena model of the press department, and simulate it for one year.

b. Estimate the following statistics:

- Average time arriving plates spend in the press department
- Utilization of the press machine in each operation
- Average queue delay at each operation
- Average time in the press department of those arriving plates that join

First the rear-plate press operation, and then proceed to the front-plate press operation.

2-*Electrolytic forming process.* An expensive custom-built product goes through two stages of operation. The first stage is an electrolytic forming process, served by two independently operating forming machines, where the product is built in a chemical operation that must conform to precise specifications. The second stage is a plating operation in which the product is silver plated. Customer orders arrive with interarrival times distributed iid Tria(3, 7, 14) hours, and join a queue in front of the forming process. The electrolytic forming processing time is distributed iid Unif(8, 12) hours. The silver-plating process also has a queue in front of it. Plating time is distributed iid Unif(4, 8) hours. The variability in the processing times is due to design variations of the incoming orders.

The two processes do not perform perfectly. In fact, 15% of the jobs that emerge from the forming process and 12% of the jobs that emerge from the plating process are defective and have to be reworked. All defective jobs are sent to a single rework facility, where design modifications and corrections are performed manually. However, plating reworks have a lower priority than forming modifications. Plating rework times are distributed iid Unif(15, 24) hours, while forming reworks are distributed iid Unif(10, 20) hours. Jobs departing from the rework facility go back to the process they came from to redo the operation found defective. Jobs that successfully complete the plating process leave the facility. Note that a job may go back and forth between a process and the rework operation any number of times.

a. Develop an Arena model of the electrolytic forming process, and simulate it for 1 year (24 hours of continuous operation).

b. How busy are each of the two operations and the rework facility?

c. What are the expected delays in process queues and the rework facility?

d. What is the expected job flow time throughout the entire facility?

e. Suggest a change in the system to reduce (even slightly) the expected job flow time. Run the modified model and compare the job flow statistics.