4. The following information is available about a project:

Activity	Activity Time (days)	Immediate Predecessor(s)
A	3	—
B	4	—
C	5	—
D	4	—
E	7	A
F	2	B, C, D
G	4	E, F
H	6	F
I	4	G
J	3	G
K	3	H

a. Draw the network diagram.

b. Find the critical path.

5. The following information has been gathered for a project:

Activity	Activity Time (weeks)	Immediate Predecessor(s)
A	4	—
B	7	A
C	9	B
D	3	B
E	14	D
F	10	C, D
G	11	F, E

a. Draw the network diagram.

b. Calculate the slack for each activity and determine the critical path. How long will the project take?

6. Consider the following information for a project to add a drive-thru window at Crestview Bank.

Activity	Activity Time (weeks)	Immediate Predecessor(s)
A	5	—
B	2	—
C	6	—
D	2	A, B
E	7	B
F	3	D, C
G	9	E, C
H	11	F, G

a. Draw the network diagram for this project.

b. Specify the critical path.

c. Calculate the slack for activities A and D.

7. Barbara Gordon, the project manager for Web Ventures, Inc., compiled a table showing time estimates for each of the activities of a project to upgrade the company's Web page, including optimistic, most likely, and pessimistic.

a. Calculate the expected time, t_e, for each activity.

b. Calculate the variance, σ^2, for each activity.

Activity	Optimistic (days)	Most Likely (days)	Pessimistic (days)
A	3	8	19
B	12	15	18
C	2	6	16
D	4	9	20
E	1	4	7

8. Recently, you were assigned to manage a project for your company. You have constructed a network diagram depicting the various activities in the project (Figure 2.13). In addition, you have asked your team to estimate the amount of time that they would expect each of the activities to take. Their responses are shown in the following table:
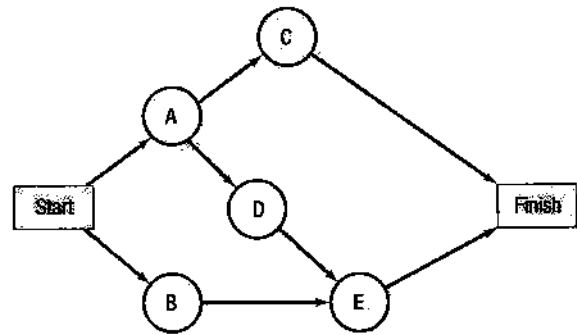
▲ FIGURE 2.13

Network Diagram for Your Company

Activity	TIME ESTIMATES (DAYS)		
	Optimistic	Most Likely	Pessimistic
A	5	8	11
B	4	8	11
C	5	6	7
D	2	4	6
E	4	7	10

18. Paul Silver, owner of Sculptures International, just initiated a new art project. The following data are available for the project:

Activity	Activity Time (days)	Immediate Predecessor(s)
A	4	—
B	1	—
C	3	A
D	2	B
E	3	C, D

   a. Draw the network diagram for the project.
   b. Determine the project's critical path and duration.
   c. What is the slack for each activity?

19. Reliable Garage is completing production of the J2000 kit car. The following data are available for the project:

Activity	Activity Time (days)	Immediate Predecessor(s)
A	2	—
B	6	A
C	4	B
D	5	C
E	7	C
F	5	C
G	5	F
H	3	D, E, G

   a. Draw the network diagram for the project.
   b. Determine the project's critical path and duration.
   c. What is the slack for each activity?

20. The following information concerns a new project your company is undertaking:

Activity	Activity Time (days)	Immediate Predecessor(s)
A	10	—
B	11	—
C	9	A, B
D	5	A, B
E	8	A, B
F	13	C, E
G	5	C, D
H	10	G
I	6	F, G
J	9	E, H
K	11	I, J

   a. Draw the network diagram for this project.
   b. Determine the critical path and project completion time.

Advanced Problems

21. The project manager of Good Public Relations gathered the data shown in Table 2.11 for a new advertising campaign.
   a. How long is the project likely to take?
   b. What is the probability that the project will take more than 38 weeks?
   c. Consider the path A–E–G–H–J. What is the probability that this path will exceed 38 weeks?

TABLE 2.11 | ACTIVITY DATA FOR ADVERTISING PROJECT

Activity	TIME ESTIMATES (WEEKS)			Immediate Predecessor(s)
	Optimistic	Most Likely	Pessimistic	
A	8	10	12	START
B	5	8	17	START
C	7	8	9	START
D	1	2	3	B
E	8	10	12	A, C
F	5	6	7	D, E
G	1	3	5	D, E
H	2	5	8	F, G
I	2	4	6	G
J	4	5	8	H
K	2	2	2	H

■

▸ **22.** Consider the office renovation project data in Table 2.12. A "zero" time estimate means that the activity could take a very small amount of time and should be treated as a numeric zero in the analysis.

a. Based on the critical path, find the probability of completing the office renovation project by 39 days.

b. Find the date by which you would be 90 percent sure of completing the project.

TABLE 2.12 | DATA FOR THE OFFICE RENOVATION PROJECT

Activity	TIME ESTIMATES (DAYS)			Immediate Predecessor(s)
	Optimistic	Most Likely	Pessimistic	
START	0	0	0	—
A	6	10	14	START
B	0	1	2	A
C	16	20	30	A
D	3	5	7	B
E	2	3	4	D
F	7	10	13	C
G	1	2	3	D
H	0	2	4	G
I	2	2	2	C, G
J	2	3	4	I
K	0	1	2	H
L	1	2	3	J, K
FINISH	0	0	0	E, F, L

▸ **23.** You are in charge of a project at the local community center. The center needs to remodel one of the rooms in time for the start of a new program. Delays in the project mean that the center must rent other space at a nearby church at additional cost. Time and cost data for your project are contained in Table 2.13. Your interest is in minimizing the cost of the project to the community center.

a. Using the *normal times* for each activity, what is the earliest date you can complete the project?

b. Suppose the variable overhead costs are $50 per day for your project. Also, suppose that the center must pay $40 per day for a temporary room on day 15 or beyond. Find the minimum-cost project schedule.

TABLE 2.13 | DATA FOR THE COMMUNITY CENTER PROJECT

Activity	Normal Time (days)	Normal Cost ($)	Crash Time (days)	Crash Cost ($)	Immediate Predecessor(s)
START	0	0	0	0	—
A	10	50	8	150	START
B	4	40	2	200	START
C	7	70	6	160	B
D	2	20	1	50	A, C
E	3	30	3	30	A, C
F	8	80	5	290	B
G	5	50	4	180	D
H	6	60	3	180	E, F
FINISH	0	0	0	0	G, H

24. The information in Table 2.14 is available for a large fund-raising project.

  a. Determine the critical path and the expected completion time of the project.

  b. Plot the total project cost, starting from day 1 to the expected completion date of the project, assuming the earliest start times for each activity. Compare that result to a similar plot for the latest start times. What implication does the time differential have for cash flows and project scheduling?

25. You are the project manager of the software installation project in Table 2.15. You would like to find the minimum-cost schedule for your project. There is a $1,000-per-week penalty for each week the project is delayed beyond week 25. In addition, your project team determined that indirect project costs are $2,500 per week.

  a. What would be your target completion week?

  b. How much would you save in total project costs with your schedule?

'TABLE 2.14 | **FUND-RAISING PROJECT DATA**

Activity	Activity Time (days)	Activity Cost ($)	Immediate Predecessor(s)
A	3	100	—
B	4	150	—
C	2	125	A
D	5	175	B
E	3	150	B
F	4	200	C, D
G	6	75	C
H	2	50	C, D, E
I	1	100	E
J	4	75	D, E
K	3	150	F, G
L	3	150	G, H, I
M	2	100	I, J
N	4	175	K, M
O	1	200	H, M
P	5	150	N, L, O

TABLE 2.15 | **DATA FOR SOFTWARE INSTALLATION PROJECT**

Activity	Immediate Predecessors	Normal Time (weeks)	Normal Cost ($)	Crash Time (weeks)	Crash Cost ($)
A	—	5	2,000	3	4,000
B	—	8	5,000	7	8,000
C	A	10	10,000	8	12,000
D	A, B	4	3,000	3	7,000
E	B	3	4,000	2	5,000
F	D	9	8,000	6	14,000
G	E, F	2	2,000	2	2,000
H	G	8	6,000	5	9,000
I	C, F	9	7,000	7	15,000