17. The City Transportation Planning Committee must decide whether to begin a long-term project to build a subway system or to upgrade the present bus service. Suppose you are an expert in fixed-path and variable-path material-handling equipment, and the committee seeks your counsel on this matter. What are the advantages and limitations of the subway and bus systems?
18. Identify the fixed-path and variable-path material-handling equipment commonly found in supermarkets.
19. What are heuristic approaches, and why are they used in designing layouts?
20. Why are product layouts atypical in service environments?
21. According to a study by the Alliance of American Insurers, it costs more than three times the original purchase price in parts and labor to reconstruct a wrecked Chevrolet. Explain the reasons for this large discrepancy in terms of the processes used to assemble the original car and those required to reconstruct the wrecked car.
22. Name some ways that a layout can help or hinder productivity.
23. What is cellular manufacturing? What are its main benefits and limitations?
24. What is group technology?
25. Explain the consequences of task time variability on line balancing.

TAKING STOCK

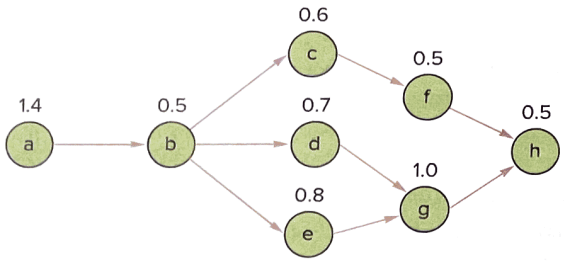
1. Name three major trade-offs in process selection.
2. What trade-offs are involved when deciding how often to rebalance an assembly line?
3. Who needs to be involved in process selection?
4. Who needs to be involved in layout design?
5. In what ways does technology have an impact on process selection? How can technology impact layout decisions?

CRITICAL THINKING EXERCISES

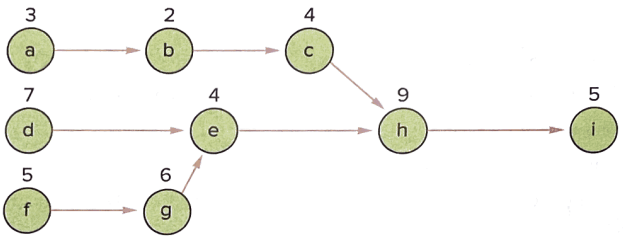
1. Name two unethical behaviors related to process selection and two related to layout, and the ethical principles they violate (see Chapter 1).
2. Layout decisions affect a wide range of facilities, from factories, supermarkets, offices, department stores, and warehouses, to malls, parking lots and garages, and kitchens. Layout is also important in the design of some products such as the interiors of automobiles and the arrangement of components inside computers and other electronic devices. Select three different items from this list, or other similar items, and explain for each what the four or five key considerations for layout design are.
3. What are the risks of automating a production process? What are the risks for a service process?
4. Consider an assembly line such as the burrito assembly line at Chipotle Mexican Grill. During slow times of the day, one server can handle assembly, but during very busy times, having many servers would be prudent. Explain why either approach wouldn't work all the time, and the benefit of matching the number of servers to the pace of customer arrivals.

PROBLEMS

1. An assembly line with 17 tasks is to be balanced. The longest task is 2.4 minutes, and the total time for all tasks is 18 minutes. The line will operate for 450 minutes per day.
   a. What are the minimum and maximum cycle times?
   b. What range of output is theoretically possible for the line?
   c. What is the minimum number of workstations needed if the maximum output rate is to be sought?
   d. What cycle time will provide an output rate of 125 units per day?
   e. What output potential will result if the cycle time is (1) 9 minutes? (2) 15 minutes?
2. A manager wants to assign tasks to workstations as efficiently as possible and achieve an hourly output of 33⅓ units. Assume the shop works a 60-minute hour. Assign the tasks shown in the accompanying precedence diagram (times are in minutes) to workstations using the following rules:
   a. In order of most following tasks. Tiebreaker: greatest positional weight.
   b. In order of greatest positional weight. Tiebreaker: most following tasks.
   c. What is the efficiency?



3. A manager wants to assign tasks to workstations as efficiently as possible and achieve an hourly output of four units. The department uses a working time of 56 minutes per hour. Assign the tasks shown in the accompanying precedence diagram (times are in minutes) to workstations using the following rules:
   a. In order of most following tasks. Tiebreaker: greatest positional weight.
   b. In order of greatest positional weight. Tiebreaker: most following tasks.
   c. What is the efficiency?



4. A producer of inkjet printers is planning to add a new line of printers, and you have been asked to balance the process, given the following task times and precedence relationships. Assume that cycle time is to be the minimum possible.

Task	Length (minutes)	Immediate (Predecessor)
a	0.2	–
b	0.4	a
c	0.3	–
d	1.3	b, c
e	0.1	–
f	0.8	e
g	0.3	d, f
h	1.2	g

   a. Do each of the following:
      (1) Draw the precedence diagram.
      (2) Assign tasks to stations in order of most following tasks. Tiebreaker: greatest positional weight.
      (3) Determine the percentage of idle time.
      (4) Compute the rate of output in printers per day that could be expected for this line, assuming a 420-minute working day.
   b. Answer these questions:
      (1) What is the shortest cycle time that will permit use of only two workstations? Is this cycle time feasible? Identify the tasks you would assign to each station.
      (2) Determine the percentage of idle time that would result if two stations were used.
      (3) What is the daily output under this arrangement?
      (4) Determine the output rate that would be associated with the maximum cycle time.

d. Balance the line using the *greatest positional weight* heuristic. Break ties with the *most following tasks* heuristic. Use a cycle time of 50 seconds.

e. Calculate the percentage idle time for the line.

Task	Task Time (seconds)	Immediate Predecessor
A	45	—
B	11	A
C	9	B
D	50	—
E	26	D
F	11	E
G	12	C
H	10	C
I	9	F, G, H
J	10	I
	193	

8. A shop works a 400-minute day. The manager of the shop wants an output of 200 units per day for the assembly line that has the elemental tasks shown in the table. Do the following:

   a. Construct the precedence diagram.

   b. Assign tasks according to the *most following tasks* rule. Break ties with the *greatest positional weight* rule.

   c. Assign tasks according to the *greatest positional weight* rule. Break ties with the *most following tasks* rule.

   d. Compute the balance delay for each rule. Which one yields the better set of assignments in this instance?

Task	Immediate Predecessor	Task Time
a	—	0.5
b	a	1.4
c	a	1.2
d	a	0.7
e	b, c	0.5
f	d	1.0
g	e	0.4
h	g	0.3
i	f	0.5
j	e, i	0.8
k	h, j	0.9
m	k	0.3

9. Arrange six departments into a 2×3 grid so that these conditions are satisfied: 1 close to 2, 5 close to 2 and 6, 2 close to 5, and 3 not close to 1 or 2.

10. Using the information given in the preceding problem, develop a Muther-type grid using the letters A, O, and X. Assume that any pair of combinations not mentioned have an O rating.

11. Using the information in the following grid, determine if the department locations shown are appropriate. If not, modify the assignments so the conditions are satisfied.