have happened, and everyone would like to do something to reduce the risks of a less remote earthquake.

b. As people age, they eventually reach a point where they should no longer be driving an automobile; yet many elderly people require their cars to buy groceries, visit friends, and receive medical care.

c. A significant portion of the fertilizers used for large-scale agriculture end up in rivers and streams adjacent to the fields, eventually finding their way to the Gulf of Mexico and contributing to ruination of that aquatic environment.

11.5 Choose the best statement of needs and objectives that was suggested for one of the topics in the previous question. Gather a group of at least five people, and use brainstorming to identify alternative ways of meeting the needs and objectives.

PROBLEMS

11.1 A company wants to construct a new factory that will have a capacity of 1 million units per year. The factory is expected cost $100 million to construct, and it should be operating within two years. The product is expected to sell for $40/unit, which is well above the expected cost of $30/unit, including the EUAC of the investment in the factory and the production cost assuming the factory operates at 95% capacity. The NPV for the project is expected to be $20 million, and the IRR is expected to be 15%. You have been asked to structure a sensitivity analysis for this project.

a. What variables would you include in the analysis, and what values would you suggest considering for each variable?

b. How would you present the results? (Describe the tables or charts that you would use—you do not have to do any of the analysis.)

11.2 A company would like to build wind farms in rural areas of New England. As of 2007, the price of oil was so high that the company believed it would make a profit if it could receive an investment tax credit of 20% from the federal government. Other initiatives were under way in the region that would reduce the demand for fossil fuels, including expanded use of water power, the use of wood-powered electrical power plants, tax incentives aimed at conservation, and greater residential use of wood stoves for heating.

a. Identify at least four key elements that you would include in developing scenarios for evaluating the potential success of the wind farms.

b. Identify at least four scenarios based on the key elements that you have identified.

CASE STUDY: WE’LL CROSS THAT BRIDGE WHEN WE COME TO IT (PART II)

This case revisits the situation that was discussed at the end of Chapter 5. The earlier case introduced the actors, the alternatives, and the issues and asked you to identify an evaluation strategy that included selection of criteria and weighting issues. Some additional information has now been gathered, and you can proceed with a more detailed analysis that leads to specific recommendations for constructing a bridge. For your convenience, the material from Chapter 5 is included at the beginning of this expanded case. The case is designed for teams of students who represent the different actors involved in the ongoing debate about which bridge is best.

Situation

Cammitribridge, a prosperous city of a million residents, is located on the north side of the Cammit River. It is adjacent to and to some extent hemmed in by a state forest to the northeast and a series of steep hills to the northwest (see map at end). The town is named for its historic bridge, first built in 1720 and most recently rebuilt in 1850. The bridge is a narrow, two-lane bridge that spans the river so as to connect Cammitribridge with the main road to the capital, Boslondale, some 100 miles away. The bridge connects to a highly scenic road that winds for several miles toward the west below sandstone cliffs along the edge of the river. Everyone in the city agrees that a new bridge is needed, for various reasons:

- Development in Cammitribridge is increasingly limited by a lack of vacant land close to the city center. On the outskirts of town, people are starting to move up the slopes of the hills, but they just aren’t much room for expansion downtown or along the major roads serving the city.
- There is considerable traffic between Cammitribridge and Boslondale, so that the old bridge is often congested, irritating those who must use it and limiting opportunities for development on the south side of the river.
- The current bridge provides little access to the land available for development south of the river. A new bridge in a new location would open up this land for development.
- The local construction industry supports the construction of a new bridge, because of the opportunity for new activity and profits.
- A consortium of private citizens, led by Canwy Bildern, has even proposed that they will replace and expand the existing bridge at their own expense if they are allowed to charge a toll of no more than $2; at the end of a 30-year period, they would turn the bridge over to the city.

There are four competing options for the bridge:

- **Bridge 1**: Expand the existing bridge at a cost of $20 million. The plan would basically build a second two-lane bridge next to the existing bridge. Once the new bridge is operating, the old bridge would be rehabilitated to handle heavier trucks and then reopened.
- **Bridge 2**: Replace the existing bridge with a new four-lane bridge at a cost of $50 million. The old bridge would be torn down upon completion of the new bridge. An additional $5 million would be required to modify the roads to match up with the new bridge.
11.1 A company wants to construct a new factory that will have a capacity of 1 million units per year. The factory is expected to cost $100 million to construct, and it should be operating within two years. The product is expected to sell for $30/unit, which is well above the expected cost of $30/unit, including the EUAC of the investment in the factory and the production cost assuming the factory operates at 95% capacity. The NPV for the project is expected to be $50 million, and the IRR is expected to be 15%. You have been asked to structure a sensitivity analysis for this project.

a. What variables would you include in the analysis, and what values would you suggest considering for each variable?

b. How would you present the results? (Describe the tables or charts that you would use—do you not have to do any of the analysis.)

CASE STUDY: WE’LL CROSS THAT BRIDGE WHEN WE COME TO IT (PART II)

This case revisits the situation that was discussed at the end of Chapter 3. The earlier case introduced the actors, the context, and asked what to identify an evaluation strategy that included selection of criteria and weighting techniques. Additional information has now been gathered, and you can proceed with a more detailed analysis that leads to specific recommendations for constructing a bridge. For your convenience, the material from Chapter 3 is included at the beginning of this expanded treatment. The case is designed for teams of students who represent the different actors involved in the ongoing debate about which bridge is best.

Situation
Caminitibridge, a prosperous city of a million residents, is located on the north side of the Caminit River. It is adjacent to and to some extent hemmed in by a state forest to the northeast and a series of steep hills to the southwest (see map at end). The town is served by its historic bridge, first built in 1730 and most recently rebuilt in 1850. The bridge is a narrow, two-lane bridge that spans the river so as to connect Caminitibridge with the main road to the south. The bridge is now a bottleneck and has been unable to handle the increase in traffic, and the cost of maintaining the bridge is high. The city council agrees that a new bridge is needed, for various reasons:

- Development in Caminitibridge is increasingly limited by a lack of vacant land close to the city center. The outskirts of town, people are starting to move up the slopes of the hills, but eventually finding their way to the Gulf of Mexico and contributing to run-off of that aquatic environment.
- The bridge’s capacity has become a bottleneck, and the city needs to upgrade its infrastructure to attract new businesses and residents.

11.2 A company would like to build wind farms in rural areas of New England. As of 2007, the price of oil was so high that the company believed it would make a profit if it could receive an investment tax credit of 20% from the federal government. Other initiatives were under way in the region that would reduce the demand for fossil fuels, including expanded use of water power, the use of wood-powered electrical power plants, tax incentives aimed at conservation, and greater residential use of wood stoves for heating.

a. Identify at least four key elements that you would include in developing scenarios for evaluating the potential success of the wind farms.

b. Identify at least four scenarios based on the key elements that you have identified.

- Bridge 3: Build a new four-lane bridge that connects to the developable land to the southeast. Since the river is wider at the location, the cost would be greater. Initial estimates are that the bridge would cost $75 million if built at the narrowest location, while access roads would cost $20 million.
- Bridge 4: A variation on Bridge 3, this option would change the bridge location slightly to improve access to the city, while requiring a longer bridge to get over the swamps; the costs would be $90 million for the bridge plus $10 million for access.

The bridge could be financed in several ways:

- The city could sell revenue bonds to the public and pay the interest on the bonds out of general tax revenue.
- The city could sell revenue bonds to the public and charge tolls on the bridge sufficiently high to pay the interest on the bonds.
- The city could authorize Mr. Belden to proceed with his plan to build a toll bridge using public money.
- The city could probably fund the required connections (but not the bridge) from its ongoing budget for road construction and maintenance.

The economic benefits from construction of the bridge fall into several categories:

- Reductions in travel time for people currently using the bridge
- Increased opportunities for development south of the river, leading to higher land values, new jobs, and greater real estate taxes for Caminitibridge

Preliminary analysis suggests that:

- Expanding or replacing the current bridge will have minor effects on traffic volume or development, since very little open land is suitable for development near the existing routes.
- Building a bridge at the cost end of town will provide a spark to development of that region; total traffic crossing the river is expected to grow quickly if a new bridge is built in that location. Also, some traffic will divert to the new bridge, reducing congestion in the city.

[Diagram: Schematic Diagram of Caminitibridge and Possible Bridge Locations]

Table 1 summarizes the expected results from constructing each of the major options. It also shows the costs expected for constructing each bridge and the current access roads. These costs can be assumed to be incurred at a uniform rate over the construction period. The travel time benefits represent the results of a network model showing the expected impacts on average commuting time for the city in the year 2015. The city normally considers travel time savings in its economic studies, using $10 per vehicle-kilometer to represent an average value of time to users. The traffic volumes are also for the year 2015; this year is currently used as a basis for the tests on the benefits of the new bridge (but not the Bridge) from its ongoing budget for road construction and maintenance.

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Description</th>
<th>Construction Cost</th>
<th>Travel Time Benefit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge 1</td>
<td>Basic four-lane bridge</td>
<td>$50 million</td>
<td>15 minutes</td>
<td>$50 million</td>
</tr>
<tr>
<td>Bridge 2</td>
<td>Expanded four-lane bridge</td>
<td>$75 million</td>
<td>12 minutes</td>
<td>$75 million</td>
</tr>
<tr>
<td>Bridge 3</td>
<td>Expanded four-lane bridge with a longer span</td>
<td>$90 million</td>
<td>10 minutes</td>
<td>$90 million</td>
</tr>
</tbody>
</table>

Questions for the Public Sector Groups
You work for the city’s transportation department. You have been asked to comment on the above alternatives and to account for the construction costs and the toll revenues over a 30-year period.

- What is the present value of the costs of building each bridge and its access roads using a discount rate of 8% per year (as required by city policy for all infrastructure projects)? To simplify the analysis, assume that all costs are incurred uniformly over the construction period.

- Assume that the city can sell 30-year bonds with an interest rate of 5% to cover all construction costs as well as interest on the bonds during the construction period (for example, at the end of year 2, 5% interest will be due on all of the bonds that had been sold at the end of the previous year). What is the total face value of the bonds that must be sold to cover all construction, access roads, and maintenance costs? (This total will equal the total amount of outstanding bonds at the time when the bridge is finished).

- Assume that annual costs for toll collection are $250,000 and maintenance costs are expected to be 5% of the construction cost for the bridge and access roads. For each new bridge, what
Table 1  Expected Costs and Benefits Related to the Bridge (preliminary and subject to change)

<table>
<thead>
<tr>
<th></th>
<th>Bridge 1</th>
<th>Bridge 2</th>
<th>Bridge 3</th>
<th>Bridge 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expand the existing bridge to 4 lanes.</td>
<td>Replace existing bridge with 4-lane bridge.</td>
<td>Build shorter bridge at east end of city.</td>
<td>Build longer, more accessible bridge at east end of city.</td>
</tr>
<tr>
<td>Bridge cost</td>
<td>$20 million</td>
<td>$50 million</td>
<td>$75 million</td>
<td>$90 million</td>
</tr>
<tr>
<td>Access roads</td>
<td>—</td>
<td>$5 million</td>
<td>$20 million</td>
<td>$10 million</td>
</tr>
<tr>
<td>Construction time</td>
<td>2 years</td>
<td>3 years</td>
<td>4 years</td>
<td>4 years</td>
</tr>
<tr>
<td>Travel time savings for current users</td>
<td>4 minutes</td>
<td>4 minutes</td>
<td>5 minutes</td>
<td>7 minutes</td>
</tr>
<tr>
<td>Total users, west bridge</td>
<td>15 million/yr</td>
<td>15 million/yr</td>
<td>12 million/yr</td>
<td>11 million/yr</td>
</tr>
<tr>
<td>Total users, east bridge</td>
<td>—</td>
<td>—</td>
<td>5 million/yr</td>
<td>6 million/yr</td>
</tr>
<tr>
<td>Maximum toll</td>
<td>$2</td>
<td>$2</td>
<td>$2</td>
<td>$2</td>
</tr>
<tr>
<td>Increase in GRP</td>
<td>$10 million</td>
<td>$12 million</td>
<td>$20 million</td>
<td>$30 million</td>
</tr>
<tr>
<td>Population</td>
<td>1.1 million</td>
<td>1.1 million</td>
<td>1.15 million</td>
<td>1.2 million</td>
</tr>
</tbody>
</table>

Questions for the Private Sector Groups
You are the financial advisor to Mr. Bildem. You need to determine whether the NPV of future tolls is sufficient to cover the NPV of the construction costs. You also need to consider the possibility of getting financing (first a construction loan that would cover the costs of construction and then, once the bridge opens, a loan with lower interest rates that would be based on toll revenues).

- What is the present value of the cost of building each bridge and its access roads, assuming that you use Mr. Bildem's discount rate of 15%?
- Assume that Mr. Bildem can get a 10% line of credit for all construction costs for the bridge. Further assume that Mr. Bildem will pay only for the bridge, requiring the city to provide the access roads as part of the deal. What will the total loan be when the bridge is open for construction? (For simplicity, assume all costs are incurred at the end of the year; the interest costs at the end of year n + 1 would equal 10% of the outstanding balance at the end of the prior year).
- You can refinance your loan once the bridge opens. Assume that the bank will let you borrow an amount that can be financed by an annual amount no greater than 50% of the average net toll revenues expected in 2015 (and the total loan cannot be greater than your construction costs).
- Will the amount of the new loan be sufficient to cover the costs of construction loan?
- If the loan is for 30 years at 8%, what will the annual payments be?
- To cover your loan payments and your share of operating costs (i.e., $250,000 plus 5% of the construction costs for the bridge), what toll would you have to charge for each bridge? Which bridge do you prefer to build? Why?

Preparation for Town Meeting
Everyone in the class has been appointed to the mayor's task force to evaluate bridge options from the perspective of the public. The people in the public sector groups are more concerned with overall economic impacts; the people in the private sector groups are more concerned with entrepreneurial opportunities for construction and development. At the meeting, you will hear reports from the head of the transportation department, Mr. Bildem, the mayor, and the head of the local high-tech development support group "Build Up or Shut Up." The group will then discuss and take a straw poll on three questions posed by the mayor:

1. Which of the bridges is the best for the city?
2. What is your recommendation concerning tolls?
3. Should the city accept Mr. Bildem's offer to build the bridge?

Agenda for Town Meeting
1. The head of Build Up or Shut Up introduces the need for a bridge and presents the criteria that should be considered.
2. Mr. Bildem presents the firm's preferred option.
3. The head of the transportation department presents city's preferred option.
4. The mayor introduces the questions and suggests criteria that should be considered.
5. General discussion.