

time value of money and the compound interest formulas are to be applied. Depreciation accounting affects the facility costs that are part of the indirect costs of products/services. Different depreciation methods will lead to more or less indirect costs for the products/services. Finally, the inventory costs are affected by the sequence in which products are introduced or withdrawn. As engineering economy foundation topics, all these concepts have been reviewed in the appendices.

Cost data may be uncertain because of factors related to the economy, market condition, political stability, labor movement, and others. For uncertain cost data, risk analysis may be needed. The Monte Carlo simulation is an efficacious method to conduct risk analyses. Several other methods are also available to account for cost uncertainties.

David Rockefeller said, "Success in business requires training, discipline and hard work. But, if you're not frightened by these things, the opportunities are just as great today as they ever were." ABC is an example of such value-adding opportunities, which were developed due to discipline and hard work.

Managers need to become well versed in cost accounting.

### Questions

1. The company is evaluating two specific proposals to market a new product. The current interest rate is 10%.

Proposal A calls for setting up an in-house manufacturing shop to make the product, requiring an investment of \$500,000. The expected profits for the first to fifth years are \$150,000, \$200,000, \$250,000, \$150,000, and \$100,000, respectively.

Proposal B suggests that the manufacturing operation be outsourced by contracting an outside shop, requiring a front-end payment of \$300,000. The expected profits for the first to fifth years are \$50,000, \$150,000, \$200,000, \$300,000, and \$200,000, respectively. The expected profits would be lower in earlier years due to third-party markup.

Which proposal should the company accept?

2. The company's warehouse has been busy taking in and shipping out vendor-supplied automotive parts. Table 6.13 shows the warehouse's activities in eight consecutive periods, during which time the price of the parts has steadily increased.

**TABLE 6.13**  
FIFO and LIFO Computation

| Period | Units In | Unit Price Paid (\$) | Units Out |
|--------|----------|----------------------|-----------|
| 1      | 150      | 100                  | —         |
| 2      | 250      | 120                  | —         |
| 3      | —        | —                    | 180       |
| 4      | —        | —                    | 100       |
| 5      | 100      | 130                  | —         |
| 6      | —        | —                    | 200       |
| 7      | 100      | 140                  | —         |
| 8      | —        | —                    | 80        |

- a. Determine the total LIFO prices for each stock withdrawal in periods 3, 4, 6, and 8.
  - b. Repeat the same price computation using the FIFO technique.
3. A dam is being considered on a river that periodically overflows. Each time the river overflows, it causes about \$600,000 in damages. The project horizon is 40 years. A 10% interest rate is being used.

Three different designs are available, each with different costs and storage capacities (see Table 6.14).

The U.S. weather service has provided a statistical analysis of annual rainfall in the area draining into the river (see Table 6.15).

Assume that the dam requires no annual maintenance, has zero salvage value at the end of its 40-year life, and is essentially empty at the start of each annual rainfall season. Which design alternative would you choose?

4. The NPV equation (Equation 6.23) is described as follows:

$$NPV = -P + \sum_{m=1}^n \frac{C(m)}{(1+i)^m} + \frac{CR}{(1+i)^n} \quad (6.23)$$

$$m = 1 \text{ to } n$$

The NPV equation is important for evaluating project-based investments. It is also a basic equation for defining the concept of "value addition," and has broad philosophical implications for what engineers do. Explain.

TABLE 6.14  
Design Options

| Design Alternatives | Cost (\$) | Maximum Storage Capacity (units) |
|---------------------|-----------|----------------------------------|
| A                   | 500,000   | 1                                |
| B                   | 625,000   | 1.5                              |
| C                   | 900,000   | 2.0                              |

TABLE 6.15  
Annual Rainfall and Probability

| Units Annual Rainfall | Probability |
|-----------------------|-------------|
| <0.1                  | 0.1         |
| 0.1-0.5               | 0.6         |
| 0.6-1.0               | 0.15        |
| 1.1-1.5               | 0.1         |
| 1.6-2.0               | 0.04        |
| 2.0 or more           | 0.01        |

5. A manufacturing company makes three products, A, B, and C. The fixed FO is \$60,000, consisting of \$10,000 for material handling, material waste, and procurement; \$30,000 for rent and utilities; and \$20,000 for safety and canteen costs. Other costs are shown in Table 6.16.
- Determine the product cost for products A, B, and C, using the ABC method.
  - If products A, B, and C are sold at \$400, \$350, and \$150 per unit, respectively, what is the gross profit for each product?
  - What is the company's total gross profit per month if all units produced are sold?
6. A company makes and sells three technology products: A, B, and C. It has a production plant with 17,000 square feet of floor area, consisting of machine setup (2000 square feet), machining operation (9000 square feet), assembly (4000 square feet), and inspection, packaging, and shipping activities (2000 square feet).  
The total annual expenditure for the plant is \$200,000 for depreciation, \$700,000 for utilities, \$20,000 for phone and travel services, \$150,000 for manufacturing supports, \$200,000 for procurement, and \$150,000 for supervision.  
The labor hours and material costs required to manufacture the products are shown in Table 6.17.  
The labor charges are \$25 per hour for machine setup, \$35 per hour for machining operation, \$30 per hour for assembly, and \$20 per hour for inspection, packing, and shipping.  
The company plans to sell Product A at \$5000 per unit, Product B at \$4,500 per unit, and Product C at \$4,100 per unit. All products manufactured during the year

TABLE 6.16  
Product Costs

|                                     | Product A | Product B | Product C |
|-------------------------------------|-----------|-----------|-----------|
| Number of units produced per month  | 250       | 400       | 900       |
| Total material costs per month (\$) | 5000      | 8000      | 4000      |
| Labor hours per unit                | 4         | 3.5       | 1.5       |
| Labor rate per unit (\$ per hour)   | 25        | 20        | 30        |
| Machine hour per unit (hour)        | 1         | 1         | 3         |

TABLE 6.17  
Manufacturing Costs for Three Products

|   | A   | B   | C   |
|---|-----|-----|-----|
| Machine setup (hours)                     | 2   | 3   | 4   |
| Machine operation (hours)                 | 16  | 12  | 8   |
| Assembly (hours)                          | 4   | 3   | 2   |
| Inspection/packing/shipment (hours)       | 2   | 2   | 2   |
| Raw materials/unit of product (\$)        | 950 | 430 | 640 |
| Purchased components/unit of product (\$) | 100 | 80  | 90  |
| Outsourced service/unit of product (\$)   | 20  | 30  | 40  |
| Number of units produced per year         | 700 | 900 | 550 |

are assumed to be sold successfully. Apply the activity-based costing technique to determine the product cost and individual gross margin for each product.

7. You are considering a good-looking Toyota hybrid car priced at \$28,000 or an elegant GM luxury car at \$24,000. The fuel efficiency is rated at 50 miles per gallon for the Toyota and 25 miles per gallon for the GM. The annual maintenance cost for both cars is about 0.5% of the car price. The gasoline in the local market is selling at \$2.00 per gallon. The cars are to be driven about 10,000 miles per year. You plan to keep your car for five years only. At the end of the fifth year, the resale values of the Toyota and the GM are about 40% and 30%, respectively, of their original prices. The interest rate is 6%.

Which car is the better choice from the standpoint of costs?

8. Company X manufactures automotive door panels that may be made of either sheet metal or plastic sheet molding (glass fiber-reinforced polymer). Sheet metal bends well to the high-volume stamping process and has a low material cost. Plastic sheet molding meets the required strength and corrosion resistance and has a lower weight. The plastic-forming process involves a chemical reaction and has a slower cycle time. Table 6.18 summarizes the cost components for each.

Assuming that the machinery and tooling have no salvage value at the end of their respective equipment lives, what is the annual production volume that would make the plastic panel more economical?

For production volume up to 536,156 panels per year, the plastic panels are more economical.

9. Company X produces two products, A and B. Table 6.19 summarizes the cost structures of these two products over a three-month period.

TABLE 6.18

Cost Components for Door Panels

| Description                        | Plastic   | Sheet Metal |
|------------------------------------|-----------|-------------|
| Material cost (\$ per panel)       | 5         | 2           |
| DL cost (\$ per hour)              | 40        | 40          |
| FO (\$ per year)                   | 500,000   | 400,000     |
| Maintenance expenses (\$ per year) | 100,000   | 80,000      |
| Machinery investment (\$)          | 3 million | 25 million  |
| Tooling investment (\$)            | 1 million | 4 million   |
| Equipment life (years)             | 10        | 15          |
| Cycle time (minutes per panel)     | 2         | 0.1         |
| Interest rate (%)                  | 6         | 6           |

TABLE 6.19

Cost Structures over Three Months

|                                | Product A | Product B |
|--------------------------------|-----------|-----------|
| Selling price (\$ per unit)    | 10        | 12        |
| Variable cost (\$ per unit)    | 5         | 10        |
| Fixed costs (\$)               | 600       | 2,000     |
| Machining time (hour per unit) | 0.5       | 0.25      |

The company's manufacturing operation is limited to 30,000 machine hours available per a three-month period. Furthermore, because of a prior sales commitment, the company must produce at least 1000 units of Product B. Determine the maximum profit the company can achieve in a three-month period.

10. *Buffalo Best Company* markets three products for sale. Product A, Product B, and Product C. Its production plant, which is located in the city of Buffalo, occupies 20,000 square feet of space. The use of this space is carefully planned as follows:
- Product assembly: 5000 square feet
  - Machine setup: 2500 square feet
  - Machining operation: 10,000 square feet
  - Inspection, packaging, and shipping: 2500 square feet
- This plant has an expenditure of
- \$200,000 for supervision
  - \$250,000 for procurement
  - \$250,000 for depreciation
  - \$750,000 for utilities
  - \$25,000 for phones and travel expenses
  - \$175,000 for manufacturing supports

Each of the three products that this company makes requires different labor hours and materials costs, as shown in Table 6.20.

The labor charges of the company are as follows:

| # | Type of Labor Hours         | \$/hour |
|---|-----------------------------|---------|
| 1 | Machine setup               | \$40.00 |
| 2 | Machine operation           | \$50.00 |
| 3 | Assembly                    | \$35.00 |
| 4 | Inspection/packing/shipping | \$30.00 |

The company will sell the products at the prices shown in Table 6.21.

TABLE 6.20

Buffalo Best Company Operations Data

| # | Requirements (per unit of products)   | A    | B    | C   |
|---|---------------------------------------|------|------|-----|
| 1 | Machine setup (hours)                 | 2    | 4    | 5   |
| 2 | Machine operation (hours)             | 20   | 15   | 12  |
| 3 | Assembly (hours)                      | 5    | 4    | 3   |
| 4 | Inspection/packing/shipment (hours)   | 3    | 3    | 3   |
| 5 | Raw material (\$)                     | 1000 | 500  | 700 |
| 6 | Purchased parts needed (\$)           | 150  | 120  | 130 |
| 7 | Purchased services (\$)               | 30   | 40   | 50  |
| 8 | Number of units produced per year (-) | 800  | 1000 | 700 |

TABLE 6.21

## Unit Prices

| # | Products  | Price/unit |
|---|-----------|------------|
| 1 | Product A | \$6000     |
| 2 | Product B | \$5000     |
| 3 | Product C | \$4000     |

All products made by the Buffalo Best Company are assumed to have successful sales rates.

- a. Apply activity-based costing to determine the unit cost and the individual gross margin for each of Product A, B, and C. Show the detailed computations.
  - b. Which product has the highest gross margin percentage?
11. Monte Carlo simulations is a mathematical tool often used in engineering and business to solve complex problems involving uncertainties or risks.
- a. Explain the technological foundation of this tool?
  - b. How can it be applied? Discuss the inputs to and outputs from Monte Carlo simulation applications.
  - c. What specific benefits may be derived from applying this tool, in comparison with those that can be readily obtained from employing a deterministic model in cost estimation, such as using an Excel spreadsheet program?
12. Employee A is about to retire. Based on his long tenure with the company, he is entitled to use his unused sick leave to pay for health insurance upon retirement. His current sick leave benefit is estimated to be worth \$3156 annually. The health insurance premium is estimated to be \$2532 per year for family coverage and \$588 for single coverage, and these rates are projected to increase by 3% per year into the future. He has two options.

Option one is to take the full amount of \$3156 now, which will continue during his lifetime. Afterwards, his spouse will need to pay for the single coverage premium out of her own pocket. He will receive no refund from the company, even though his sick leave benefit (\$3156) exceeds the family coverage premium (\$2532) initially.

Option two is to take only 70% of the full amount (\$2,209) during his lifetime, and this benefit is guaranteed to continue beyond his death to cover the health insurance premium for the spouse, should the spouse survive him.

Currently, Employee A is 73 years old and has a life expectancy of 11 more years. His spouse is 70 and her life expectancy is 18 years. Assume the cost of money is 4%, which option is better for Employee A and his spouse?

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## Appendices

### Appendix 6.A: Basic Terms in Cost Accounting

Managers need to become familiar with the standard vocabulary used by cost accountants or cost engineers, as costs are important elements for corporate performance evaluation,