9.8 Training Cases

9.8.1 Case 1: Improving the X-Ray Process at County Hospital*

County Hospital wishes to improve the service level of its regular x-ray operation, which runs from 8:00 AM to 8:00 PM. Patients have identified the total required time as their main concern with this process. Management, on the other hand, is concerned with utilization of available resources. Management has created a process-improvement team to study this problem. The process might be redesigned as a result of the team's recommendations.

* Adapted from Anupindi, R. et al., *Managing Business Process Flows*, Prentice Hall, Upper Saddle River, NJ, 1999.

The team has defined the entry point to the x-ray process to be the instant a patient leaves the physician's office en route to the x-ray lab. The exit point has been defined as the instant at which the patient and the completed x-ray enter the physician's office.

Broadly speaking, two types of patients arrive to the x-ray process: emergency and nonemergency patients (priority levels 1 and 2, respectively). The emergency patients arrive according to a Poisson process with a mean of four patients per hour. The nonemergency patients are registered as they enter, and a sample of the arrival time data is provided in Table 9.14. Until now, no attempt has been made to further analyze these data, so there is no insight into what the arrival process looks like.

The team has identified 12 activities in the current x-ray process (see Table 9.15), which is the same irrespective of the patient type. The only differences between patient categories are the activity times and their distributions, specified in Table 9.16.

TABLE 9.14

Sample Arrival Times of Nonemergency Patients

Patient #	Time of Arrival (in Minutes from Time Zero)	Patient #	Time of Arrival (in Minutes from Time Zero)
1	6.30	31	197.89
2	10.13	32	205.50
3	17.07	33	215.42
4	17.09	34	219.95
5	23.94	35	223.50
6	26.06	36	233.33
7	27.65	37	234.89
8	29.21	38	239.20
9	41.65	39	244.29
10	44.69	40	247.29
11	49.79	41	249.90
12	60.07	42	250.25
13	70.34	43	256.34
14	70.73	44	257.90
15	74.32	45	268.97
16	84.59	46	276.82
17	91.77	47	280.43
18	95.78	48	281.94
19	98.20	49	293.23
20	117.24	50	293.57
21	122.85	51	299.79
22	130.58	52	303.75
23	137.46	53	306.58
24	139.76	54	308.13
25	142.52	55	314.06
26	150.70	56	322.84
27	151.95	57	326.51
28	154.74	58	338.21
29	157.48	59	339.91
30	193.25	60	365.79

TABLE 9.15

Activities in the Current X-Ray Process

Activity	Description	Type
1	Patient leaves physician's office with instructions.	Start of the x-ray process
2	Patient is taken to the lab by an orderly, on foot in wheelchair or lying in bed.	Transportation
3	The patient is left in the waiting area outside the x-ray lab in anticipation of an x-ray technician.	Waiting
4	An x-ray technician fills out a standard form based on information supplied by the physician and the patient (done outside the x-ray lab). The technician then leaves the patient, who queues up in front of the x-ray labs.	Business value added
5	The patient enters the x-ray lab and undresses, and an x-ray technician takes the required x-rays (all done in the x-ray lab).	Value added
6	A dark room technician develops the x-rays. (Assume that the patient and the x-ray technician accompany the x-rays.)	Value added
7	The dark room technician and the x-ray technician check the x-rays for clarity. (Assume that the patient accompanies his or her x-rays.)	Inspection
8	If x-rays are not clear, then the patient needs to go back to the waiting room in anticipation of repeating steps 5, 6, and 7. Historically, the probability of rejecting x-rays has been 25%. If the x-rays are acceptable, the patient proceeds to activity 9, while the x-rays are put in the outbox, where eventually the messenger service will pick them up.	Decision
9	Patient waits for an orderly to take him or her back to the physician's office.	Waiting
10	Patient is taken back to the physician's office by an orderly.	Transportation
11	A messenger service transfers the x-rays to the physicians in batches of five jobs.	Transportation
12	Patient and x-rays enter physician's office together.	End

The patient priority levels determine the service order of all the x-ray activities. Emergency patients (priority 1) come first at the expense of nonemergency patients (priority 2). However, after service is started, it will never be interrupted to benefit a high-priority patient.

The resource data for the x-ray process are specified in Table 9.17. The orderlies will always take one patient back from the x-ray lab when they have dropped one off. Assume that the transportation time back from the x-ray lab is exactly the same as the transportation time to the x-ray lab. If no patient is ready to go back, the orderly will wait for 5 min; if no patient becomes available during this time, the orderly will return to the ward without a patient. The time for an orderly to walk back without a patient is always 5 min. The orderlies will never go and pick up a patient at the x-ray area without bringing another patient with them from the ward.

TABLE 9.16

Activity Times for X-Ray Process

Activity	Patient Type	Activity Time Distribution	Parameter Values (Min)
1	All types	Not applicable	Not applicable
2	Emergency patients	Uniform	Max = 9, min = 5
	Nonemergency patients	Uniform	Max = 12, min = 5
3	All types	Not applicable	Not applicable
4	All types	Uniform	Max = 6, min = 4
5	Emergency patients	Normal	$\mu = 9, \sigma = 4$
	Nonemergency patients	Normal	$\mu = 11, \sigma = 4$
6	All types	Normal	$\mu = 12, \sigma = 5$
7	All types	Constant	Value = 2
8	All types	Constant	Value = 0
9	All types	Not applicable	Not applicable
10	Emergency patients	Uniform	Max = 9, min = 5
	Nonemergency patients	Uniform	Max = 12, min = 5
11	All types	Uniform	Max = 7, min = 3
12	All types	Not applicable	Not applicable

TABLE 9.17

Resource Data for X-Ray Process

Resource	Activities	No. of Units Available
Orderlies	2 and 10	3
X-ray technician	4, 5, 6, and 7	3
X-ray lab	5	2
Dark room technician	6 and 7	2
Dark room	6	1

Part I: Analyzing the Current Process Design

1. Draw a flowchart of the current x-ray process.
2. Develop a simulation model of this process.
   - The model requires analysis of input data regarding the arrival process of nonemergency patients.
   - *Modeling hint:* Build the model incrementally based on your flowchart. Do not try to put everything together at once and then test whether it works.
   - As a first check that everything works as it is supposed to, it is often useful to run a shorter simulation with animation. Use different symbols for different types of items, such as different types of labor and different types of jobs.
3. For a first-cut analysis, run a 1 day simulation with the random seed set at 100, using the correct activity time distributions. Look at the average cycle time, the throughput rate, the resource, the queue, and the activity statistics. What are the problems in this process?

4. Simulate 30 days of operation and compute the cycle time and daily throughput (average, standard deviation, and 95% confidence intervals). Also compute the activity and resource utilization statistics and queue statistics with 95% confidence intervals. (Use the Statistics block in the Value library of ExtendSim.) Assume that any patients remaining in the system at the end of the day will be taken care of by the night shift. Every morning, the system is assumed to be empty. Are there any surprises when you compare these results with the ones in question 3?
5. Assess the performance of the process using the values calculated in question 4. Where is the bottleneck? Which are the problems for reducing the cycle time and increasing the throughput rate?

Part II: Suggest and Evaluate a New Process Design

6. Based on your insight about the current operations, identify a plausible way of reducing the average cycle time by redesigning the process. For example: What happens if the x-ray technician no longer has to stay with the patient while the x-rays are developed? What if the messenger batch size changes? Is the messenger service necessary? What if more personnel are hired? What type of personnel would be most useful?
7. Investigate the performance of the redesigned process in terms of the cycle time and the daily throughput. Also look at the resource and activity utilization statistics and queue statistics with 95% confidence intervals as before. What are your conclusions? Is the new design significantly better than the old process with regard to the cycle time and throughput? Are there any obvious drawbacks?

9.8.2 Case 2: Process Modeling and Analysis in an Assembly Factory

The LeedsSim factory is a traditional assembly facility working as a subcontractor to the telecommunications industry. Their main product is a specialized switchboard cabinet used in the fourth-generation (4G) network base stations. The company has been successful on the sales side, and with the 4G expansion taking off, the orders are piling up. Unfortunately, the operations department has had some problems with reaching the desired (and necessary) productivity levels. Therefore, they have decided to seek help to create a simulation model of the involved processes as a first step to analyze and improve the process design.

To find the right level of detail in the model description, they want to start with a simple model and then successively add more details until a suitable model with the right level of complexity is obtained. The simulation should be run over a 3 month (12 week) period of five 8 h workdays/week. A schematic flowchart of the manufacturing process is shown in Figure 9.35.

After the cabinets are completed and inspected, the finished cabinets leave the factory. It is noteworthy that each workstation can handle only one item at a time. Moreover, a forklift truck is required to move the assembled cabinets. Workstations 1 through 3 cannot store items. Similarly, there is no room to store items before workstation 4, but after it, there is room to store two assembled cabinets. At workstation 5, there is ample space to store cabinets before the workstation, but after it, there is only room to store at most two painted cabinets. At the inspection station, there is ample space to store cabinets both before and after the station.

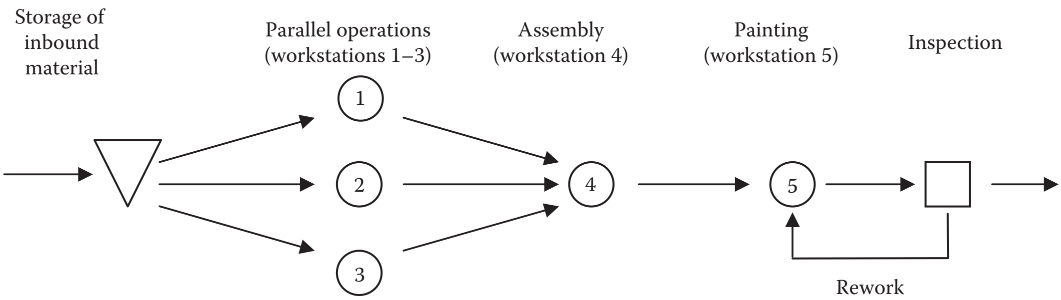

FIGURE 9.35
Flowchart of the LeedsSim manufacturing process.

TABLE 9.18
Estimated Processing and Inspection Times

Processing Unit	Processing Time Distribution	Parameter Values (h)
Workstation 1	Triangular	Max = 3, min = 1.5, most likely = 2
Workstation 2	Triangular	Max = 3, min = 1.5, most likely = 2
Workstation 3	Triangular	Max = 3, min = 1.5, most likely = 2
Workstation 4	Triangular	Max = 4, min = 2, most likely = 3
Workstation 5	Triangular	Max = 6, min = 3, most likely = 4

Each cabinet that is made requires one unit each of five different components/raw materials delivered to the inbound storage area. Workstation 1 requires one unit each of raw materials 1 and 2, workstation 2 requires one unit of raw material 3, and workstation 3 requires one unit each of raw materials 4 and 5. Table 9.18 specifies the estimated processing times in workstations 1 through 5. Table 9.19 shows collected inspection time data that have not yet been analyzed. This needs to be done in order to build a valid model of the process.

The performance measure that LeedsSim is most interested in is the number of cabinets produced in a 3 month period. However, they also want to keep track of the following:

- The WIP levels (measured in units of raw material)—the total as well as at different parts of the workshop (the mean and the standard deviation for a single run and the mean with 95% confidence intervals in case of multiple simulation runs)
- The inbound storage levels of the raw materials (the maximum, the mean, and the standard deviation for a single run and the mean with 95% confidence intervals in case of multiple simulation runs)
- The cycle time, measured from the instant a component arrives to the storage area until a finished cabinet leaves the factory (the mean and the standard deviation for a single run and the mean with 95% confidence intervals in case of multiple simulation runs) (Hint: Note that all components for a particular cabinet have the same cycle time.)
- Utilizations of workstations and equipment such as the forklift truck (the mean with 95% confidence intervals in case of multiple simulation runs)

TABLE 9.19

Observed Inspection Time Data in Minutes

No.	Inspection Time	No.	Inspection Time	No.	Inspection Time	No.	Inspection Time
1	0.994	31	0.218	61	0.343	91	1.532
2	3.084	32	1.498	62	2.129	92	2.561
3	0.169	33	2.433	63	0.756	93	6.198
4	7.078	34	1.491	64	0.991	94	1.663
5	2.440	35	0.088	65	1.001	95	0.984
6	5.546	36	0.502	66	2.070	96	0.183
7	0.201	37	2.324	67	3.216	97	1.385
8	1.185	38	0.458	68	2.037	98	0.212
9	5.308	39	1.474	69	5.358	99	0.757
10	0.989	40	1.180	70	0.024	100	1.291
11	0.590	41	0.307	71	2.397	101	0.063
12	8.476	42	5.252	72	4.718	102	3.571
13	3.676	43	6.797	73	1.478	103	7.869
14	0.504	44	2.461	74	1.089	104	0.233
15	0.016	45	0.418	75	12.196	105	0.661
16	1.392	46	0.699	76	0.109	106	0.697
17	0.552	47	0.293	77	4.355	107	4.937
18	2.059	48	4.245	78	1.158	108	0.045
19	2.858	49	1.594	79	0.003	109	1.239
20	5.982	50	0.733	80	0.137	110	0.357
21	2.337	51	0.389	81	0.293	111	1.143
22	2.426	52	1.088	82	0.193	112	3.068
23	0.252	53	1.457	83	1.263	113	0.548
24	0.290	54	0.206	84	2.249	114	3.460
25	5.139	55	0.755	85	0.689	115	1.271
26	1.727	56	1.786	86	2.376	116	3.401
27	3.859	57	0.510	87	0.729	117	3.082
28	3.356	58	3.400	88	1.408	118	0.357
29	0.884	59	1.690	89	5.199	119	2.098
30	1.992	60	2.186	90	3.286	120	0.728

Questions

1. The raw material arrives by truck once every week on Monday morning. Each shipment contains 15 units each of the five necessary components. The internal logistics within the factory is such that the transportation times for the incomplete cabinets can be neglected. However, to transport the fully assembled cabinet to and from the paint shop, a special type of forklift truck is needed. The transportation time from the assembly line to the paint shop is exponentially distributed with a mean of 45 min. The transportation time between the paint shop and the inspection station at the loading dock is normally distributed with a mean of 60 min and a standard deviation of 15 min. After each delivery, the forklift truck always returns to the strategically located parking area to get new instructions. The travel time for the forklift truck, without load, between the parking area and each of the workstations is negligible.

Transportation of painted cabinets is prioritized. This means that whenever a forklift truck is available for a new assignment (at its parking area), and there are unpainted and painted cabinets awaiting transport, the latter ones will be transported first. Currently one forklift truck is available in the factory. For the first model, assume that all painted cabinets pass inspection, so no rework occurs.

a. Analyze the input data for the inspection times and fit a suitable distribution. Build the model and run the simulation once with random seed = 5. How many cabinets are being produced? How is the WIP situation? What does a plot over the storage inventory levels tell us? Where is the bottleneck?
b. Run the simulation 30 times with different random seeds. How many cabinets are being produced on average? What is the standard deviation? How is the WIP situation? Where is the bottleneck? (*Hint*: Use the Statistics block in the Value library to collect data and analyze it efficiently. For the number of units produced, use a Mean and Variance block, connect it to the exit block, and check the dialogue options Calculate for Multiple Simulations, and use number of inputs—1.)

2. In reality, only 75% of the painted cabinets pass the inspection. If a cabinet fails the inspection, it needs to be transported back to the paint shop to be repainted. The transportation time is the same as in the opposite direction (normally distributed with a mean of 60 min and a standard deviation of 15 min). The transportation of painted cabinets that has failed inspection back to the paint shop has higher priority than any other transportation assignment. The forklift truck will always go back to the parking area after a completed mission. When arriving to the paint shop, repainting has higher priority than the ordinary paint jobs and follows an exponential distribution with a mean of 2 h. Inspecting the reworked cabinets is no different from inspecting non-reworked cabinets. How does the introduction of these features affect the performance measures?
   a. Run the simulation once with random seed = 5. How many cabinets are being produced? How is the WIP situation? Where is the bottleneck?
   b. Run the simulation 30 times with different random seeds. How many cabinets are being produced on average? What is the standard deviation? How is the WIP situation? Where is the bottleneck?
3. Based on your understanding of the process, suggest a few design changes and try them out. What is your recommendation to LeedsSim regarding how to improve their operations?
4. In this model, collection of statistics data starts at time zero, when the system is empty. It would be more accurate to run the system for a warm-up period, say 1 week, before starting to collect data. Implement this and see the difference. Does it change your conclusions?

9.8.3 Case 3: Redesign of a Credit Applications Process

The management of a mortgage company has decided with limited information that the company can save money if it reduces its staff. Before downsizing, management asks you to model the credit application process to provide reassurance that service will not be severely affected by the reduction in staff.

The mortgage company currently employs three loan agents, two of whom perform an initial review of credit applications and a third who performs a second review of the applications that fails the initial review. The second review is performed as an attempt to correct the deficiencies by contacting the originating party. The process has the following characteristics:

- Approximately four to eight credit applications (and most likely six) arrive every hour.
- It takes 12–16 min to complete the first review.
- About 20% of the applications fail the first review.
- It takes 25–35 min to complete the second review.
- About 50% of the applications fail the second review.

Your task is to compare the performance of the current process with the performance of the process using two loan agents. For the downsized process, management wants the two remaining loan agents to work in either of the two reviewing steps; that is, the loan agents are not assigned to the first or second review step, but rather they are to perform initial or second reviews as needed.

Questions

1. Create a simulation model of the current process. Use the triangular distribution to model the arrivals of credit applications and the uniform distribution for the reviewing times.
2. Simulate the process for 5 working days (40 h), and collect the following data: utilization of loan agents, waiting time, and cycle time.
3. Modify the model to simulate the downsized process. Repeat question 2 for the new model. Compare the performance of the two processes by analyzing the data collected during the simulation runs.

9.8.4 Case 4: Redesigning the Adoption Process in a Humane Society

The purpose of this project is to redesign the pet adoption process of a Humane Society. One of the main goals of the project is the development of a simulation model of the process. The adoptions department of the Humane Society would like to use this model as a tool for evaluating the effect of proposed changes to the current pet adoption process. Management considers that the model significantly reduces the risks associated with this redesign project because a number of what-if scenarios can be tested before implementing any changes. Furthermore, management believes that the model can help them obtain buy-in from the employees directly involved in the process.

The modeling process consists of the following steps:

1. Flowcharting and analysis of the current process
2. Simulation modeling and validation
3. Performance analysis of the current process
4. Discussion of different options for redesigning the current process
5. Development of several scenarios
6. Modeling and testing of scenarios
7. Selection of final proposed process

A task force is created to understand the current process. After several meetings of the task force, the current process is summarized as follows.

Patrons arrive to the Humane Society and look for a place to park. The arrival rate is about 10 patrons/h, and the interarrival times follow an exponential distribution. If a patron finds the parking lot full, he or she leaves. If the parking lot is not full, the patron parks the car and enters the building (between 2 and 5 uniformly distributed minutes). Patrons then walk through the kennels (between 10 and 45 uniformly distributed minutes) and may decide to leave if they don't find a suitable pet. About 15% of patrons leave at this point. If a patron finds a suitable pet, then he or she finds out what to do next to start the adoption process (between 1 and 5 uniformly distributed minutes).

After receiving the instructions on how to proceed, the patrons count the number of people in the waiting area. (This includes people filling out the sign-in form and people waiting for a counselor.) If a patron finds fewer than 10 people in the waiting area, he or she lines up to sign in. If 10 people or more are in the waiting area, the patron leaves with a 70% probability. It takes a patron normal (5,1) minutes to fill out the entrance form. After signing in, patrons wait to be called to the counter to meet with a counselor. Counseling takes between 10 and 60 min, and 20% of the time, patrons also must talk to a supervisor after counseling, an activity that takes normal (15,2) minutes. After finishing counseling (or talking to the supervisor), patrons decide to stay and continue with the adoption process or they leave. About 35% of the patrons leave at this stage of the adoption process.

If a patron decides to stay, he or she must wait for a kennel technician. After a brief conversation with a kennel technician (between 2 and 5 uniformly distributed minutes), the patron and the technician visit the animals and explore options (between 5 and 45 uniformly distributed minutes). After visiting the animals, about 15% of the patrons decide to leave. Those who stay work with the technician to check on holds, which takes normal (15,3) minutes. This is necessary because some of the animals are held for people who have visited them at the Humane Society and currently are considering adoption. If there are holds (10% of the time), the patron is asked to return later. If there are no holds, the patron receives instructions from the kennel technician, normal (10,2) minutes, and walks (between 1 and 2 uniformly distributed minutes) to meet with a counselor.

A counselor and the patron then fill out the adoption contract (between 10 and 45 uniformly distributed minutes). After the contract is signed, the health of the animal is checked (5 exponentially distributed minutes). After the health check is complete, the patron walks to the car with his or her pet and leaves (between 2 and 5 uniformly distributed minutes).

NOTE: A processing time given as a range of numbers is assumed to follow a uniform distribution. For example, if the time is between 10 and 45 min, the actual time follows a uniform distribution with a minimum value of 10 min and a maximum value of 45 min. Also, a processing time of normal (15,3) minutes means that the actual time follows a normal distribution with a mean of 15 min and a standard deviation of 3 min.

The current process operates 10 h/day and utilizes the following resources:

- 30 parking spaces
- 8 counselors
- 1 supervisor
- 5 kennel technicians
- 1 veterinarian

It is assumed that the process is empty when the doors open every morning. Also, the doors are closed after 10 h, but personnel stay until the last patron leaves the building. Working time beyond 10 h is considered overtime.

Part I

1. Draw a flowchart of the current process.
2. Create a simulation model of the current process.
3. Run 30 days of operation (using 55 for the random seed number).
4. Analyze the performance of the system according to cycle time, resource utilization, ratio of number of adoptions per number of arrivals, and daily overtime.

The report for part I of this project consists of an executive summary with the objectives and main findings. The supporting materials should include a flowchart of the current process, a printout of the simulation model (i.e., an annotated task network), and the following charts and tables:

- A frequency distribution of the cycle times observed during the 30 day simulation.
- A table of daily resource utilization with five columns, one for each resource, and 30 rows, one for each day. Three additional rows should contain the minimum, the average, and the maximum utilization for each resource type.
- A table with 30 rows, one for each day, and two columns, one for the daily ratio of number of adoptions per number of arrivals and one for the daily overtime. Three additional rows should contain the minimum, the average, and the maximum overtime and the adoption ratio.

Part II

1. Discuss different options for redesigning the current process. For example, consider eliminating activities or performing some activities in parallel.
2. Develop a redesign scenario.
3. Model a redesigned process.
4. Predict the performance of the redesigned process in terms of cycle time, resource utilization, ratio of adoptions to patron arrivals, and daily overtime.

The report for part II of this project consists of an executive summary with objectives, methodology, main findings, and recommendations. The supporting materials should be the same as in the report for part I.

9.8.5 Case 5: Performance Analysis and Improvement of an Internet Ordering Process

The management of a software company wants to study the performance of the company's web order processing. The interarrival times of orders are exponentially distributed with a mean of 7 min. The orders arrive in the form of e-mail. Upon arrival, a clerk looks for the buyer's name in the company's database. The time required to look for a name in the database is uniformly distributed between 20 and 45 s. If the buyer is not in the database, the clerk enters the buyer's information, which includes name, address, phone number, and e-mail address. The time required to enter the buyer's information in the database is uniformly distributed between 10 and 30 s. Approximately 60% of the time, the buyer's name is not in the database.

Some orders are for an upgrade of the software, and the others are from first-time buyers. For all practical purposes, it takes no time to figure whether an order is for an upgrade or from a first-time buyer. Approximately 30% of the orders are for upgrades. If the order is for an upgrade, then the clerk simply enters a code in the electronic purchase order (PO), created when the buyer's name was entered or found in the database. (This code is later e-mailed to the customer, so he or she can download an upgrade from the company's website.) Entering the code requires an exponentially distributed time with a mean of 2 min because the clerk needs to verify the customer's current software version and platform. After entering the code, the electronic PO goes to accounting.

When the order is from a first-time buyer, the clerk checks whether the buyer wants the CD version with printed documentation or whether he or she prefers to download the software from the company's website. This requires an exponentially distributed time with a mean of 1 min because sometimes this information has been misplaced. About 70% of the buyers prefer the CD version. When the CD version is preferred, the clerk needs to retrieve it from the storage room. This activity requires a normally distributed time with a mean of 5 min and a standard deviation of 1. The clerk then prepares the software for shipping, which takes between 3 and 6 min (uniform distribution). If the buyer prefers to download the software, the clerk enters an appropriate code in the electronic PO. Entering the code requires an exponentially distributed time with a mean of 1 min because a computer program sometimes is slow at generating a license for each customer.

POs for upgrades and first-time buyers go to accounting after a clerk has either entered a code for downloading or prepared the CD version for shipping. Accounting personnel charge the purchase to a credit card (exponential distribution with a mean of 2 min) and prepare the invoice. Data on invoice preparation times have been collected and are available in Table 9.20. Finally, the accounting personnel mail the software or e-mail the access code with the invoice. This activity requires a uniformly distributed time between 45 and 90 s.

Currently, the company employs two people for this process: one clerk for the initial processing and one person in charge of the accounting. However, management is considering adding one person to the process and would like to use simulation to determine where to add this new employee to obtain the maximum customer service benefit.

Questions

1. The first task is to understand this process, and develop a flowchart. This chart should be the first exhibit in your written report.
2. Using the flowchart as a guideline, develop a simulation model of this process. In order to build a valid model, the available data on how long time it takes to prepare an invoice need to be analyzed. More precisely, a suitable distribution should be fitted to the data.

TABLE 9.20

Observed Invoice Preparation Times in Minutes

No.	Invoice Preparation	No.	Invoice Preparation	No.	Invoice Preparation	No.	Invoice Preparation
1	0.987	31	1.037	61	0.875	91	0.721
2	0.881	32	1.103	62	0.763	92	1.132
3	1.022	33	0.965	63	1.283	93	0.705
4	0.799	34	1.199	64	0.856	94	1.211
5	0.986	35	0.989	65	1.091	95	0.831
6	1.053	36	1.055	66	1.028	96	0.866
7	0.493	37	0.916	67	1.163	97	1.243
8	0.883	38	0.611	68	0.972	98	0.431
9	1.028	39	1.044	69	1.082	99	1.193
10	1.057	40	0.775	70	0.578	100	1.193
11	0.793	41	0.975	71	0.717	101	1.220
12	1.068	42	0.699	72	1.473	102	0.954
13	0.836	43	0.948	73	1.418	103	1.050
14	0.984	44	1.072	74	1.119	104	0.747
15	1.092	45	0.929	75	1.102	105	1.270
16	1.006	46	0.752	76	1.208	106	0.754
17	1.113	47	1.041	77	0.970	107	0.807
18	0.914	48	0.878	78	0.757	108	0.890
19	0.877	49	1.180	79	1.189	109	0.771
20	1.196	50	1.326	80	1.183	110	1.099
21	1.139	51	1.064	81	1.300	111	1.114
22	0.937	52	0.803	82	1.280	112	0.982
23	0.640	53	1.035	83	1.023	113	1.235
24	1.347	54	1.073	84	0.852	114	1.152
25	0.961	55	1.011	85	1.148	115	0.708
26	1.004	56	1.300	86	0.972	116	0.745
27	1.068	57	1.333	87	0.747	117	0.938
28	1.170	58	1.043	88	1.031	118	1.384
29	1.406	59	0.810	89	1.190	119	1.033
30	1.288	60	1.141	90	1.017	120	1.378

3. Set the random seed value to 34 in the Simulation Setup of the Run menu. Run the model for 15 working days and collect the waiting time at the queues, cycle time, resource utilization, and WIP. (A working day consists of 8 h.)
4. Discuss the performance of the current process based on the collected data. Include the following exhibits to support your arguments: queue statistics, line graphs of resource utilization, a histogram of cycle times, and the WIP value at the end of the 15 days.
5. Identify the bottleneck and add the new employee to the bottleneck. Compare the utilization of clerks and accounting personnel before and after adding the new employee. Also compare the frequency distribution of cycle times before and after adding the new employee. Include line graphs for the utilization of resources after adding the new employee and a histogram of cycle times.