Simulation and Inventory Analysis

Simulation and Inventory Analysis

- **We have seen deterministic inventory models.**
- **In many real-world inventory situations, demand and lead time are variables.**
- **Accurate analysis is difficult without simulation.**
- **We will look at an inventory problem with two decision variables and two probabilistic components.**
- **The owner of a hardware store wants to establish *order quantity* and *reorder point* decisions for a product that has probabilistic daily demand and reorder lead time.**

Simkin's Hardware Store

- The owner of a hardware store wants to find a good, low cost inventory policy for an electric drill.
- Simkin identifies two types of variables, controllable and uncontrollable inputs.
- The controllable inputs are the order quantity and reorder points.
- The uncontrollable inputs are daily demand and variable lead time.
- The demand data for the drill is shown in Table 14.6.

Simkin's Hardware Store

Probabilities and Random Number Intervals for Daily Ace Drill Demand

(1) DEMAND FOR ACE DRILL	(2) FREQUENCY (DAYS)
0	15
1	30
2	60
3	120
4	45
5	30
	300

Table 14.6

Bonus

Simkin's Hardware Store

Probabilities and Random Number Intervals for Daily Ace Drill Demand

(1) DEMAND FOR ACE DRILL	(2) FREQUENCY (DAYS)	(3) PROBABILITY	(4) CUMULATIVE PROBABILITY	(5) INTERVAL OF RANDOM NUMBERS
0	15	0.05	0.05	01 to 05
1	30	0.10	0.15	06 to 15
2	60	0.20	0.35	16 to 35
3	120	0.40	0.75	36 to 75
4	45	0.15	0.90	76 to 90
5	30	0.10	1.00	91 to 00
	300	1.00		

Table 14.6

Simkin's Hardware Store

Probabilities and Random Number Intervals for Reorder Lead Time

(1) LEAD TIME (DAYS)	(2) FREQUENCY (ORDERS)
1	10
2	25
3	15
	50

Table 14.7

Bonus

Simkin's Hardware Store

Probabilities and Random Number Intervals for Reorder Lead Time

(1) LEAD TIME (DAYS)	(2) FREQUENCY (ORDERS)	(3) PROBABILITY	(4) CUMULATIVE PROBABILITY	(5) RANDOM NUMBER INTERVAL
1	10	0.20	0.20	01 to 20
2	25	0.50	0.70	21 to 70
3	15	0.30	1.00	71 to 00
	50	1.00		

Table 14.7

Simkin's Hardware Store

- The third step is to develop a simulation model.
- A flow diagram, or flowchart, is helpful in this process.
- The fourth step in the process is to specify the values of the variables that we wish to test.
- The first policy that Simkin wants to test is an order quantity of 10 with a reorder point of 5.
- The fifth step is to actually conduct the simulation.
- The process is simulated for a 10 day period.

Flow Diagram for Simkin's Inventory Example

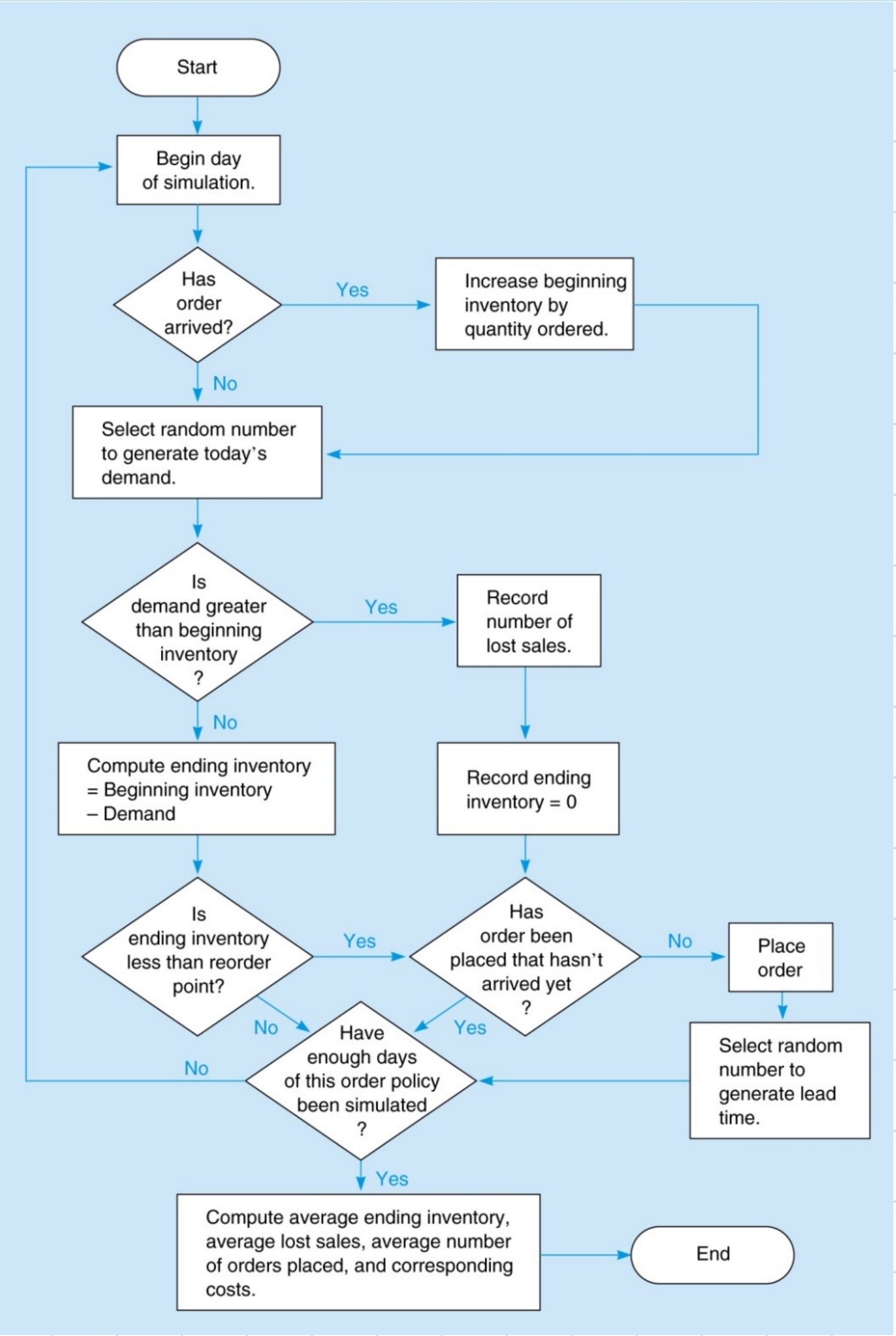

Figure 14.3

Simkin's Hardware Store

Using the table of random numbers, the simulation is conducted using a four-step process:

1. **Begin each day by checking whether an ordered inventory has arrived. If it has, increase the current inventory by the quantity ordered.**
2. **Generate a daily demand from the demand probability by selecting a random number.**
3. **Compute the ending inventory every day. If on-hand inventory is insufficient to meet the day's demand, satisfy as much as possible and note the number of lost sales.**
4. **Determine whether the day's ending inventory has reached the reorder point. If necessary place an order.**

Simkin's Hardware Store

Table 14.8 **Simkin Hardware's First Inventory Simulation**

ORDER QUANTITY = 10 UNITS				REORDER POINT = 5 UNITS					
(1) DAY	(2) UNITS RECEIVED	(3) BEGINNING INVENTORY	(4) RANDOM NUMBER	(5) DEMAND	(6) ENDING INVENTORY	(7) LOST SALES	(8) ORDER	(9) RANDOM NUMBER	(10) LEAD TIME
1	…	10	06	1	9	0	No		
2	0	9	63	3	6	0	No		
3	0	6	57	3	3	0	Yes	02	1
4	0	3	94	5	0	2	No		
5	10	10	52	3	7	0	No		
6	0	7	69	3	4	0	Yes	33	2
7	0	4	32	2	2	0	No		
8	0	2	30	2	0	0	No		
9	10	10	48	3	7	0	No		
10	0	7	88	4	3	0	Yes	14	1
				Total	41	2			

Analyzing Simkin's Inventory Cost

- The objective is to find a low-cost solution so Simkin must determine the costs.
- Equations for average daily ending inventory, average lost sales, and average number of orders placed.

Average ending inventory $= \dfrac{41 \text{ total units}}{10 \text{ days}} = 4.1 \text{ units per day}$

Average lost sales $= \dfrac{2 \text{ sales lost}}{10 \text{ days}} = 0.2 \text{ unit per day}$

Average number of orders placed $= \dfrac{3 \text{ orders}}{10 \text{ days}} = 0.3 \text{ order per day}$

Analyzing Simkin's Inventory Cost

- Simkin's store is open 200 days a year.
- Estimated ordering cost is $10 per order.
- Holding cost is $6 per drill per year.
- Lost sales cost $8.

Daily order cost = (Cost of placing one order)
x (Number of orders placed per day)
= $10 per order x 0.3 order per day = $3

Daily holding cost = (Cost of holding one unit for one day) x (Average ending inventory)
= $0.03 per unit per day x 4.1 units per day
= $0.12

Analyzing Simkin's Inventory Cost

- Simkin's store is open 200 days a year.
- Estimated ordering cost is $10 per order.
- Holding cost is $6 per drill per year.
- Lost sales cost $8.

Daily stockout cost = (Cost per lost sale) x (Average number of lost sales per day)
= $8 per lost sale x 0.2 lost sales per day
= $1.60

Total daily inventory cost = Daily order cost + Daily holding cost + Daily stockout cost
= $4.72

Analyzing Simkin's Inventory Cost

- For the year, this policy would cost approximately $944.
- This simulation should really be extended for many more days, perhaps 100 or 1,000 days.
- Even after a larger simulation, the model must be verified and validated to make sure it truly represents the situation on which it is based.
- If we are satisfied with the model, additional simulations can be conducted using other values for the variables.
- After simulating all reasonable combinations, Simkin would select the policy that results in the lowest total cost.