CHAPTER TEN

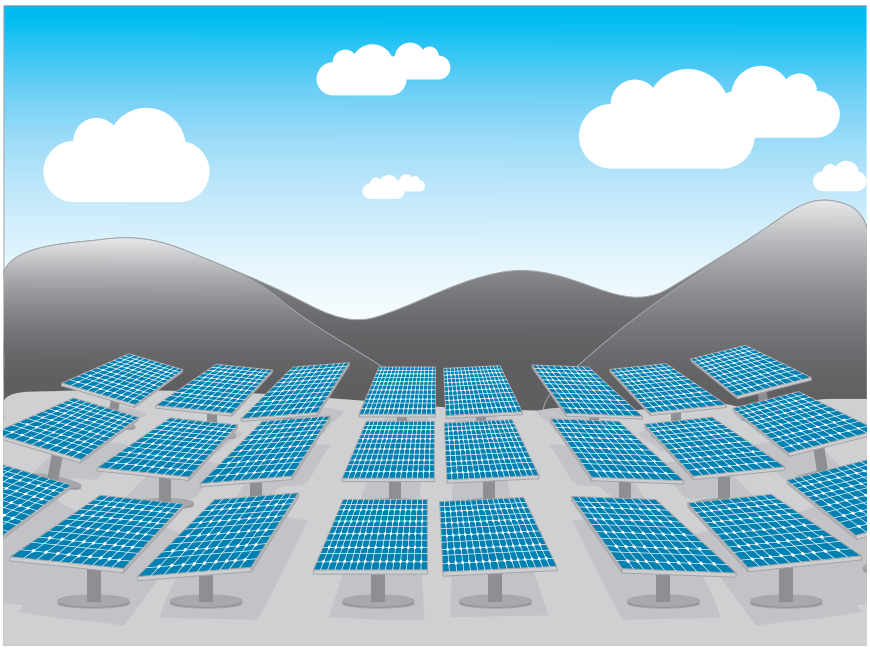
Project Cash-Flow Analysis

California Valley Solar Ranch project[1] NRG Energy Inc. is the leading power company in the United States, built on the largest and most diverse generation portfolio. One of the generation assets includes the 250-MW California Valley Solar Ranch (CVSR) photovoltaic (PV) generating facility acquired from SunPower. It is one of the world's largest operating solar PV power plants. The uniqueness of CVSR is that solar PV panels use a tracking system that tracks the sun's movement during the day, increasing energy capture by up to 25% over conventional fixed-tilt systems. The electricity generated by CVSR is enough to serve a yearly average of 100,000 homes. The project is also expected to offset approximately 336,000 metric tons of greenhouse gas emissions each year of operation. In financing the CVSR project, NRG has secured a $1.2 billion construction loan from the U.S. Department of Energy at an exceptionally low interest rate of about 3.5%. The plant is expected to cost $1.6 billion to build. Some of the highlights of the project is as follows[2]:

- The federal loan guarantee alone is worth about $25 million to NRG over the life of the loan.
- When construction is complete, NRG is eligible to receive a $430 million from the Treasury Department, 30% of their cost as a cash grant upfront instead of taking other tax breaks gradually over several years.
- Under the California State Law passed to encourage the construction of more solar projects, NRG will not have to pay property taxes to San Luis Obispo County on its solar panels. The savings are estimated to be $14 million a year.

[1] NRG, "California Valley Solar Ranch Project," (http://www.nrg.com/renewables/projects/generation/california-valley-solar-ranch/).

[2] Eric Lipton and Clifford Krauss, "A Gold Rush of Subsidies in Clean Energy Search," *The New York Times*, November 11, 2011.



- The local utility, Pacific Gas & Electric (P.G. & E.), has to buy the plant's power for 25 years at the rate of $150 to $180 a megawatt-hour from NRG.
- The extra revenue generated from the higher rates over the life of the projects amounts to a present value of $462 million subsidy.
- Additional depreciation tax breaks for renewable energy plants could save the company an additional $110 million.
- NRG expects earnings of at least $300 million a year before interest, taxes, depreciation, and amortization from all of its solar projects combined, making these investments some of the more lucrative pieces in its sprawling portfolio.

In summary, the total value of all those subsidies in today's dollars is about $1.4 billion, leading to an expected rate of return of 25% for the project's equity investors. NRG, which initially is investing about $400 million of its own money in the project, expects to get all of its equity back in 2–5 years.

On what basis should NRG justify its $1.6 billion investment in the solar project? Clearly NRG will continue to expend tens of millions dollars to develop the more efficient technology, and it will need to spend more to build and maintain the necessary generating facilities. The question is how to estimate the projected cash flows from the Solar Ranch project—such as potential power sales revenues and all other operating expenses associated with solar power generation?

To justify any investment, we need the detailed project cash flows over the estimated product life. Projecting cash flows is the most important—and the most difficult—step in the analysis of any capital project. Typically, a capital project will initially require investment outlays and only later produces annual net cash inflows. A great many variables are involved in estimating future cash flows, and many individuals, ranging from engineers to cost accountants and marketing executives, participate in the process. This chapter provides the general principles on which the determination of a project's cash flows is based.

10.1 Understanding Project Cost Elements

First, we need to understand the types of costs that must be considered in estimating project cash flows. Because there are many types of costs, each is classified differently, according to the immediate needs of management. For example, engineers may want cost data in order to prepare external reports, prepare planning budgets, or make decisions. Also, different usage cost data demand a different classification and definition of cost. For example, the preparation of external financial reports requires the use of historical cost data whereas decision making may require current cost or estimated future cost data.

10.1.1 Classifying Costs for Manufacturing Environments

Our initial focus in this chapter is on manufacturing companies because their basic activities (such as acquiring raw materials, producing finished goods, and marketing) are commonly found in most other businesses.

Manufacturing Costs

Many manufacturing costs incurred by a typical manufacturer are exhibited and classified in Figure 10.1. In converting raw materials into finished goods, a manufacturer incurs the various costs of operating a factory. Most manufacturing companies divide manufacturing costs into three broad categories—direct materials, direct labor, and manufacturing overhead.

- **Direct Materials:** Direct raw materials are any materials that are used in the final product and that can be easily traced into it. Some examples are wood in furniture, steel in bridge construction, paper in printed products, and fabric in clothing. It is also important to conceptualize that the finished product of one company can become the raw materials of another company. For example, the computer chips produced by Broadcom® are a raw material used by Apple in its smartphones.

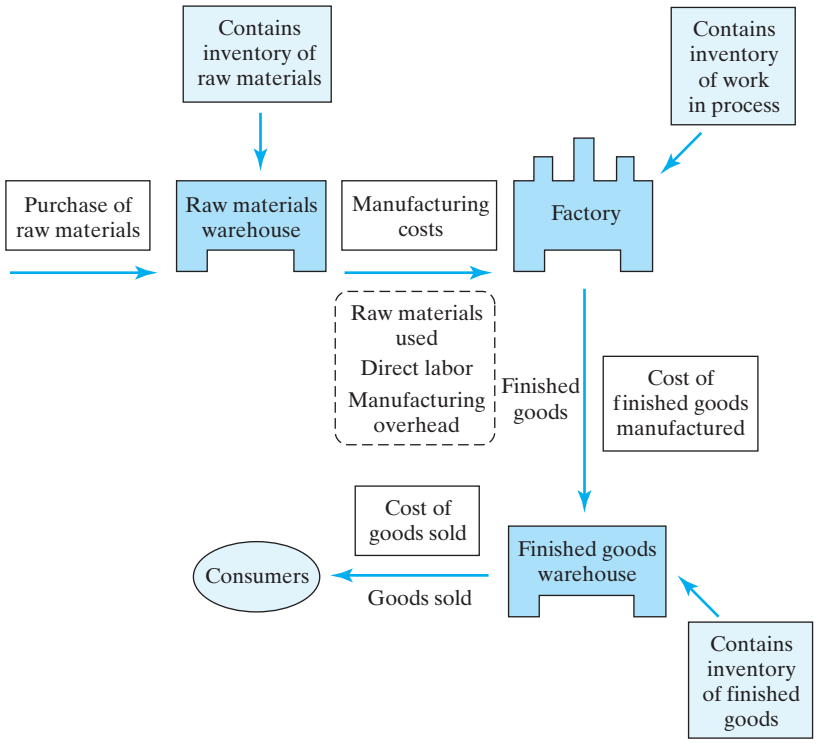


Figure 10.1 Various types of manufacturing costs.

- **Direct Labor:** Just as the term "direct materials" refers to materials costs for the final product, "direct labor" refers to those labor costs that go into the fabrication of a product. The labor costs of assembly-line workers, for example, would be direct labor costs as would the labor costs of welders in metal-fabricating industries, carpenters and bricklayers in home-building businesses, and machine operators in various manufacturing operations.
- **Manufacturing Overhead:** The third type of manufacturing cost, manufacturing overhead, includes all costs of manufacturing except direct materials and direct labor. In particular, it includes such items as indirect materials,[3] indirect labor,[4] maintenance and repairs on production equipment, heat and light, property taxes, depreciation, insurance on manufacturing facilities, and overtime premium. Unlike direct materials and direct labor, manufacturing overhead is not easily

[3] Sometimes, it may not be worth the effort to trace the costs of relatively insignificant materials to the finished products. Such minor items would include the solder used to make electrical connections in a computer circuit board or the glue used to bind this textbook. Materials such as solder and glue are called indirect materials and are included as part of manufacturing overhead.

[4] Sometimes, we may not be able to trace some of the labor costs to the creation of a product. We treat this type of labor cost as a part of manufacturing overhead along with indirect materials. Indirect labor includes the wages of janitors, supervisors, material handlers, and night security guards. Although the efforts of these workers are essential to production, it would be either impractical or impossible to trace their costs to specific units of product. Therefore, we treat such labor costs as indirect labor.

traceable to specific units of output. In addition, many manufacturing overhead costs do not change as output changes as long as the production volume stays within the capacity.

Typically, the combined cost of direct materials, direct labor, and manufacturing overhead is commonly known as "**Cost of Goods Manufactured** (or **Sold**)."

Nonmanufacturing Costs

There are two additional types of cost incurred to support any manufacturing: (1) operating costs, such as warehouse leasing and vehicle rentals and (2) marketing (or selling) and administrative costs. Marketing or selling costs include all expenses necessary to secure customer orders and get the finished product or service into the customer's operations. Cost breakdowns of these types provide data for control over selling and administrative functions in the same way that manufacturing-cost breakdowns provide data for control over manufacturing functions. For example, a company incurs costs for the following nonmanufacturing items:

- **Overhead:** Heat and light, property taxes, depreciation, and similar items associated with its selling and administrative functions.
- **Marketing:** Advertising, shipping, sales travel, sales commissions, and sales salaries.
- **Administrative Functions:** Executive compensation, general accounting, public relations, and secretarial support. Administrative costs include all executive, organizational, and clerical costs associated with the general management of an organization.

10.1.2 Classifying Costs for Financial Statements

For purposes of preparing financial statements, we often classify costs as either period costs or product costs. To understand the difference between period costs and product costs, we must introduce the matching concept essential to accounting studies. In financial accounting, the **matching principle** states that *the costs incurred to generate particular revenue should be recognized as expenses in the same period that the revenue is recognized*. This matching principle is the key to distinguishing between period costs and product costs. Some costs are matched against periods and become expenses immediately. Other costs, however, are matched against products and do not become expenses until the products are sold, which may be in the following accounting period.

Period Costs

Costs that are charged to expenses in the period they are incurred are **period costs**. The underlying assumption is that the associated benefits are received in the same period as the expenses are incurred. Some specific examples of period costs are all general and administrative expenses, selling expenses, insurance, and income-tax expenses. Advertising costs, executive salaries, sales commissions, public-relations costs, and the other nonmanufacturing costs discussed earlier would also be period costs. Such costs are not related to the production and flow of manufactured goods but are deducted from revenue in the income statement. In other words, period costs will appear on the income statement as expenses in the time period in which they occur.

Product Costs

Some costs are better matched against products than they are against periods. Costs of this type, called **product costs**, include those involved in the purchase or manufacturing of goods. In the case of manufactured goods, these costs consist of direct materials, direct labor, and manufacturing overhead. Product costs are not viewed as expenses; rather, they are the cost of creating inventory. Thus, product costs are considered an asset until the related goods are sold. At this point of sale, the costs are released from inventory as expenses (typically called **cost of goods sold**) and matched against sales revenue. Since product costs are assigned to inventories, they are also known as *inventory costs*. In theory, product costs include all manufacturing costs—that is, all costs relating to the manufacturing process. Product costs appear on financial statements when the inventory (or final good) is sold, not when the product is manufactured.

Cost Flows in a Manufacturing Company

To understand product costs more fully, we now look briefly at the flow of costs in a manufacturing company. By doing so, we will be able to see how product costs move through the various accounts and affect the balance sheet and the income statement in the course of the manufacture and sale of goods. The flows of period costs and product costs through the financial statements are illustrated in Figure 10.2. All product costs filter through the balance-sheet statement in the name of "inventory cost." If a product is sold, its inventory costs in the balance-sheet statement are transferred to the income statement in the name of "cost of goods sold." There are three types of inventory cost reflected in the balance sheet:

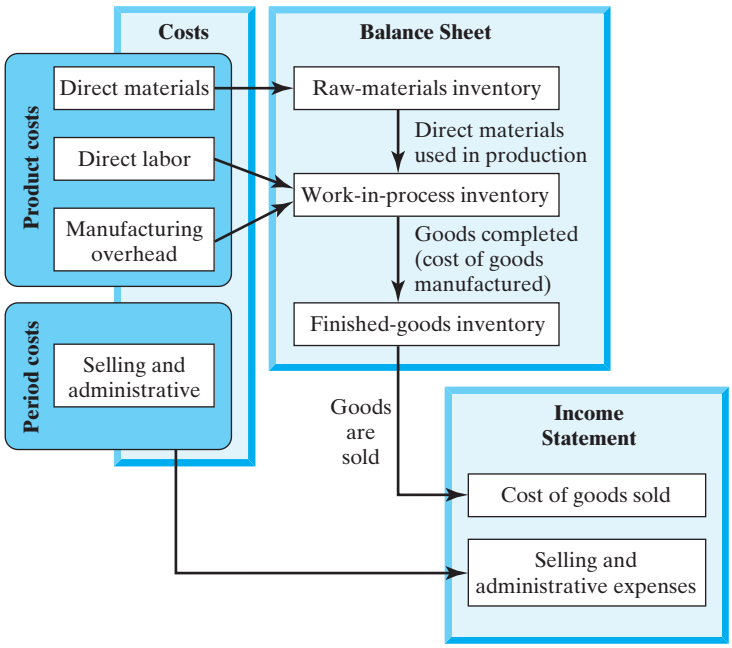


Figure 10.2 Cost flows and classifications in a manufacturing company.

- **Raw-materials inventory** represents the unused portion of the raw materials on hand at the end of the fiscal year.
- **Work-in-process inventory** consists of the partially completed goods on hand in the factory at year-end. When raw materials are used in production, their costs are transferred to the work-in-process inventory account as direct materials. Note that direct-labor costs and manufacturing overhead costs are also added directly to the work-in-process entry. The **work-in-process** concept can be viewed as the assembly line in a manufacturing plant where workers are stationed and where products slowly take shape as they move from one end of the assembly line to the other.
- **Finished-goods inventory** shows the cost of finished goods on hand and awaiting sale to customers at year end. As goods are completed, accountants transfer the corresponding cost in the work-in-process account into the finished-goods account. Here, the goods await sale to a customer. As goods are sold, their cost is transferred from finished goods into cost of goods sold (or **cost of revenue**). At this point, we finally treat the various material, labor, and overhead costs that were involved in the manufacture of the units being sold as *expenses* in the income statement.

10.1.3 Classifying Costs for Predicting Cost Behavior

In project cash-flow analysis, we need to predict how a certain cost will behave in response to a change in activity. For example, a manager may want to estimate the impact that a 5% increase in production will have on the company's total wages before a decision to alter production is made. **Cost behavior** describes how a typical cost will react or respond to changes in the level of business activity.

Volume Index

In general, the operating costs of any company are likely to respond in some way to changes in its operating volume. In studying cost behavior, we need to determine some measurable volume or activity that has a strong influence on the amount of cost incurred. The unit of measure used to define volume is called a **volume index**. A volume index may be based on production inputs (such as tons of coal processed, direct labor-hours used, or machine-hours worked) or on production outputs (such as number of kilowatt-hours generated). Take a vehicle for example: the number of miles driven per year may be used as a volume index. Once we identify a volume index, we try to find out how costs vary in response to changes in this volume index.

Fixed and Variable Costs

Accounting systems typically record the cost of resources acquired and track their subsequent usage. Fixed costs and variable costs are the two most common cost behavior patterns. The costs in an additional category known as "mixed (semivariable) costs" contain two parts: the first part of the cost is fixed, and the other part is variable as the volume of output varies.

- ***Fixed Costs:*** The costs of providing a company's basic operating capacity are known as its **fixed costs** or **capacity costs**. For a cost item to be classified as fixed, it must have a relatively wide span of output for which costs are expected to remain constant. (See Figure 10.3.) This span is called the **relevant range**. In other words, fixed costs do not change within a given period although volume may change. For our previous automobile example, the annual insurance premium, property tax,

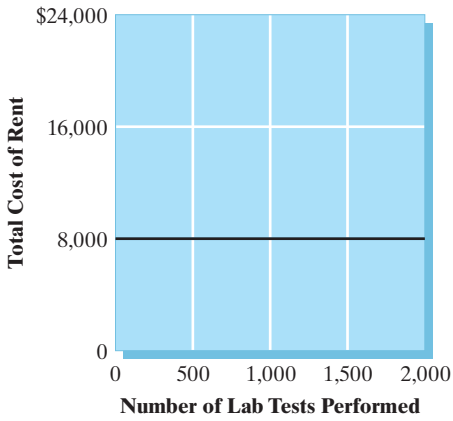


Figure 10.3 Fixed-cost behavior.

and license fee are fixed costs, since they are independent of the number of miles driven per year. Some common examples of fixed costs are building rents; depreciation of buildings, machinery, and equipment; and salaries of administrative and production personnel.

- ***Variable Costs:*** In contrast to fixed operating costs, variable operating costs have a close relationship to the level of volume. (See Figure 10.4.) If, for example, volume increases 10%, a total variable cost will also increase by approximately 10%. Gasoline is a good example of a variable automobile cost, as fuel consumption is directly related to miles driven. Similarly, the tire replacement cost will also increase as a vehicle is driven more. In a typical manufacturing environment, direct labor and material costs are major variable costs. The difference between the unit sales price and the unit variable cost is known as the **unit contribution margin**. We could express the contribution margin in two ways:

$$\text{Unit contribution margin} = \text{Unit sales price} - \text{Unit variable cost.}$$

$$\text{Contribution margin} = \text{Total sales revenue} - \text{Total variable costs.}$$

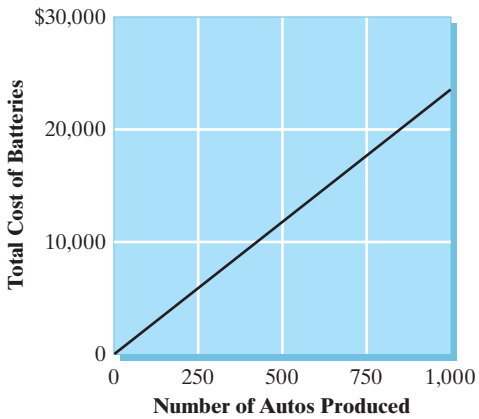


Figure 10.4 Variable-cost behavior.

The first equation expresses the contribution margin on a unit basis whereas the second formula does so in terms of total volume. This means each unit sold contributes toward absorbing the company's fixed costs.

Mixed Costs

Some costs do not fall precisely into either the fixed or the variable category but contain elements of both. We refer to these costs as **mixed costs** (or **semivariable costs**). In our automobile example, **depreciation** (loss of value) is a **mixed cost**. Some depreciation occurs simply from the passage of time regardless of how many miles a car is driven, and this amount represents the fixed portion of depreciation. On the other hand, the more miles an automobile is driven a year, the faster it loses its market value, and this amount represents the variable portion of depreciation. A familiar example of a mixed cost in manufacturing is the cost of electric power. Some components of power consumption, such as lighting, are independent of operating volume while other components are likely to vary directly with volume (e.g., number of machine-hours operated).

Break-Even Sales Volume

As mentioned earlier, contribution margin is the amount remaining from sales revenue after variable expenses have been deducted. Thus, it is the amount available to cover fixed expenses—whatever remains becomes profit. If the contribution margin is not sufficient to cover the fixed expenses, a loss occurs for the period. Therefore, the **break-even point** can be defined either as the point where total sales revenue equals total expenses, variable and fixed, or as the point where the total contribution margin equals the total fixed expenses:

$$\text{Break-even point} = \frac{\text{Fixed expenses}}{\text{Unit contribution margin}}.$$

Once the break-even point has been reached, net income will increase by the unit contribution margin for each additional unit sold.

EXAMPLE 10.1 Break-Even Sales Volume

Ashland Company manufactures and sells a single product. The company's sales and expenses for a recent month based on a sales volume of 25,000 units are as follows:

	Total	Per Unit
Sales	$500,000	$20
Less variable expenses	$250,000	$10
Contribution margin	$250,000	$10
Less fixed expenses	$150,000	
Income (before tax)	$100,000	

(a) What is the monthly break-even point in units sold and in sales dollars?
(b) How many units would have to be sold each month to earn a minimum target net income of $50,000?

DISSECTING THE PROBLEM

Given: Financial data as provided in the preceding table.

Find: (a) The monthly break-even point and (b) the number of unit sales required to achieve the target income of $50,000 before tax.

METHODOLOGY

Compute the monthly break-even point and then the unit sales.

SOLUTION

(a) Monthly break-even point:

$$\text{Break-even point} = \frac{\$150{,}000}{\$10} = 15{,}000 \text{ units.}$$

(b) Number of units to be sold to make $50,000 profit before tax:

$$\text{Desired-profit point} = \frac{\$150{,}000 + \$50{,}000}{\$10} = 20{,}000 \text{ units.}$$

COMMENTS: We can express the relationships among revenue, cost, profit, and volume graphically by preparing a **cost-volume-profit graph** as shown in Figure 10.5. The break-even point (15,000 units) is where the total revenue and total expense lines cross. We can also read off the units sold to attain the target profit from the same chart (20,000 units). It shows clearly that once the fixed costs are covered, the unit contribution margin is fully available for meeting profit requirements.

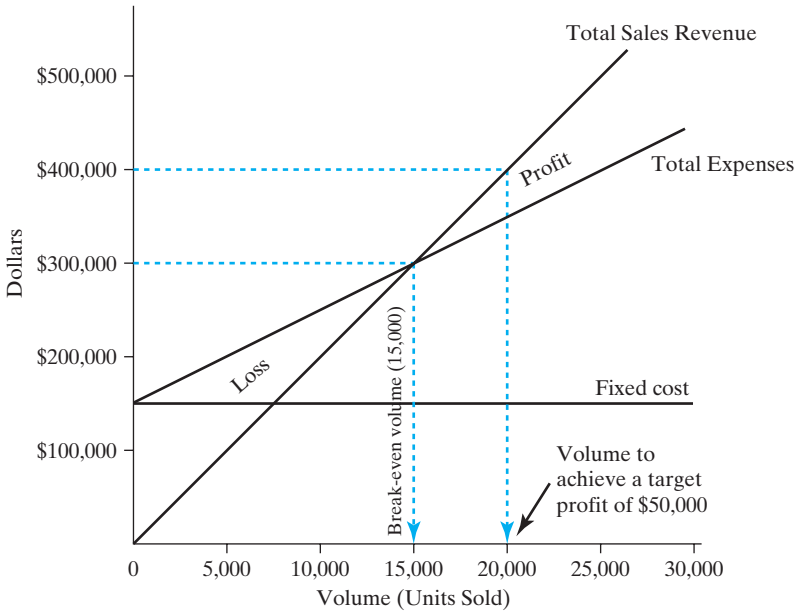


Figure 10.5 Cost-Volume-Profit graph showing that the break-even point occurs at 15,000 units.

10.2 Why Do We Need to Use Cash Flows in Economic Analysis?

Traditional accounting stresses net income as a means of measuring a firm's profitability, but it is also desirable to discuss why cash flows are relevant data to be used in project evaluation. As noted in Section 10.1.2, net income is an accounting measure based, in part, on the **matching principle**. Costs become expenses as they are matched against revenue. The actual timing of cash inflows and outflows is ignored.

Over the life of a firm, net aggregate incomes and net aggregate cash inflows will usually be the same. However, the timing of incomes and cash inflows can differ substantially. Remember the time value of money, it is better to receive cash now rather than later because cash can be invested to earn more cash. (You cannot invest net income.) For example, consider the following income and cash-flow schedules of two firms over two years:

		Company *A*	Company *B*
Year 1	Net income	$1,000,000	$1,000,000
	Cash flow	$1,000,000	$0
Year 2	Net income	$1,000,000	$1,000,000
	Cash flow	$1,000,000	$2,000,000

Both companies have the same amount of net income and cash sum over two years, but Company *A* returns $1 million cash yearly while Company *B* returns $2 million at the end of the second year. Company *A* could invest the $1 million it receives at the end of the first year at 10%, for example. In this case, while Company *B* receives only $2 million in total at the end of the second year, Company *A* receives $2.1 million in total.

Cash Flow versus Net Income

Net income: An accounting means of measuring a firm's profitability by the matching concept. Costs become expenses as they are matched against revenue. The actual timing of cash inflows and outflows is ignored.

Cash flow: Given the time value of money, it is better to receive cash now rather than later because cash can be invested to earn more money. This factor is the reason that cash flows are relevant data to use in project evaluation.

10.3 Income-Tax Rate to Be Used in Project Evaluation

As we have seen in Chapter 9, average income-tax rates for corporations are a flat 21% regardless of the level of taxable income. Suppose that a company now paying a federal tax rate of 21% on its current operating income is considering a profitable investment. What tax rate should be used in calculating the taxes on the investment's projected income? As we will explain, the choice of the rate depends on the incremental effect the investment has on taxable income. In other words, *the tax rate to use is the rate that applies to the additional taxable income projected in the economic analysis*. For business, in addition to federal income taxes, state income taxes are levied on corporations in most states. State income taxes are an allowable deduction in computing federal taxable income, and we may consider explicitly the effects of state income taxes in two ways.

- The first approach is to estimate explicitly the amount of state income taxes before calculating the federal taxable income. We then reduce the federal taxable income by the amount of the state taxes and apply the marginal tax rate to the resulting federal taxes. The total taxes would be the sum of the state taxes and the federal taxes.
- The second approach is to calculate a single tax rate that reflects both state and federal income taxes. This single rate is then applied to the federal taxable income without subtracting state income taxes. Taxes computed in this fashion represent total taxes. If state income taxes are considered, the combined state and federal marginal tax rate is normally higher than 21%. Since state income taxes are deductible as expenses in determining federal taxes, the marginal rate for combined federal and state taxes can be calculated with the expression.

$$t_m = t_f + t_s - (t_f \times t_s)$$

where

t_m = combined marginal tax rate
t_f = federal marginal tax rate
t_s = state marginal tax rate

This second approach provides a more convenient and efficient way to handle taxes in an economic analysis in which the marginal tax rates are known. For example, for a corporation whose state and local income tax rate is 5%, the incremental tax rate will be stated as combined marginal tax rate of

$$t_m = 0.21 + 0.05 - (0.21 \times 0.05) = 24.95\%$$

For most corporations, these would be about 25%, but they vary from state to state. As you will see in many examples and practice problems in this text, we assume 25% as an approriate tax rate to use in a typical economic analysis based on this reasoning.

EXAMPLE 10.2 Calculation of Net Income Attributable to New Project

Tucker Enterprise Inc. is considering a project that requires a numerically controlled (NC) machine for $28,000 (year 0) and plans to use it for five years, after which time it will be scrapped. The allowed depreciation deduction during the first year is $4,000 because the equipment falls into the seven-year MACRS property category. (The first-year depreciation rate is 14.29%.) The cost of the goods produced by this NC machine should include a charge for the depreciation of the machine. Suppose the company estimates the following revenues and expenses, including the depreciation for the first operating year:

- Gross income = $50,000
- Cost of goods sold (excluding depreciation) = $20,000
- Depreciation on the NC machine = $4,000
- Operating expenses = $6,000

Without the project, the company's taxable income from regular business operations amounts to $20 million, which places the company in the combined marginal tax rate of 25%. Compute the net income from the project during the first year.

DISSECTING THE PROBLEM

A corporation with $20 million taxable income will have both marginal and average federal tax rates of 21%. That means the taxable income from the project will be taxed at its marginal rate of 21%. However, considering a state marginal tax rate of 5%, the combined marginal tax rate would be about 25%.

Given: Gross income and expenses as stated; income-tax rate = 25%.

Find: Net income.

METHODOLOGY

Compute net income.

SOLUTION

We consider the purchase of the machine to have been made at the end of year 0, which is also the beginning of year 1. (Note that our example explicitly assumes that the only depreciation charges for year 1 are those for the NC machine, a situation that may not be typical.)

Item	Amount
Gross income (revenues)	$50,000
Expenses	
Cost of goods sold	$20,000
Depreciation	$4,000
Operating expenses	$6,000
Taxable income	$20,000
Taxes (25%)	$5,000
Net income	$15,000

COMMENTS: In this example, the inclusion of a depreciation expense reflects the true cost of doing business. This expense is meant to correspond to the amount of the total cost of the machine that has been utilized, or "used up," during the first year. This example also highlights some of the reasons that income-tax laws govern the depreciation of assets. If the company were allowed to claim the entire $28,000 as a year 1 expense, a discrepancy would exist between the one-time cash outlay for the machine's cost and the gradual benefits of its productive use. This discrepancy would lead to dramatic variations in the firm's net income, and net income would become a less accurate measure of the organization's performance. On the other hand, failing to account for this cost at all would lead to increased reported profit during the accounting period. In this situation, the profit would be a "false profit" in that it would not accurately account for the usage of the machine. Capitalizing the purchase cost over time allows the company a logical distribution of costs that matches the utilization of the machine's value. Therefore, full 100% capital expensing the first year can be beneficial in terms of tax deferring, but may not reflect the true earning each period (in accounting sense) over the life of the project.

10.4 Incremental Cash Flows from Undertaking a Project

When a company purchases a fixed asset such as equipment, it makes an investment. The company commits funds today with the expectation of earning a return on those funds in the future. For a fixed asset, the future return is in the form of cash flows generated by the profitable use of the asset. In evaluating a capital investment, we are concerned only with those cash flows that result directly from the investment. These cash flows, called **differential**, or **incremental**, **cash flows**, represent the change in the firm's total cash flow that occurs as a direct result of the investment.

In this section, we will look into some of the cash flow elements common to most investments. Once the cash flow elements are determined (both inflows and outflows), we may group them into three areas according to their use or sources: (1) elements associated with operations, (2) elements associated with investment activities (such as capital expenditures), and (3) elements associated with project financing (such as borrowing).We will use Figure 10.6 as a road map in explaining these cash flow elements. The main purpose of grouping cash flows in this way is to provide information about the operating, investing, and financing activities of a project.

10.4.1 Operating Activities

In general, cash flows from operations include current sales revenues, cost of goods sold, operating expenses, and income taxes. Cash flows from operations should generally reflect the cash effects of transactions entering into the determination of net income. The interest portion of a loan repayment is a deductible operating expense allowed when net income is determined and is included in the operating activities. Since we usually look only at yearly flows, it is logical to express all cash flows on a yearly basis.

Although depreciation has a direct impact on net income, it is *not* a cash outlay; as such, it is important to distinguish between annual income in the presence of depreciation and annual operating cash flow. The situation described in Example 10.2 demonstrates the difference between depreciation costs as expenses and the cash

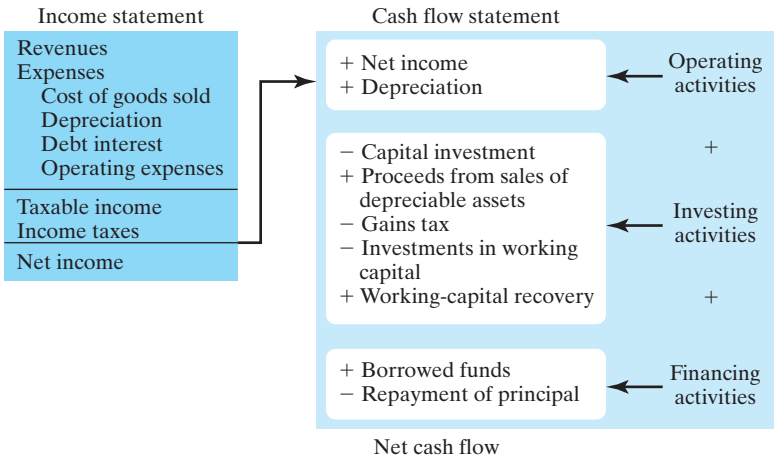


Figure 10.6 A typical format used in presenting a net cash flow statement.

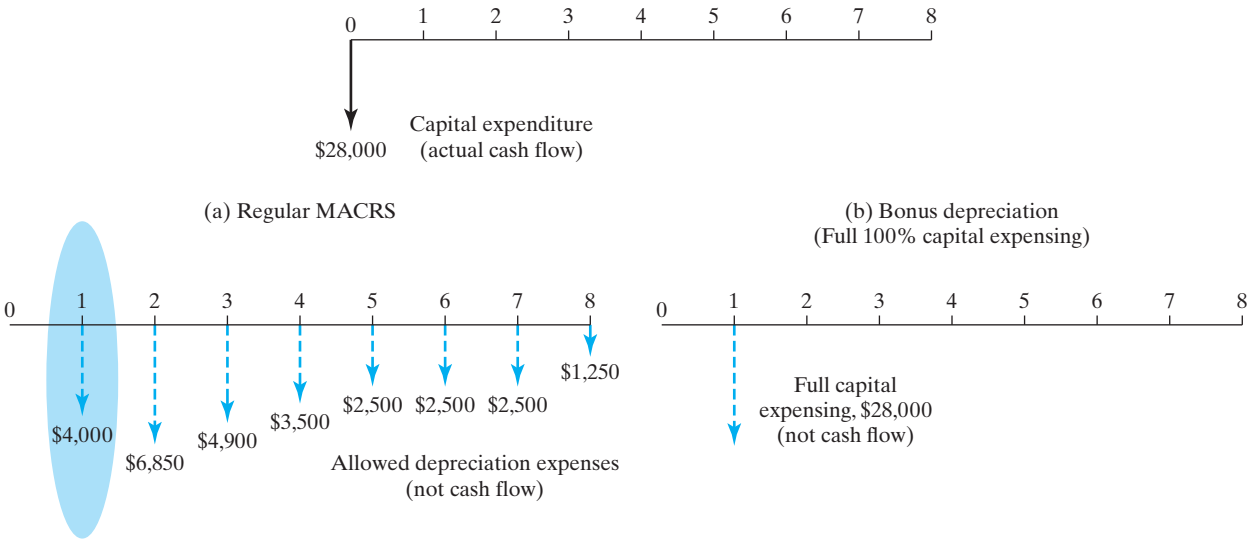


Figure 10.7 Capital expenditure versus depreciation expenses. (a) with regular MACRS, (b) with bonus depreciation (100% capital expensing).

flow generated by the purchase of a fixed asset. In this example, cash in the amount of $28,000 was expended in year 0, but the $4,000 (or $28,000) depreciation charged against the income in year 1 is not a cash outlay. Figure 10.7 summarizes the difference.

Therefore, we can determine the net cash flow from operations by using either (1) the net income or (2) the cash flow by computing income taxes in a separate step. When we use net income as the starting point for cash flow determination, we should add any noncash expenses (mainly, depreciation and amortization expenses) to net operating income in order to estimate the net cash flow from the operation. It is easy to show mathematically that the two approaches are identical:

Cash flow from operation = Net income + (Depreciation and Amortization).

EXAMPLE 10.3 Cash Flow from Operation

For the situation described in Example 10.2, assume that (1) all sales are cash sales and (2) all expenses except depreciation were paid during year 1. How much cash would be generated from operations?

DISSECTING THE PROBLEM

Depreciation and amortization are different from other expenses as they *are not* really cash outflows. Even though depreciation (or amortization expense) is deducted from revenue for tax or book purposes on a yearly basis, no cash is paid to anyone except when the asset was purchased.

Given: Net-income components as in Example 10.2.

Find: Cash flow from operation.

METHODOLOGY

Generate a cash-flow statement.

Cash flow = net income + depreciation

SOLUTION

We can generate a cash-flow statement by simply examining each item in the income statement and determining which items actually represent cash receipts or cash disbursements. Some of the assumptions listed in the statement of the problem make this process simpler. We summarize our findings as follows:

Item	Income	Cash Flow
Gross income (revenues)	$50,000	$50,000
Expenses		
Cost of goods sold	$20,000	−$20,000
Depreciation	$4,000	
Operating expenses	$6,000	−$6,000
Taxable income	$20,000	
Taxes (25%)	$5,000	−$5,000
Net income	$15,000	
Cash flow from operations		$19,000

The second column shows the income statement, and the third column shows the statement on a cash-flow basis. The sales of $50,000 are all cash sales. Costs other than depreciation were $26,000; these costs were paid in cash, leaving $24,000. Depreciation is not a cash flow; that is, the firm did not pay $4,000 cash in depreciation expenses. Taxes, however, are paid in cash, so the $5,000 for taxes must be deducted from the $24,000, leaving a net cash flow from operations of $19,000.

COMMENTS: Figure 10.8 illustrates how the net cash flow is related to the net income. The procedure for calculating net income is identical to that used for obtaining net cash flow (after tax) from operations with the exception of depreciation, which is

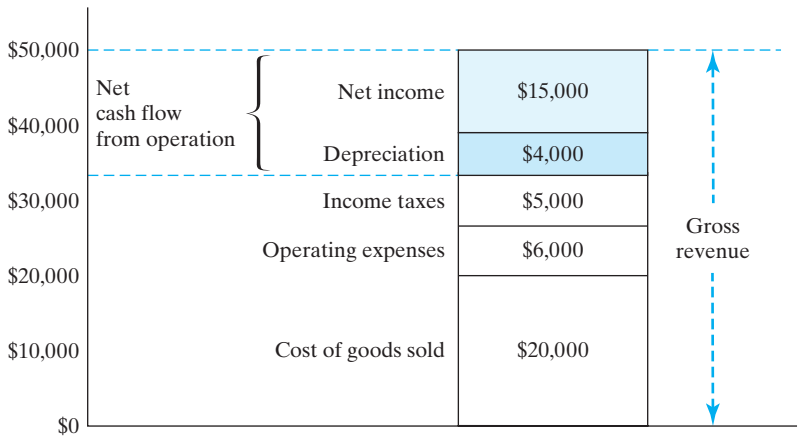


Figure 10.8 Relationship between net income and operating cash flow.

excluded from the net cash flow computation. Depreciation is needed only for computing income taxes.

$$\begin{aligned}\text{Net cash flow} &= \text{Net income} + \text{Depreciation}\\ &= \$15{,}000 + \$4{,}000\\ &= \$19{,}000.\end{aligned}$$

10.4.2 Investing Activities

As shown in Figure 10.6, three types of investment flows are associated with buying a piece of equipment: (1) the original investment, (2) the salvage value at the end of the equipment's useful life, and (3) the **working-capital investment** (or recovery). Here, *the investment in working capital typically refers to the investment made in nondepreciable assets,* such as carrying raw-material inventories. The distinction between investment in physical assets and investment in working capital is as follows.

- *Investment in physical assets* should be capitalized (depreciated) over the depreciable life of the asset, unless taking 100% capital expensing. Any salvage value of the asset exceeding its book value is subject to taxation as a gain.
- *Investment in working capital* should be treated as capital expenditure, but no depreciation deduction is allowed. Any recovery of working capital is not viewed as income, so there is no tax consequence.

We will assume that our outflows for both capital investment and working-capital investment take place in year 0. It is possible, however, that both investments will not occur instantaneously but over a few months as the project gets into gear; we could then use year 1 as an investment year. (Capital expenditures may occur over several years before a large investment project becomes fully operational. In this case, we should enter all expenditures as they occur.) For a small project, either method of timing these flows is satisfactory because the numerical differences are likely to be insignificant.

10.4.3 Financing Activities

Cash flows classified as financing activities in Figure 10.6 include (1) the amount of borrowing and (2) the repayment of principal. Recall that interest payments are tax-deductible expenses, so they are classified as operating, not financing, activities.

The net cash flow for a given year is simply the sum of the net cash flows from operating, investing, and financing activities. Once again, throughout the chapter, Figure 10.6 will be used as a road map when you set up a cash flow statement because it classifies each type of cash flow element as an operating, investing, or financing activity.

10.5 Developing Project Cash Flow Statements

In this section, we will illustrate through a series of numerical examples how we actually prepare a project's cash flow statement. Using a generic version in Figure 10.6, we first determine the net income from operations and then adjust the net income

by adding any noncash expenses, mainly depreciation (or amortization). We will also consider a case in which a project generates a negative taxable income for an operating year.

10.5.1 When Projects Require Only Operating and Investing Activities

We will start with the simple case of determining after-tax cash flows for an investment project with only operating and investment activities. This is a situation in which the firm has enough funds to finance the entire investment, either using cash generated from its regular business operation or issuing common stock to investors (or simply known as **equity** financing). In the next section, we will add complexities to this problem by including financing borrowing activities.

EXAMPLE 10.4 Cash Flow Statement with Only Operating and Investing Activities

G&W Machine Shop is evaluating the proposed acquisition of a new milling machine in 2019. The milling machine costs $150,000 and would cost another $12,000 to modify it for special use by the company. The milling machine has an estimated service life of five years, with a salvage value of $45,000. With this milling machine, the firm will be able to generate additional annual revenues of $175,000. However, it requires a specially trained operator to run the machine. This will entail $60,000 in annual labor, $20,000 in annual material expenses, and another $10,000 in annual overhead (power and utility) expenses. It also requires an investment in working capital in the amount of $25,000, which will be recovered in full at the end of year 5. The milling machine falls into the seven-year MACRS class.

Find the year-by-year after-tax net cash flow for the project at a 25% marginal tax rate, and determine the net present worth of the project at the company's MARR of 15% (after tax) (a) if the company opts out of claiming the 100% bonus depreciation and uses MACRS (b) if the company takes 100% full capital expensing.

DISSECTING THE PROBLEM

We will employ the business convention that no signs (positive or negative) be used in preparing the income statement except in the situation where we have a negative taxable income or tax savings. In this situation, we will use () to denote a negative entry. However, in preparing the cash-flow statement, we will observe explicitly the sign convention: A positive sign indicates a cash inflow; a negative sign, or (), indicates a cash outflow.

Given: Previously mentioned cash-flow information.

Find: After-tax cash flow.

METHODOLOGY

Compute after-tax cash flow.

(a) If the company opts out of claiming the bonus deprecation, then it uses standard 7-year MACRS.

SOLUTION

(a) We can approach the problem in two steps by using the format shown in Figure 10.6 to generate an income statement and then a cash-flow statement. Table 10.1 summarizes the cash-flow statement associated with the milling machine project. The following notes explain the essential items in Table 10.1:

- **Revenue:** The revenues and costs are uniform annual flows in years 1 through 5. Annual revenues do not have to be uniform.
- **Expenses (excluding depreciation):** In our example, we assumed that the annual labor cost, materials cost, and overhead are all constant throughout the project period.
- **Depreciation calculation:** In year 0 (that is, at present), we have an investment cost of $162,000 for the equipment.[5] This cost will be depreciated in years 1 through 5. Since the equipment is held for only five years (shorter than the recovery period), the applicable depreciation amounts would be as follows:

Period	Dep. Rate (%)	Dep. Amount	Book Value
1	14.286%	$23,143	$138,857
2	24.490%	$39,673	$99,184
3	17.493%	$28,338	$70,845
4	12.495%	$20,242	$50,604
5	$\left(\frac{8.925\%}{2}\right)$ half-year convention	$7,229	$43,375

Note that the fifth-year depreciation would ordinarily be $14,458 but is halved due to the half-year convention. We now have a value for our unknown D_n, which will enable us to complete the cell entries from C10 to G10.

- **Taxable income:** Once we find depreciation allowances for each year, we can easily compute the taxable incomes for years 1 through 5, which have fixed revenue and expense entries, including the variable depreciation charges.
- **Salvage value and gains tax:** In year 5, we must deal with two aspects of the asset's disposal: salvage value and taxable gains. We list the estimated salvage value as a positive cash flow. Taxable gains are calculated as follows:

[5] We will assume that the asset is purchased and placed in service at the beginning of year 1 (or the end of year 0) and that the first year's depreciation will be claimed at the end of year 1.

TABLE 10.1 Cash Flow Statement for the Milling Machine Project (Example 10.4)

	A	B	C	D	E	F	G
1							
2	**Income Statement**						
3	End of Year	0	1	2	3	4	5
4							
5	Revenue		$ 175,000	$ 175,000	$ 175,000	$ 175,000	$ 175,000
6	Expenses:						
7	Labor		$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000
8	Materials		$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
9	Overhead		$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
10	Depreciation		$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
11							
12	Taxable Income		$ 61,857	$ 45,327	$ 56,662	$ 64,758	$ 77,771
13	Income Taxes (25%)		$ 15,464	$ 11,332	$ 14,166	$ 16,190	$ 19,443
14							
15	Net Income		$ 46,393	$ 33,995	$ 42,497	$ 48,569	$ 58,328
16							
17	**Cash Flow Statement**						
18	Operating Activities:						
19	Net Income		$ 46,393	$ 33,995	$ 42,497	$ 48,569	$ 58,328
20	Depreciation		$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
21	Investment Activities:						
22	Milling machine	$ (162,000)					
23	Salvage Value						$ 45,000
24	Gains Tax						$ (406)
25	Working capital	$ (25,000)					$ 25,000
26							
27	Net Cash Flow	$ (187,000)	$ 69,536	$ 73,668	$ 70,835	$ 68,811	$ 135,151
28							
29							
30		PW(15%)=	$ 82,281				
31		IRR =	30.72%				
32							
33							
34							

=-(G23-(-B22-SUM(C10:G10)))*0.25

=NPV(15%,C27:G27)+B27

=IRR(B27:G27,15%)

1. The total depreciation in years 1 through 5 is $118,625.
2. The book value at the end of year 5 is the cost basis minus the total depreciation, or $162,000 − $118,625 = $43,375.
3. The taxable gains on the sale are the salvage value minus the book value, or $45,000 − $43,375 = $1,625. (The salvage value is less than the cost basis, so these gains are ordinary gains.)
4. The tax on the ordinary gains is $1,625 × 25% = $406. This is the amount placed in the table in cell G24.

- **Working capital:** The investment in working capital is shown in cell B25, and its recovery appears in cell G25. As mentioned earlier, there are no tax consequences on the recovery amount even though it is a positive cash inflow.

	• **Investment analysis:** Once we obtain the project's net cash flows after-tax, we can determine their equivalent present worth at the firm's discount rate. Since this series does not contain any patterns to simplify our calculations, we must find the net present worth of each payment. Using $i = 15\%$, we have $\text{PW}(15\%) = -\$187{,}000 + \$69{,}536(P/F, 15\%, 1) + \$73{,}668(P/F, 15\%, 2) + \$70{,}835(P/F, 15\%, 3) + \$68{,}811(P/F, 15\%, 4) + \$135{,}151(P/F, 15\%, 5) = \$82{,}281.$ This result means that investing \$187,000 in the milling machine project would bring in enough revenues to recover the initial investment and the cost of funds with an equivalent surplus of \$82,281. Clearly, this is a good project to undertake.
(b) If the asset is eligible for bonus depreciation, the allowed first-year depreciation in 2019 would be 100% of the equipment cost.	(b) With the bonus depreciation deduction made at the end of tax year of 2019, the resulting project cash flows are shown in Table 10.2. Since the entire cost is written off at the end of the first year, the book value of the asset would be zero at the end of project life. Therefore, the entire salvage value is subject to taxable gains. In Table 10.2, we may notice that the project's net income is negative during the first year with the huge depreciation deduction, but it generates a much higher net cash flow in the amount of \$104,250. When compared with the standard MACRS deduction for the same period (\$69,536), the firm has \$34,714 worth of tax-deferred amount that can be used for other business activities. The firm will eventually pay back this amount over the life of the project.

COMMENTS: In comparing Tables 10.1 and 10.2, you would notice that the total amount of taxes paid to government and the net cash flows generated would be the same.

- With the standard MACRS (Table 10.1):
  - Total income taxes paid: $\$15{,}464 + \$11{,}332 + \cdots + \$19{,}443 = \$76{,}594$
  - Total gains tax paid $= \$406$
  - Total taxes paid $= \$76{,}594 + \$406 = \$77{,}000$
  - Total net cash flows generated: $-\$187{,}000 + \$69{,}536 + \cdots + \$135{,}151 = \$231{,}000$
- With 100% bonus depreciation (Table 10.2):
  - Total income taxes paid: $-\$19{,}250 + \$21{,}250 + \cdots + \$21{,}250 = \$65{,}750$
  - Total gains tax paid $= \$406$
  - Depreciation recapture $= \$162{,}000 - \$118{,}625 = \$43{,}375$
  - Additional income taxes from depreciation recapture $= \$43{,}375(0.25) = \$10{,}844$
  - Total taxes paid $= \$65{,}750 + \$406 + \$10{,}844 = \$77{,}000$
  - Total net cash flows generated: $-\ \$187{,}000 + \$104{,}250 + \cdots + \$122{,}500 = \$231{,}000$

TABLE 10.2 **Cash Flow Statement for the Milling Machine Project (with Bonus Depreciation)**

	A	B	C	D	E	F	G
2	**Income Statement**						
3	End of Year	0	1	2	3	4	5
4							
5	Revenue		$ 175,000	$ 175,000	$ 175,000	$ 175,000	$ 175,000
6	Expenses:						
7	Labor		$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000
8	Materials		$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
9	Overhead		$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
10	Depreciation		$ 162,000	$ -	$ -	$ -	$ -
11							
12	Taxable Income		$ (77,000)	$ 85,000	$ 85,000	$ 85,000	$ 85,000
13	Income Taxes (25%)		$ (19,250)	$ 21,250	$ 21,250	$ 21,250	$ 21,250
14							
15	Net Income		$ (57,750)	$ 63,750	$ 63,750	$ 63,750	$ 63,750
16							
17	**Cash Flow Statement**						
18	Operating Activities:						
19	Net Income		$ (57,750)	$ 63,750	$ 63,750	$ 63,750	$ 63,750
20	Depreciation		$ 162,000	$ -	$ -	$ -	$ -
21	Investment Activities:						
22	Milling machine	$ (162,000)					
23	Salvage Value						$ 45,000
24	Gains Tax						$ (11,250)
25	Working capital	$ (25,000)					$ 25,000
26							
27	Net Cash Flow	$ (187,000)	$ 104,250	$ 63,750	$ 63,750	$ 63,750	$ 122,500
28							
29							
30		PW(15%)=	$ 91,126				
31		IRR =	34.28%				
32							
33							
34							

=-(G23-(-B22-SUM(C10:G10)))*0.25

=NPV(15%,C27:G27)+B27

=IRR(B27:G27,15%)

Note that the total gains tax paid in the amount of $11,250 shown in Table 10.2 consists of two parts – regular gains tax and income taxes on depreciation recapture (= $406 + $10,844). With the bonus depreciation taken at year 1, the book value is supposed to be $0 at the end of year 5. Since you are disposing of the asset before the recovery period, you need to recalculate the correct book value assuming that you have claimed a regular MACRS, which results in $43,375. This difference is called depreciation recapture and it is treated as ordinary taxable income.

Even though the total amount of taxes paid and the accounting sum of net cash flows generated over the project life are the same for both options, the resulting periodic project cash flow series are different. Considering the time value of money, clearly the firm could increase the profitability of the project by simply electing the bonus depreciation option.

10.5.2 When Projects Are Financed with Borrowed Funds

Many companies use a mixture of debt and equity to finance their physical plant and equipment. The ratio of total debt to total investment, generally called the **debt ratio**, represents the percentage of the total initial investment provided by borrowed funds. For example, a debt ratio of 0.3 indicates that 30% of the initial investment is borrowed and the rest is provided from the company's earnings (also known as **equity**). Since interest is a tax-deductible expense, companies in high tax brackets may incur lower after-tax interest costs by financing through debt. (The method of loan repayment can also have a significant impact on taxes.)

EXAMPLE 10.5 Cash Flow Statement with Financing (Borrowing) Activities

Reconsider Example 10.4 where

- Investment cost (year 0): $162,000
- Project life: 5 years
- Salvage value (year 5): $45,000
- Working capital requirement (year 0): $25,000
- Working capital recovery (year 5): $25,000
- Annual revenue (years 1–5): $175,000
- Annual expenses (years 1–5): $90,000
- Annual depreciation (years 1–5): $23,143, $39,673, $28,338, $20,242, $7,229
- Tax rate: 25%

Now assume that $64,800 of the $162,000 paid for the investment is obtained through debt financing (debt ratio = 0.4). The loan is to be repaid in equal annual installments at 12% interest over five years. The remaining $97,200 will be provided by equity (e.g., from retained earnings).

DISSECTING THE PROBLEM

Given: Same scenario as in Example 10.4, but $64,800 is borrowed and repaid in equal installments over five years at 12%.

Find: Net after-tax cash flows in each year.

METHODOLOGY

Compute after-tax cash flow.

Note that the tax laws cap business interest deductions for debt interest payments at 30 percent of taxable income before interest and depreciation.

SOLUTION

We first need to compute the size of the annual loan repayment installments:

$$\$64{,}800(A/P, 12\%, 5) = \$17{,}976.$$

Next, we determine the repayment schedule of the loan by itemizing both the interest and the principal represented in each annual repayment.

Amount financed: $64,800, or 40% of total capital expenditure
Financing rate: 12% per year
Annual installment: $17,976, or A = $64,800 (A/P, 12%, 5)

End of Year	Beginning Balance	Interest Payment	Principal Payment	Ending Balance
1	$64,800	$7,776	$10,200	$54,600
2	$54,600	$6,552	$11,424	$43,176
3	$43,176	$5,181	$12,795	$30,381
4	$30,381	$3,646	$14,330	$16,051
5	$16,051	$1,926	$16,050	$0
			$17,976	

Note: The amount of interest and principal to be paid in each period can be easily obtained with Excel.

- Interest payment: = IPMT (rate, period, loan life, borrowing amount). For example, to find the interest payment in period 2, we use the following format: " = IPMT(12%, 2, 5, −64800)."
- Principal payment: = PPMT (rate, period, loan life, borrowing amount). For example, to find the principal payment in period 2, we use the following format: " = PPMT(12%, 2, 5, −64800)."

The resulting after-tax cash flow is detailed in Table 10.3. The present-worth equivalent of the after-tax cash flow series is

TABLE 10.3 Cash Flow Statement for the Milling Machine Project with Debt Financing (Example 10.5)

	A	B	C	D	E	F	G
2	**Income Statement**						
3	End of Year	0	1	2	3	4	5
4							
5	Revenue		$ 175,000	$ 175,000	$ 175,000	$ 175,000	$ 175,000
6	Expenses:						
7	Labor		$ 60,000	$ 60,000	$ 60,000	$ 60,000	$ 60,000
8	Materials		$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
9	Overhead		$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 10,000
10	Debt Interest		$ 7,776	$ 6,552	$ 5,181	$ 3,646	$ 1,926
11	Depreciation		$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
12							
13	Taxable Income		$ 54,081	$ 38,775	$ 51,481	$ 61,112	$ 75,845
14	Income Taxes (25%)		$ 13,520	$ 9,694	$ 12,870	$ 15,278	$ 18,961
15							
16	Net Income		$ 40,561	$ 29,081	$ 38,611	$ 45,834	$ 56,884
17							
18	**Cash Flow Statement**						
19	Operating Activities:						
20	Net Income		$ 40,561	$ 29,081	$ 38,611	$ 45,834	$ 56,884
21	Depreciation		$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
22	Investment Activities:						
23	Milling machine	$ (162,000)					
24	Salvage Value						$ 45,000
25	Gains Tax						$ (406)
26	Working capital	$ (25,000)					$ 25,000
27	Financing Activities:						
28	Borrowed Funds	$ 64,800					
29	Principal Repayment		$ (10,200)	$ (11,424)	$ (12,795)	$ (14,330)	$ (16,050)
30							
31	Net Cash Flow	$ (122,200)	$ 53,504	$ 57,330	$ 54,154	$ 51,746	$ 117,657
32							
33							
34	PW(15%)=	$ 91,364					
35	IRR =	40.15%					

=IPMT(12%,2,5,-64800)
=-(G24-(-B23-SUM(C11:G11)))*0.25
=PPMT(12%,D3,5,64800)
=NPV(15%,C31:G31)+B31
=IRR(B31:G31,15%)

Note that all debt interest payments are less than 30% of taxable income of each year, these amounts are fully deductible as business expenses.

$$\begin{aligned} \text{PW}(15\%) &= -\$122{,}200 + \$53{,}504(P/F, 15\%, 1) + \cdots \\ &\quad + \$117{,}657\ (P/F, 15\%,\ 5) \\ &= \$91{,}364. \end{aligned}$$

When this amount is compared with the amount found in the case that involved no borrowing, $82,281 in Example 10.4, we see that debt financing actually increases the present worth by $9,083. This surprising result is caused entirely by the fact that the firm is able to borrow the funds at a lower rate, 12%, than its MARR (opportunity cost rate) of 15%. However, we should be careful in interpreting the result. It is true, to some extent, that firms can usually borrow money at lower rates than their MARR. However, if the firm can borrow money at a significantly lower rate, this factor also affects the firm's MARR because the borrowing rate is one of the elements used in determining the MARR as we will see in Section 11.4. Therefore, a significant difference between present values with borrowing and without borrowing is not always expected in practice.

10.6 Effects of Inflation on Project Cash Flows

We will now consider the effects of inflation in determining the project cash flows. We are especially interested in three elements of project cash flows: (1) depreciation expenses, (2) interest expenses, and (3) investment in working capital. The first two elements are essentially immune to the effects of inflation, as they are always given in actual dollars. We will also consider the complication of how to proceed when multiple price indices have been used to generate various project cash flows. Capital projects requiring increased levels of **working capital** suffer from inflation because additional cash must be invested to maintain new price levels. For example, if the cost of inventory increases, additional cash infusions are required in order to maintain appropriate inventory levels over time. A similar phenomenon occurs with funds committed to account receivables. These additional working-capital requirements can significantly reduce a project's profitability or rate of return.

10.6.1 Depreciation Allowance under Inflation

Because depreciation expenses are calculated on some base-year purchase amount (historical cost), they do not increase over time to keep pace with inflation. Thus, they lose some of their value to defer taxes in real terms, because inflation drives up the general price level and, hence, taxable income. Similarly, the selling prices of depreciable assets can increase with the general inflation rate, but the book value of the asset remains the same. Because any gains on salvage values are taxable, they can result in increased taxes. Example 10.6 illustrates how a project's profitability changes under an inflationary economy.

EXAMPLE 10.6 Effects of Inflation on Projects with Depreciable Assets

Reconsider Example 10.5 where 40% of the investment required by the milling machine center project was financed by a loan. A summary of the financial facts in the absence of inflation is shown in the following table.

Recall that the after-tax cash flow for the milling machine project was given in Table 10.3, and the net present worth of the project in the absence of inflation was calculated to be $91,364.

What will happen to this investment project if the general inflation rate ($\bar{f}$) during the next five years is expected to be 5% annually? Sales, operating costs, and working-capital requirements are assumed to increase accordingly. Depreciation and interest expenses will remain unchanged, but taxes, profits, and thus cash flow will be higher. The firm's inflation-free interest rate (i') is known to be 15%.

(a) Determine the PW of the project.

(b) Determine the real rate of return for the project.

Project Description	Milling Machine Project in the Absence of Inflation
Required investment:	$162,000
Investment in working capital:	$25,000
Debt ratio (0.40), meaning that 40% of the capital will be borrowed at 12% interest:	$64,800
Project life:	5 years
Salvage value:	$45,000
Depreciation method:	7-year MACRS
Annual revenues:	$175,000 per year
Annual expenses:	
Labor	$60,000 per year
Material	$20,000 per year
Overhead	$10,000 per year
Marginal tax rate:	25%
Inflation-free interest rate (i'):	15%

DISSECTING THE PROBLEM

Given: Financial data as shown in Table 10.3 but with a general inflation rate of 5%.

Find: (a) PW of the after-tax project cash flows and (b) real rate of return of the project.

METHODOLOGY

Compute present worth and real rate of return.

SOLUTION

(a) Table 10.4 shows the after-tax cash flows in actual dollars. Since we are dealing with cash flows in actual dollars, we need to find the market interest rate (see Section 4.3.3). The market interest rate to use is $i = 0.15 + 0.05 + (0.15)(0.05) = 20.75\%$.

$$\begin{aligned} \text{PW}(20.75\%) &= -\$122{,}200 + \$55{,}441(P/F, 20.75\%, 1) \\ &\quad + \cdots + \$149{,}982(P/F, 20.75\%, 5) \\ &= \$90{,}846. \end{aligned}$$

Since $\text{PW}(20.75\%) > 0$, the investment is still economically attractive.

(b) If you calculate the rate of return of the project on the basis of actual dollars, it will be 46.91% as shown in Table 10.4. Since the approximate market interest rate is 20.75%, the project is still justifiable. To approximate the real (inflation-free) rate of return, you can use the following relationship from Eq. (4.8):

$$i' = \frac{i - \bar{f}}{1 + \bar{f}} = \frac{0.4691 - 0.05}{1 + 0.05} = 40\%.$$

Since the inflation-free MARR is 15%, the project also can be justified on the basis of real dollars.

COMMENTS: All cash flow elements, except depreciation and interest expenses, are assumed to be in constant dollars. Since income taxes are levied on actual taxable income, we will use the actual-dollar analysis, which requires that all cash flow elements be expressed in actual dollars. We make the following observations:

- For the purposes of this illustration, all inflationary calculations are made as of year-end.
- Cash flow elements such as sales, labor, material, overhead, and selling price of the asset will be inflated at the general inflation rate. For example, whereas annual sales had been estimated at $175,000, under conditions of inflation they become 5% higher in year 1 (or $183,750), 10.25% higher in year 2 ($192,938), and so forth.
- Future cash flows in actual dollars for other elements can be obtained in a similar way.
- No change occurs in the investment in year 0 or in the depreciation and interest expenses, since these items are unaffected by expected future inflation.

TABLE 10.4 Cash Flow Statement for the Milling Machine Project under Inflation (Example 10.6)

	A	B	C	D	E	F	G	H
1								
2	**Income Statement**							
3	End of Year	Inflation Rate	0	1	2	3	4	5
4								
5	Revenue	5%		$ 183,750	$ 192,938	$ 202,584	$ 212,714	$ 223,349
6	Expenses:							
7	Labor	5%		$ 63,000	$ 66,150	$ 69,458	$ 72,930	$ 76,577
8	Materials	5%		$ 21,000	$ 22,050	$ 23,153	$ 24,310	$ 25,526
9	Overhead	5%		$ 10,500	$ 11,025	$ 11,576	$ 12,155	$ 12,763
10	Debt Interest			$ 7,776	$ 6,552	$ 5,181	$ 3,646	$ 1,926
11	Depreciation			$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
12								
13	Taxable Income			$ 58,331	$ 47,488	$ 64,879	$ 79,430	$ 99,329
14	Income Taxes (25%)			$ 14,583	$ 11,872	$ 16,220	$ 19,858	$ 24,832
15								
16	Net Income			$ 43,748	$ 35,616	$ 48,659	$ 59,573	$ 74,497
17								
18	**Cash Flow Statement**							
19	Operating Activities:							
20	Net Income			$ 43,748	$ 35,616	$ 48,659	$ 59,573	$ 74,497
21	Depreciation			$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
22	Investment Activities:							
23	Milling machine		$ (162,000)					
24	Salvage Value	5%						$ 57,433
25	Gains Tax							$ (3,514)
26	Working capital	5%	$ (25,000)	($1,250)	($1,313)	($1,378)	($1,447)	$ 30,388
27	Financing Activities:							
28	Borrowed Funds		$ 64,800					
29	Principal Repayment			$ (10,200)	$ (11,424)	$ (12,795)	$ (14,330)	$ (16,050)
30								
31	Net Cash Flow (Actual Dollars)		$ (122,200)	$ 55,441	$ 62,552	$ 62,824	$ 64,038	$ 149,982
32								
33								
34			PW(20.75%)=	$ 90,846				
35			IRR =	46.91%				
36								
37								
38								

=-(H24-(-C23-SUM(D11:H11)))*0.25

=NPV(20.75%,D31:H31)+C31

=IRR(C31:H31,15%)

- Investment in working capital will change with inflation. Working-capital levels can be maintained only by an additional infusion of cash. For example, the $25,000 investment in working capital made in year 0 will be recovered at the end of the first year, assuming a one-year recovery cycle. However, because of 5% inflation, the required working capital for the second year increases to $26,250. Thus, in addition to reinvesting the $25,000 recovered at the end of year 1, $1,250 worth of new cash must be made. The $26,250 will be recovered at the end of the second year. However, the project will need a 5% increase in working capital, or $27,563, for the third year, and so forth. The deficit amount must be financed at the beginning of each year. Eventually, no investment in working capital is required in year 5, as the project terminates. Therefore, the firm recovers all the investments it made in working capital in a lump sum ($30,388) at the end of year 5, and it can use this recovered fund for other purposes.

End of Year	0	1	2	3	4	5
Recovered Working Capital		→$25,000	→$26,250	→ $27,563	→$28,941	→ $30,388
Required Working Capital	($25,000)	($26,250)	($27,563)	($28,941)	($30,388)	$0
Balance	($25,000)	($1,250)	($1,313)	($1,378)	($1,447)	$30,388

- The depreciation expense is a charge against taxable income, which reduces the amount of taxes paid and, as a result, increases the cash flow attributable to an investment by the amount of taxes saved. But the depreciation expense under existing tax laws is based on historic cost. As time goes by, the depreciation expense is charged to taxable income in dollars of declining purchasing power; as a result, the "real" cost of the asset is not totally reflected in the depreciation expense. Depreciation costs are thereby understated, and the taxable income is thus overstated, resulting in higher taxes. With 100% capital expensing, however, the inflation loss could be reduced.
- On the other hand, the debt payment schedule with a fixed-interest rate is not going to change as the lender experiences inflation. Therefore, you are paying back with cheaper dollars, resulting in higher profitability. In our example, the increase in profit due to debt financing is smaller than the increase in taxes paid plus additional cash required to maintain proper working capital, so we still see overall loss in NPW.
- The resale price of the asset is expected to increase at the general inflation rate. Therefore, the salvage value in actual dollars will be

$$\$45{,}000(1 + 0.05)^5 = \$57{,}433.$$

  This increase in salvage value will also increase the taxable gains, as the book value remains unchanged. The calculations for both the book value and gains tax are shown in Table 10.4.
- Note that the PW in the absence of inflation was $91,364 in Example 10.5. The $518 (= $91,364 − $90,846) decrease (known as inflation loss) in the PW under inflation, illustrated in this example, is due entirely to income-tax considerations and *working-capital drains*.

10.6.2 Handling Multiple Inflation Rates

As we noted in Chapter 4, the inflation rate f_j represents a rate applicable to a specific segment j of the economy. For example, if we are estimating the future cost of a piece of machinery, we should use the inflation rate appropriate for that item. Furthermore, we may need to use several rates in order to accommodate the different costs and revenues in our analysis. Example 10.7 introduces the complexity of multiple inflation rates.

EXAMPLE 10.7 Applying Specific Inflation Rates

In this example, we will rework Example 10.6 using different annual indices (differential inflation rates) in the prices of cash-flow components. Suppose that we expect the general rate of inflation, $\bar{f}$, to average 6% during the next five years. We also expect that the selling price (salvage value) of the equipment will increase at 3% per year, that wages (labor) and overhead will increase at 5% per year, and

that the cost of material will increase at 4% per year. The working-capital requirement will increase at 5% per year. We expect sales revenue to climb at the general inflation rate. Determine the net present worth of this investment. Recall the basic financial data mentioned in Example 10.4 as follows:

Project Description	Milling Machine Project in the Absence of Inflation
Required investment:	$162,000
Investment in working capital:	$25,000
Debt ratio (0.40), meaning that 40% of the capital will be borrowed at 12% interest:	$64,800
Project life:	5 years
Salvage value:	$45,000
Depreciation method:	7-year MACRS
Annual revenues:	$175,000 per year
Annual expenses:	
Labor	$60,000 per year
Material	$20,000 per year
Overhead	$10,000 per year
Marginal tax rate:	25%
Inflation-free interest rate (i'):	15%

DISSECTING THE PROBLEM

Given: Financial data as shown in Table 10.5 but with multiple inflation rates.

Find: PW of the after-tax project cash flows.

METHODOLOGY

SOLUTION

Table 10.5 shows the relevant calculations according to the income-statement format. For simplicity, all cash flows and inflation effects are assumed to occur at year-end.

Once we determine the project cash flows in actual dollars, we must adjust the original discount rate of 15%, which is an inflation-free interest rate, i'. The appropriate interest rate to use is the market interest rate:

$$i = i' + \bar{f} + i'\bar{f} = 0.15 + 0.06 + (0.15)(0.06) = 21.90\%.$$

The equivalent present worth is obtained as follows:

$$\begin{aligned} \text{PW}(21.90\%) &= -\$122{,}200 + \$56{,}904(P/F, 21.90\%, 1) \\ &\quad + \$65{,}635(P/F, 21.90\%, 2) + \cdots \\ &\quad + \$155{,}058(P/F, 21.90\%, 5) \\ &= \$95{,}735. \end{aligned}$$

TABLE 10.5 Cash Flow Statement for the Milling Machine Project under Inflation (Multiple Price Indices)

	A	B	C	D	E	F	G	H
1								
2	**Income Statement**				=D5*(1+B5)			
3	End of Year	Inflation Rate	0	1	2	3	4	5
4								
5	Revenue	6%		$ 185,500	$ 196,630	$ 208,428	$ 220,933	$ 234,189
6	Expenses:							
7	Labor	5%		$ 63,000	$ 66,150	$ 69,458	$ 72,930	$ 76,577
8	Materials	4%		$ 20,800	$ 21,632	$ 22,497	$ 23,397	$ 24,333
9	Overhead	5%		$ 10,500	$ 11,025	$ 11,576	$ 12,155	$ 12,763
10	Debt Interest			$ 7,776	$ 6,552	$ 5,181	$ 3,646	$ 1,926
11	Depreciation			$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
12								
13	Taxable Income			$ 60,281	$ 51,598	$ 71,378	$ 88,563	$ 111,362
14	Income Taxes (25%)			$ 15,070	$ 12,900	$ 17,844	$ 22,141	$ 27,840
15								
16	Net Income			$ 45,211	$ 38,699	$ 53,533	$ 66,422	$ 83,521
17								
18	**Cash Flow Statement**							
19	Operating Activities:							
20	Net Income			$ 45,211	$ 38,699	$ 53,533	$ 66,422	$ 83,521
21	Depreciation			$ 23,143	$ 39,673	$ 28,338	$ 20,242	$ 7,229
22	Investment Activities:							
23	Milling machine		$ (162,000)		=-(H24-(-C23-SUM(D11:H11)))*0.25			
24	Salvage Value	3%						$ 52,167
25	Gains Tax							$ (2,198)
26	Working capital	5%	$ (25,000)	($1,250)	($1,313)	($1,378)	($1,447)	$ 30,388
27	Financing Activities:							
28	Borrowed Funds		$ 64,800					
29	Principal Repayment			$ (10,200)	$ (11,424)	$ (12,795)	$ (14,330)	$ (16,050)
30								
31	Net Cash Flow (Actual Dollars)		$ (122,200)	$ 56,904	$ 65,635	$ 67,698	$ 70,887	$ 155,058
32								
33								
34			PW(21.90%)=	$ 95,735	=NPV(21.9%,D31:H31)+C31			
35			IRR =	49.71%				
36					=IRR(C31:H31,15%)			

COMMENTS: Whenever you are dealing with multiple price indices in economic analysis, the price index that will affect the market interest rate set by many financial institutions is the consumer price index. In other words, the general inflation rate is used in calculating the market interest rate, which computes the equivalent net present worth.

SUMMARY

- Most manufacturing companies divide **manufacturing costs** into three broad categories: *direct materials, direct labor,* and *manufacturing overhead*. **Nonmanufacturing costs** are classified into two categories: *marketing* or *selling costs* and *administrative costs*.
- For the purpose of valuing inventories and determining expenses for the balance sheet and income statement, costs are classified as either **product costs** or **period costs**.
- For the purpose of predicting **cost behavior**—how costs will react to changes in activity—managers commonly classify costs into two categories: variable and fixed costs.
- Cash flow (not net income) must be considered to evaluate the economic merit of any investment project. Recall that depreciation (or amortization) is not a cash flow but is deducted, along with other operating expenses, from gross income to find taxable income and, therefore, taxes. Accountants calculate net income by subtracting taxes from taxable income. But depreciation is subtracted to find taxable income, so it must be added back into net income if we wish to use the net-income figure as an intermediate step along the path to determining after-tax cash flow.
- The tax rate to use in economic analysis is the incremental tax rate resulting from undertaking the project in question, not the overall tax rate or average tax rate.
- Identifying and estimating relevant project cash flows is perhaps the most challenging aspect of engineering economic analysis. All cash flows can be organized into one of the following three categories:
  1. Operating activities
  2. Investing activities
  3. Financing activities
- The **income-statement approach** is typically used in organizing project cash flows. This approach groups cash flows according to whether they are associated with operating, investing, or financing functions.
- Project cash flows may be stated in one of two forms:
  Actual dollars (A_n): dollars that reflect the inflation or deflation in economy.
  Constant dollars (A'_n): year-0 dollars.
- Interest rates for project evaluation may be stated in one of two forms:
  Market interest rate (i): a rate that combines the effects of interest and inflation and is used with **actual-dollar analysis**.
  Inflation-free interest rate (i'): a rate from which the effects of inflation have been removed and is used with constant-dollar analysis.

SELF-TEST QUESTIONS

10s.1 J&J Electric Company expects to have taxable income of $320,000 from its regular business over the next two years. The company is considering a new residential wiring project for a proposed apartment complex during year 0. This two-year project requires purchase of new equipment for $30,000. The equipment falls into the MACRS five-year class. The equipment will be sold after two years for $12,000. The project will bring in additional revenue of $100,000 each year, but it is expected to incur an additional operating expenses of $40,000

each year. J&J pays a flat 5% state income tax on top of the federal taxes. What is the income tax rate to use in year 1 for this project evaluation?

(a) 21%
(b) 26%
(c) 33.77%
(d) 24.95%

10s.2 Consider the following financial data for an investment project:

- Required capital investment at $n = 0$: \$100,000
- Project service life: 10 years
- Salvage value at $n = 10$: \$22,000
- Annual revenue: \$180,000
- Annual O&M costs (not including depreciation): \$60,000
- Depreciation method for tax purpose: seven-year MACRS
- Income tax rate: 25%.

Determine the project cash flow at the end of year 10.

(a) \$67,000
(b) \$78,500
(c) \$97,750
(d) \$106,500

10s.3 Suppose that in Problem 10s.2 the firm borrowed the entire capital investment at 10% interest over 10 years. If the required principal and interest payments in year 10 are

- Principal payment: \$15,650
- Interest payment: \$1,565,

what would be the net cash flow at the end of year 10?

(a) \$63,000
(b) \$74,500
(c) \$89,676
(d) \$97,652

10s.4 A new absorption chiller system costs \$360,000 and will save \$52,500 in each of the next 12 years. The asset is classified as a seven-year MACRS property for depreciation purpose. The expected salvage value is \$20,000. The firm pays taxes at a combined rate of 40% and has an MARR of 12%. What is the net present worth of the system?

(a) \$46,725
(b) −\$63,739
(c) \$62,112
(d) \$53,317

10s.5 A corporation is considering purchasing a machine that costs \$154,000 and will save \$$X$ per year after taxes. The cost of operating the machine, including maintenance and depreciation, is \$26,000 per year after taxes. The machine will be needed for four years after which it will have a zero salvage value. If the firm wants a 12% rate of return after taxes, what is the minimum after-tax annual savings that must be generated to realize a 12% rate of return after taxes?

(a) \$59,744
(b) \$61,185
(c) \$91,974
(d) \$101,974

10s.6 A corporation is considering purchasing a machine that will save $200,000 per year before taxes. The cost of operating the machine, including maintenance, is $80,000 per year. The machine costing $150,000 will be needed for five years, after which it will have a salvage value of $25,000. A full 100% bonus depreciation will be claimed on this asset. If the firm wants 15% rate of return after taxes, what is the net present value of the cash flows generated from this machine? The firm's income tax rate is 25%.

(a) $137,306
(b) $218,313
(c) $193,625
(d) $375,000

10s.7 Which of the following statements is *incorrect* under inflationary economy?

(a) Borrowers will always come out ahead as they pay back with cheaper dollars.
(b) In general, a business that has depreciable assets will pay more taxes in real dollars.
(c) In general, there will be more drain in working capital.
(d) Bond interest rates will tend to be higher in the financial market so that it would cost more to finance a new project.

Problem Statement Questions for 10s.8–10s.10

A firm is trying to choose between two machines to manufacture a new line of office furniture. The financial data for each machine have been compiled as follows:

	Machine A	Machine B
Initial investment required	$20,000	$12,000
Service life	6 years	3 years
Salvage value	$5,000	$3,000
Annual operating expenses	$4,000	$2,500
Annual operating revenue	$15,000	$12,500
Depreciation method	5-year MACRS	5-year MACRS

The firm's marginal tax rate is 40% and uses a 15% discount rate to value the projects. Also, assume that the required service period is indefinite.

10s.8 What is the internal rate of return (after tax) of machine A?

(a) 28%
(b) 39%
(c) 35%
(d) 43%

10s.9 What is the net present worth of machine B after tax over 3 years?

(a) $6,394
(b) $6,233
(c) $5,562
(d) $7,070

10s.10 Using the replacement chain method (machine B can be replaced with an identical machine at the end of year 3), determine which project should be adopted after tax.

(a) Machine A
(b) Machine B
(c) Either machine
(d) Neither machine

10s.11 Phoenix Construction Ltd. is considering the acquisition of a new 18-wheeler.

- The truck's base price is $80,000, and it will cost another $20,000 to modify it for special use by the company.
- This truck falls into the MACRS five-year class.
- It will be sold after three years (project life) for $30,000.
- The truck purchase will have no effect on revenues, but it is expected to save the firm $45,000 per year in before-tax operating costs, mainly in leasing expenses.
- The firm's marginal tax rate (federal plus state) is 25%, and its MARR is 15%.

What is the net present worth of this acquisition?

(a) −$45,158 (loss)
(b) $532
(c) $1,677
(d) $10,140

10s.12 A special purpose machine tool set would cost $20,000. The tool set will be financed by a $10,000 bank loan repayable in two equal annual installments at 10% compounded annually. The tool is expected to provide annual savings (material) of $30,000 for two years and is to be depreciated by the three-year MACRS method. This special machine tool will require annual O&M costs in the amount of $5,000. The salvage value at the end of two years is expected to be $8,000. Suppose that it is expected a 6% annual inflation during the project period. Assuming a marginal tax rate of 25% and an MARR of 20% (inflation adjusted), what is the net present worth of this project?

(a) $21,074
(b) $24,558
(c) $23,607
(d) $18,562

10s.13 You are interested in purchasing a machine that will save $200,000 per year before taxes. The cost of operating the machine, including maintenance, is $80,000 per year. The machine, which costs $150,000, will be needed for five years after which it will have a salvage value of $25,000. The machine would qualify for a 7-year MACRS property. What is the net present value of the cash flows generated from this machine at 15%? The firm's income tax rate is 40%.

(a) $123,554
(b) $137,883
(c) $131,852
(d) $122,438

10s.14 Suppose a business is considering the purchase of a $40,000 machine whose operation will result in increased sales of $30,000 per year and increased operating costs of $10,000; additional profits will be taxed at a rate of 25%. Depreciation is assumed to be taken on a 3-year MACRS over four years with no expected

salvage value. What will happen to this project's real rate of return if inflation during the next four years is expected to be 10% compounded annually?

(a) 43.22%
(b) 27.87%
(c) 16.85%
(d) 26.41%

PROBLEMS

Cost Behavior

10.1 Identify which of the following transactions and events are *product costs* and which are *period costs*:

- Direct materials cost
- Depreciation of office equipment
- Cost of receiving and unloading materials
- Rent of factory premises
- Sales promotion expenses
- Manufacturing wages
- Depreciation of the factory manager's automobile
- Gains or losses on the disposal of plant
- Lease rent of manufacturing equipment
- Delivery costs of finished goods
- Depreciation of a warehouse

10.2 Identify which of the following costs are *fixed*, which are *variable*, and which are *mixed*.

- Property taxes on factory building
- Heat and air-conditioning for the plant
- Wages paid to production workers
- Assembly floor superintendent's salary
- Production bonus paid to factory staff
- Salary of the factory manager
- Direct materials used in production
- Lubricants used for machines machinery and equipment used in production
- Cameras used in handset production
- Depreciation on machinery and equipment
- Electricity for machinery and equipment in the plant

10.3 Some commonly known costs associated with manufacturing operations are listed below:

- Regular maintenance on machinery and equipment
- Property fire insurance
- Production-based incentive to shop floor superintendent
- Labor costs in assembling a product
- Rent on office premises
- RFID units embedded in final product during shipping
- Commission to salesmen

- Property taxes on production premises
- Factory security cost
- Cardboards used in packaging finished goods
- Milk used in cake production
- Electricity for operation of machines

Classify each cost as being either variable or fixed or mixed with respect to volume or level of activity.

10.4 The following descriptions portray typical cost behaviors in many industrial settings. With the vertical axis on each graph representing total cost and the horizontal axis representing level of activity (volume), draw a graph that matches each situation:

(a) Material component cost of timber used in furniture production.

(b) Factory fire insurance bill: Annual insurance premium $7,500

(c) Material purchase cost with a volume discount: 0–500: $4; 501–2,000: $3.75; 2,001–5,000: $3.20; 5,001–8,000: $3.

(d) Internet charges: A flat fixed charge up to certain consumption level, followed by a variable cost after that threshold.

(e) Depreciation cost of factory equipment: Fixed depreciation associated with year of service and actual mileage driven.

Contribution Margin and Break-Even Volume

10.5 Suppose that a company expects the following financial results from a project during its first-year operation:

- Sales revenue: $420,000
- Variable costs: $180,000
- Fixed costs: $60,000
- Total units produced and sold: 12,000 units

(a) Compute the contribution margin percentage.

(b) Compute the break-even point in units sold.

10.6 Suppose ADI Corporation's break-even sales volume is $500,000 with fixed costs of $200,000.

(a) Compute the contribution margin percentage.

(b) Compute the selling price if variable costs are $30 per unit.

10.7 Given the following information, answer the questions:

- The ratio of variable cost per unit divided by selling price per unit equals 0.35.
- Fixed costs amount to $65,000.

(a) Draw the cost-volume-profit chart.

(b) What is the break-even point?

(c) What effect would a 10% decrease in selling price have on the break-even point from part (b)?

10.8 The J&J Company has three product lines of belts—A, B, and C—having contribution margins of $5, $4, and $2, respectively. The president foresees sales up to

240,000 units in the coming period, consisting of 50,000 units of A, 100,000 units of B, and 90,000 units of C. The company's fixed costs for the period amount to $300,000.

(a) What is the company's break-even point in units, assuming that the given sales mix is maintained?

(b) If the mix is maintained, what is the total contribution margin when 240,000 units are sold? What is the operating income?

(c) What would the operating income become if 50,000 units of A, 10,000 units of B, and 180,000 units of C were sold? What is the new break-even point in units if these relationships persist in the next period?

Net Income and Net Cash Flow

10.9 The Bloemfontein Citrus Corporation estimates its taxable income for next year at $3,200,000. The company is considering expanding its product line by introducing pineapple–orange juice for the next year. The market responses could be good, fair, or poor. Depending on the market response, the expected additional taxable incomes are (1) $3,000,000 for a good response, (2) $1,000,000 for a fair response, and (3) a $80,000 loss for a poor response.

(a) Determine the marginal tax rate applicable to each situation.

(b) Determine the federal tax that results from each situation.

10.10 The Hillside Machine Shop expects to have an annual taxable income of $500,000 from its regular business over the next six years. The company is considering acquiring a new milling machine during year 0. The machine's price is $200,000 installed. The machine falls into the MACRS seven-year class, and it will have an estimated salvage value of $50,000 at the end of six years. The machine is expected to generate additional before-tax revenue of $125,000 per year.

(a) What is the total amount of economic depreciation for the milling machine if the asset is sold at $50,000 at the end of six years?

(b) Determine the company's marginal tax rates over the next six years with the machine.

(c) Determine the company's net cash flow over the next six years with the machine.

10.11 The Columbus Electrical Company expects to have an annual taxable income of $560,000 from its residential accounts over the next two years. The company is bidding on a two-year wiring service for a large apartment complex. This commercial service requires the purchase of a new truck equipped with wire-pulling tools at a cost of $60,000. The equipment falls into the MACRS five-year class and will be retained for future use (instead of being sold) after two years, indicating no gain or loss on the property. The project will bring in additional annual revenue of $260,000, but it is expected to incur additional annual operating costs of $180,000. Compute the marginal tax rate applicable to the project's operating profits and net cash flow for the next two years.

10.12 A small manufacturing company has an estimated annual taxable income of $210,000. Due to an increase in business, the company is considering purchasing a new machine that will generate additional (before-tax) annual revenue of

$70,000 over the next five years. The new machine requires an investment of $100,000, which will be depreciated under the five-year MACRS method.

(a) What is the increment in income tax caused by the purchase of the new machine in tax year 1?

(b) What is the incremental net cash flow generated that is associated with the purchase of the new equipment in year 1?

10.13 The Nicklaus Machinery Corporation is considering purchasing a new set of machine tools to process special orders. The following financial information is available.

- Without the project, the company expects to have a taxable income of $440,000 each year from its regular business over the next three years.
- With the three-year project, the purchase of a new set of machine tools at a cost of $50,000 is required. The equipment falls into the MACRS three-year class. The tools will be sold for $10,000 at the end of the project. The project will be bringing in additional annual revenue of $100,000, but it is expected to incur additional annual operating costs of $25,000.

(a) What are the additional taxable incomes (due to undertaking the project) during each of years 1 through 3?

(b) What are the additional income taxes (due to undertaking the new orders) during each of years 1 through 3?

(c) Compute the gain taxes when the asset is disposed of at the end of year 3.

10.14 Jackson Heating & Air Company had sales revenue of $2,800,000 from operations during tax-year 1. Here are some operating data on the company for that year:

Labor expenses	$535,000
Materials costs	$370,000
Depreciation expenses	$137,500
Interest income on time deposit	$8,000
Bond interest income (non-operating income)	$5,000
Interest expenses	$30,700
Rental expenses	$62,000
Proceeds from sale of old equipment with a book value of $25,000	$30,000

(a) What are Jackson's taxable gains?

(b) What is Jackson's taxable income?

(c) What are Jackson's marginal and average tax rates?

(d) What is Jackson's net cash flow after tax?

10.15 The Huron Roofing Company had gross revenues of $4,100,000 from operations. Financial transactions were posted during the year as

Manufacturing expenses (including depreciation)	$724,000
Operating expenses (excluding interest expenses)	$326,000
A new short-term loan from a bank	$100,000
Interest expenses on borrowed funds (old and new)	$46,000
Dividends paid to common stockholders	$85,000
Old equipment sold	$70,000

The old equipment had a book value of $82,000 at the time of its sale.

(a) What is Huron's income-tax liability?

(b) What is Huron's operating income?

(c) What is the net cash flow?

Incremental Project Cash Flows

10.16 An asset in the five-year MACRS property class costs $150,000 and has a zero estimated salvage value after six years of use. The asset will generate annual revenues of $320,000 and will require $80,000 in annual labor and $50,000 in annual material expenses. There are no other revenues and expenses. Assume a tax rate of 25%.

(a) Compute the after-tax cash flows over the project life.

(b) Compute the NPW at MARR = 12%. Is the investment acceptable?

10.17 An auto-part manufacturing company is considering the purchase of an industrial robot to do spot welding, which is currently done by skilled labor. The initial cost of the robot is $250,000, and the annual labor savings are projected to be $125,000. If purchased, the robot will be depreciated under MACRS as a seven-year recovery property. This robot will be used for five years after which the firm expects to sell it for $50,000. The company's marginal tax rate is 25% over the project period.

Determine the net after-tax cash flows for each period over the project life. Assume MARR = 15%.

10.18 You are considering purchasing a new injection molding machine. This machine will have an estimated service life of 10 years with a negligible after-tax salvage value. Its annual net after-tax operating cash flows are estimated to be $60,000. If you expect a 15% rate of return on investment, what would be the maximum amount that you should spend to purchase the injection molding machine?

10.19 A facilities engineer is considering a $55,000 investment in an energy management system (EMS). The system is expected to save $14,000 annually in utility bills for N years. After N years, the EMS will have a zero salvage value. In an after-tax analysis, what would N need to be in order for the investment to earn a 12% return? Assume MACRS depreciation with a three-year class life and a 25% tax rate.

10.20 A corporation is considering purchasing a machine that will save $150,000 per year before taxes. The cost of operating the machine (including maintenance) is $30,000 per year. The machine will be needed for five years, after which it will have a zero salvage value. MACRS depreciation will be used, assuming a three-year class life. The marginal income tax rate is 25%. If the firm wants 15% return on investment after taxes, how much can it afford to pay for this machine?

10.21 Enterprise Capital Leasing Company is in the business of leasing tractors to construction companies. The firm wants to set a three-year lease payment schedule for a tractor purchased at $53,000 from the equipment manufacturer. The asset is classified as a five-year MACRS property. The tractor is expected to have a salvage value of $22,000 at the end of three years' rental. Enterprise will require a lessee to make a security deposit in the amount of $1,500 that is refundable at the end of the lease term. Enterprise's marginal tax rate is 25%. If Enterprise wants an after-tax return of 10%, what lease payment schedule should be set?

10.22 Peachtree Construction Company, a highway contractor, is considering the purchase of a new trench excavator that costs $300,000 and can dig a 3-foot-wide trench at the rate of 16 feet per hour. The contractor gets paid according to the usage of the equipment, $100 per hour. The expected average annual usage is 500 hours, and maintenance and operating costs will be $10 per hour. The contractor will depreciate the equipment by using a five-year MACRS, units-of-production method. At the end of five years, the excavator will be sold for $100,000.
Assuming the contractor's marginal tax rate is 25% per year, determine the annual after-tax cash flow.

10.23 Tucson Solar Company builds residential solar homes. Because of an anticipated increase in business volume, the company is considering the acquisition of a loader at a cost of $54,000. This acquisition cost includes delivery charges and applicable taxes. The firm has estimated that if the loader is acquired, the following additional revenues and operating expenses (excluding depreciation) should be expected:

End of Year	Additional Operating Revenue	Additional Operating Expenses, Excluding Depreciation	Allowed Tax Depreciation
1	$66,000	$29,000	$10,800
2	$70,000	$28,400	$17,280
3	$74,000	$32,000	$10,368
4	$80,000	$38,800	$6,221
5	$64,000	$31,000	$6,221
6	$50,000	$25,000	$3,110

The projected revenue is assumed to be in cash in the year indicated, and all the additional operating expenses are expected to be paid in the year in which they are incurred. The estimated salvage value for the loader at the end of the sixth year is $8,000. The firm's incremental (marginal) tax rate is 25%.

(a) What is the after-tax cash flow if the loader is acquired?

(b) What is the equivalent annual cash flow the firm can expect by owning and operating this loader at an interest rate of 12%?

10.24 An automaker is considering installing a three-dimensional (3-D) computerized car-styling system at a cost of $230,000 (including hardware and software). With the 3-D computer modeling system, designers will have the ability to view their design from many angles and to fully account for the space required for the engine and passengers. The digital information used to create the computer model can be revised in consultation with engineers, and the data can be used to run milling machines that make physical models quickly and precisely. The automaker expects to decrease the turnaround time for designing a new automobile model (from configuration to final design) by 22%. The expected savings in dollars is $250,000 per year. The training and operating maintenance cost for the new system is expected to be $50,000 per year. The system has a five-year useful life and can be depreciated according to the five-year MACRS class. The system will have an estimated salvage value of $5,000. The automaker's marginal tax rate is 25%. Determine the annual cash flows for this investment. What is the return on investment for the project?

10.25 The Manufacturing Division of Ohio Vending Machine Company is considering its Toledo plant's request for a half-inch-capacity automatic screw-cutting machine to be included in the division's 2018 capital budget:

- Name of project: Mazda Automatic Screw Machine
- Project cost: $68,701
- Purpose of project: To reduce the cost of some of the parts that are now being subcontracted by this plant, to cut down on inventory by shortening lead time, and to better control the quality of the parts. The proposed equipment includes the following cost basis:

Machine cost	$48,635
Accessory cost	$8,766
Tooling	$4,321
Freight	$2,313
Installation	$2,110
Sales tax	$2,556
Total cost	$68,701

- Anticipated savings: as shown in the accompanying table
- Tax depreciation method: seven-year MACRS
- Marginal tax rate: 25%
- MARR: 15%

Item	Hours Present Machine Center Labor	Proposed Machine Center Labor	Present Method	Proposed Method
Setup		350 hrs		$7,700
Run	2,410 hrs	800 hrs		$17,600
Overhead				
Indirect labor				$3,500
Fringe benefits				$8,855
Maintenance				$1,350
Tooling				$6,320
Repair				$890
Supplies				$4,840
Power				$795
Taxes and insurance				$763
Other relevant costs:				
Floor space				$3,210
Subcontracting			$122,468	
Material				$27,655
Other				$210
Total			$122,468	$83,688
Operating advantage				$38,780

(a) Determine the net after-tax cash flows over the project life of six years. Assume a salvage value of $3,500.
(b) Is this project acceptable based on the PW criterion?
(c) Determine the IRR for this investment.

Effects of Working Capital

10.26 Reconsider Problem 10.17. Suppose that the project requires a $30,000 investment in working capital at the beginning of the project and the entire amount will be recovered at the end of project life. How does this investment in working capital change the net cash flows series?

10.27 Reconsider Problem 10.22. Suppose that the purchase also requires an investment in working capital in the amount of $50,000, which will be recovered in full at the end of year 5. Determine the net present worth of the project.

Effects of Borrowing on Project Cash Flows

10.28 Consider a project with an initial investment of $400,000, which must be financed at an interest rate of 10% per year. Assuming that the required repayment period is five years, determine the repayment schedule by identifying the principal as well as the interest payments for each of the following repayment methods:
(a) Equal repayment of the principal: $80,000 principal payment each year
(b) Equal repayment of the interest: $40,000 interest payment each year
(c) Equal annual installments: $105,520 each year.

10.29 A special-purpose machine tool set would cost $20,000. The tool set will be financed by a $10,000 bank loan repayable in two equal annual installments at 10% compounded annually. The tool is expected to provide annual (material) savings of $30,000 for two years and is to be depreciated by the MACRS three-year recovery period. The tool will require annual O&M costs in the amount of $5,000. The salvage value at the end of the two years is expected to be $8,000. Assuming a marginal tax rate of 25% and MARR of 15%, what is the net present worth of this project? You may use Table P10.29 as a worksheet for your calculation.

TABLE P10.29

Cash Flow Statement	0	1	2
Operating activities			
Net income		$10,400	$12,019
Depreciation		$6,666	$4,445
Investment activities			
Investment	−$20,000		
Salvage			$8,000
Gains tax (40%)			
Financial activities			
Borrowed funds	$10,000		
Principal repayment	$0		
Net cash flow	−$10,000		

10.30 The Balas Manufacturing Company is considering buying an overhead pulley system. The new system has a purchase price of $150,000, an estimated useful life and MACRS class life of five years, and an estimated salvage value of $10,000. The system is expected to enable the company to economize on electric power usage, labor, and repair costs, as well as to reduce the number of defective products made. A total annual savings of $95,000 will be realized if the new pulley system is installed. The company is in the 35% marginal tax bracket. The initial investment will be financed with 40% equity and 60% debt. The before-tax debt interest rate, which combines both short-term and long-term financing, is 12% with the loan to be repaid in equal annual installments over the project life.

(a) Determine the after-tax cash flows.

(b) Evaluate this investment project by using an MARR of 20%.

(c) Evaluate this investment project on the basis of the IRR criterion.

10.31 The A.M.I. Company is considering installing a new process machine for the firm's manufacturing facility. The machine costs $220,000 installed, will generate additional revenues of $85,000 per year, and will save $65,000 per year in labor and material costs. The machine will be financed by a $120,000 bank loan repayable in three equal annual principal installments, plus 9% interest on the outstanding balance. The machine will be depreciated using seven-year MACRS. The useful life of the machine is 10 years, after which it will be sold for $20,000. The combined marginal tax rate is 25%.

(a) Find the year-by-year after-tax cash flow for the project.

(b) Compute the IRR for this investment.

(c) At MARR = 18%, is the project economically justifiable?

10.32 Consider the following financial information about a retooling project at a computer manufacturing company:

- The project costs $2.5 million and has a five-year service life.
- The retooling project can be classified as seven-year property under the MACRS rule.
- At the end of the fifth year, any assets held for the project will be sold. The expected salvage value will be about 10% of the initial project cost.
- The firm will finance 40% of the project money from an outside financial institution at an interest rate of 10%. The firm is required to repay the loan with five equal annual payments.
- The firm's incremental (marginal) tax rate on the investment is 35%.
- The firm's MARR is 18%.

With the preceding financial information,

(a) Determine the after-tax cash flows.

(b) Compute the annual equivalent worth for this project.

10.33 A manufacturing company is considering acquiring a new injection-molding machine at a cost of $150,000. Because of a rapid change in product mix, the need for this particular machine is expected to last only eight years, after which time the machine is expected to have a salvage value of $10,000. The annual operating cost is estimated to be $11,000. The addition of the machine to the current production facility is expected to generate an annual revenue of $48,000. The firm has only $100,000 available from its equity funds, so it must borrow the additional $50,000 required at an interest rate of 10% per year with repayment

of principal and interest in eight equal annual amounts. The applicable marginal income tax rate for the firm is 25%. Assume that the asset qualifies for a seven-year MACRS property class.

(a) Determine the after-tax cash flows.

(b) Determine the NPW of this project at MARR = 14%.

10.34 Suppose an asset has a first cost of $8,000, a life of five years, a salvage value of $2,000 at the end of five years, and a net annual before-tax revenue of $2,500. The firm's marginal tax rate is 25%. The asset will be depreciated by three-year MACRS.

(a) Determine the cash flow after taxes.

(b) Rework part (a), assuming that the entire investment would be financed by a bank loan at an interest rate of 9%.

(c) Given a choice between the financing methods of parts (a) and (b), show calculations to justify your choice of which is the better one at an interest rate of 9%.

10.35 A construction company is considering acquiring a new earthmover. The purchase price is $110,000, and an additional $25,000 is required to modify the equipment for special use by the company. The equipment falls into the MACRS seven-year classification (the tax life), and it will be sold after five years (the project life) for $50,000. The purchase of the earthmover will have no effect on revenues, but the machine is expected to save the firm $68,000 per year in before-tax operating costs, mainly labor. The firm's marginal tax rate is 25%. Assume that the initial investment is to be financed by a bank loan at an interest rate of 10% payable annually. Determine the after-tax cash flows and the net present worth of the investment for this project if the firm's MARR is known to be 12%.

10.36 Federal Express (FedEx) is considering adding 18 used Boeing 757 jets by buying the twin engine planes to replace some of its oldest, least-efficient freighters, Boeing 727s. FedEx pays about $10 million each, then FedEx spends about $5 million each to refit the planes to carry cargo. FedEx is required to make a 10% down payment at the time of delivery, and the balance is to be paid over a 10-year period at an interest rate of 12% compounded annually. The actual payment schedule calls for only interest payments over the 10-year period with the original principal amount to be paid off at the end of the 10th year. FedEx expects to generate $45 million per year in fuel savings by adding these aircrafts to its current fleet. The aircraft is expected to have a 15-year service life with a salvage value of 15% of the original purchase price. If the aircrafts are bought, they will be depreciated by the seven-year MACRS property classifications. The firm's combined federal and state marginal tax rate is 25%, and its required minimum attractive rate of return is 18%.

(a) Determine the cash flow associated with the debt financing.

(b) Is this project acceptable?

Comparing Mutually Exclusive Alternatives

10.37 The headquarters building owned by a rapidly growing company is not large enough for the company's current needs. A search for larger quarters revealed two new alternatives that would provide sufficient room, enough parking, and the desired appearance and location. The company now has three options:

- **Option 1:** Lease the new quarters for $144,000 per year.
- **Option 2:** Purchase the new quarters for $800,000, including a $150,000 cost for land.
- **Option 3:** Remodel the current headquarters building.

It is believed that land values will not decrease over the ownership period, but the value of all structures will decline to 10% of the purchase price in 30 years. Annual property tax payments are expected to be 5% of the purchase price. The present headquarters building is already paid for and is now valued at $300,000. The land it is on is appraised at $60,000. The structure can be remodeled at a cost of $300,000 to make it comparable to other alternatives. However, the remodeling will occupy part of the existing parking lot. An adjacent, privately owned parking lot can be leased for 30 years under an agreement that the first year's rental of $9,000 will increase by $500 each year. The annual property taxes on the remodeled property will again be 5% of the present valuation, plus the cost of remodeling. The new quarters are expected to have a service life of 30 years, and the desired rate of return on investments is 12%. Assume that the firm's marginal tax rate is 25% and that the new building and remodeled structure will be depreciated under MACRS using a real-property recovery period of 39 years. If the annual upkeep costs are the same for all three alternatives, which one is preferable?

10.38 An international manufacturer of prepared food items needs 50,000,000 kWh of electrical energy a year, with a maximum demand of 10,000 kW. The local utility company currently charges $0.085 per kWh—a rate considered high throughout the industry. Because the firm's power consumption is so large, its engineers are considering installing a 10,000-kW steam-turbine plant. Three types of plant have been proposed (units in thousands of dollars) and are given in Table P10.38.

TABLE P10.38

	Plant A	Plant B	Plant C
Average station heat rate (BTU/kWh)	$16,500	$14,500	$13,000
Total investment (boiler/turbine/electrical/structures)	$8,530	$9,498	$10,546
Annual operating cost:			
Fuel	$1,128	$930	$828
Labor	$616	$616	$616
O&M	$150	$126	$114
Supplies	$60	$60	$60
Insurance and property taxes	$10	$12	$14

The service life of each plant is expected to be 20 years. The plant investment will be subject to a 20-year MACRS property classification. The expected salvage value of the plant at the end of its useful life is about 10% of its original investment. The firm's MARR is known to be 12%. The firm's marginal income tax rate is 25%.

(a) Determine the unit power cost ($/kWh) for each plant.

(b) Which plant would provide the most economical power?

10.39 The Prescott Welding Company needs to acquire a new lift truck for transporting its final product to the warehouse. One alternative is to purchase the truck for $45,000, which will be financed by the bank at an interest rate of 12%. The loan must be repaid in four equal installments, payable at the end of each year. Under the borrow-to-purchase arrangement, Prescott Welding would have to maintain the truck at an annual cost of $1,200, also payable at year-end. Alternatively, Prescott Welding could lease the truck under a four-year contract for a lease payment of $12,000 per year. Each annual lease payment must be made at the beginning of each year. The truck would be maintained by the lessor. The truck falls into the five-year MACRS classification, and it has a salvage value of $10,000, which is the expected market value after four years, at which time Prescott Welding plans to replace the truck, irrespective of whether it leases or buys. Prescott Welding has a marginal tax rate of 25% and a MARR of 15%.

(a) What is Prescott Welding's cost of leasing in present worth?

(b) What is Prescott Welding's cost of owning in present worth?

(c) Should the truck be leased or purchased?

Note: This is an operating lease, so the truck would be maintained by the lessor.

10.40 Janet Wigandt, an electrical engineer for Instrument Control, Inc. (ICI), has been asked to perform a lease–buy analysis of a new pin-inserting machine for ICI's PC-board manufacturing that has a project life of four years with annual revenues of $200,000.

- **Buy Option:** The equipment costs $120,000. To purchase it, ICI could obtain a term loan for the full amount at 10% interest, which is payable in four equal end-of-year annual installments. The machine falls into a five-year MACRS property classification. Annual operating costs of $40,000 are anticipated. The machine requires annual maintenance at a cost of $10,000. Because technology is changing rapidly in pin-inserting machinery, the salvage value of the machine is expected to be only $20,000.
- **Lease Option:** Business Leasing, Inc. (BLI) is willing to write a four-year operating lease on the equipment for payments of $44,000 at the beginning of each year. Under this arrangement, BLI will maintain the asset so that the annual maintenance cost of $10,000 will be saved. ICI's marginal tax rate is 25%, and its MARR is 15% during the analysis period.

(a) What is ICI's present-value (incremental) cost of owning the equipment?

(b) What is ICI's present-value (incremental) cost of leasing the equipment?

(c) Should ICI buy or lease the equipment?

10.41 The Boggs Machine Tool Company has decided to acquire a pressing machine. One alternative is to lease the machine under a three-year contract for a lease payment of $15,000 per year with payments to be made at the beginning of each year. The lease would include maintenance. The second alternative is to purchase the machine outright for $100,000, which involves financing the machine with a bank loan for the net purchase price and amortizing the loan over a three-year period at an interest rate of 12% per year (annual payment = $41,635).

Under the borrow-to-purchase arrangement, the company would have to maintain the machine at an annual cost of $5,000, which is payable at year-end.

The machine falls into a five-year MACRS classification and has a salvage value of $50,000, which is the expected market value at the end of year 3, at which time, the company plans to replace the machine, irrespective of whether it leases or buys. Boggs has a tax rate of 25% and a MARR of 15%.

(a) What is Boggs' PW cost of leasing?

(b) What is Boggs' PW cost of owning?

(c) From the financing analysis in parts (a) and (b), what are the advantages and disadvantages of leasing and owning?

Effects of Inflation on Project Cash Flows

10.42 Gentry Machines, Inc. has just received a special job order from one of its clients. The following financial data have been collected:

- This two-year project requires the purchase of special-purpose equipment for $55,000. The equipment falls into the MACRS five-year class.
- The machine will be sold for $27,000 (today's dollars) at the end of two years.
- The project will bring in additional annual revenue of $114,000 (actual dollars), but it is expected to incur an additional annual operating cost of $53,800 (today's dollars).
- The project requires an investment in working capital in the amount of $12,000 at $n = 0$. In each subsequent year, additional working capital needs to be provided at the general inflation rate. Any investment in working capital will be recovered after the project is terminated.
- To purchase the equipment, the firm expects to borrow $50,000 at 10% over a two-year period. The remaining $5,000 will be taken from the firm's retained earnings. The firm will make equal annual payments of $28,810 (actual dollars) to pay off the loan.
- The firm expects a general inflation of 5% per year during the project period. The firm's marginal tax rate is 25%, and its market interest rate is 18%.

(a) Compute the after-tax cash flows in actual dollars.

(b) What is the equivalent present value of this amount at time 0?

10.43 Hugh Health Product Corporation is considering purchasing a computer system to control plant packaging for a spectrum of health products. The following data have been collected:

- First cost = $120,000 to be borrowed at 9% interest with only interest paid each year and the principal due in a lump sum at end of year 2
- Economic service life (project life) = 6 years
- Estimated selling price in year-0 dollars = $15,000
- Depreciation = five-year MACRS property
- Marginal income-tax rate = 25% (remains constant)
- Annual revenue = $145,000 (today's dollars)
- Annual expense (not including depreciation and interest) = $82,000 (today's dollars)
- Market interest rate = 18%

(a) With an average general inflation rate of 5% expected during the project period (which will affect all revenues, expenses, and the salvage value of the computer), determine the cash flows in actual dollars.

(b) Compute the net present value of the project under inflation.

(c) Compute the net present-value loss (gain) due to inflation.

(d) In part (c), how much is the present-value loss (or gain) due to borrowing?

10.44 The J. F. Manning Metal Co. is considering the purchase of a new milling machine during year 0. The machine's base price is $135,000, and it will cost another $15,000 to modify it for special use. This results in a $150,000 cost base for depreciation. The machine falls into the MACRS seven-year property class. The machine will be sold after three years for $80,000 (actual dollars). The use of the machine will require an increase in net working capital (inventory) of $10,000 at the beginning of the project year. The machine will have no effect on revenues, but it is expected to save the firm $80,000 (today's dollars) per year in before-tax operating costs, mainly for labor. The firm's marginal tax rate is 25%, and this rate is expected to remain unchanged over the duration of the project. However, the company expects that the labor cost will increase at an annual rate of 5% but that the working-capital requirement will grow at an annual rate of 8% (caused by inflation). The selling price of the milling machine is not affected by inflation. The general inflation rate is estimated to be 6% per year over the project period. The firm's market interest rate is 20%.

(a) Determine the project cash flows in actual dollars.

(b) Determine the project cash flows in constant (time-0) dollars.

(c) Is this project acceptable?

10.45 Miami Machine Shops, Ltd. is considering purchasing a vertical drill machine. The machine will cost $62,000 and will have an eight-year service life. The selling price of the machine at the end of eight years is expected to be $5,000 in today's dollars. The machine will generate annual revenues of $22,000 (today's dollars), but the company expects to have an annual expense (excluding depreciation) of $9,500 (today's dollars). The asset is classified as a seven-year MACRS property. The project requires a working-capital investment of $10,000 at year 0. The marginal income tax rate for the firm is averaging 25%. The firm's market interest rate is 18%.

(a) Determine the internal rate of return of this investment.

(b) Assume that the firm expects a general inflation rate of 5%, but that it also expects an 8% annual increase in revenue and working capital and a 6% annual increase in expense caused by inflation. Compute the real (inflation-free) internal rate of return. Is this project acceptable?

10.46 Suppose you have $10,000 cash that you want to invest. Normally, you would deposit the money in a savings account that pays an annual interest rate of 6%. However, you are now considering the possibility of investing in a bond. Your alternatives are either a nontaxable municipal bond paying 9% or a taxable corporate bond paying 12%. Your marginal tax rate is 30% for both ordinary income and capital gains. You expect the general inflation to be 3% during the investment period. You can buy a high-grade municipal bond costing $10,000 that pays interest of 9% ($900) per year. This interest is not taxable. A comparable high-grade corporate bond is also available that is just as safe as the municipal bond, but it pays an interest rate of 12% ($1,200) per year. This interest is taxable as ordinary income. Both bonds mature at the end of year 5.

(a) Determine the real (inflation-free) rate of return for each bond.

(b) Without knowing your MARR, can you make a choice between these two bonds?

10.47 An airline is considering two types of engines for use in its planes. Each engine has the same life, the same maintenance, and the same repair record.

- Engine A costs \$100,000 and uses 50,000 gallons of fuel per 1,000 hours of operation at the average service load encountered in passenger service.
- Engine B costs \$200,000 and uses 32,000 gallons of fuel per 1,000 hours of operation at the same service load.

Both engines are estimated to have 10,000 service hours before any major overhaul of the engines is required. If fuel currently costs \$5.90 per gallon and its price is expected to increase at the rate of 8% because of inflation, which engine should the firm install for an expected 2,000 hours of operation per year? The firm's marginal income-tax rate is 25%, and the engine will be depreciated on the basis of the unit-of-production method. Assume that the firm's market interest rate is 20%. It is estimated that both engines will retain a market value of 40% of their initial cost (actual dollars) if they are sold on the market after 10,000 hours of operation.

(a) Using the present-worth criterion, which project would you select?

(b) Using the annual-equivalent criterion, which project would you select?

(c) Using the future-worth criterion, which project would you select?

10.48 The Johnson Chemical Company has just received a special subcontracting job from one of its clients. The two-year project requires the purchase of a special-purpose painting sprayer of \$60,000. This equipment falls into the MACRS five-year class. After the subcontracting work is completed, the painting sprayer will be sold at the end of two years for \$40,000 (actual dollars). The painting system will require an increase of \$5,000 in net working capital (for spare-parts inventory, such as spray nozzles). This investment in working capital will be fully recovered after the project is terminated. The project will bring in an additional annual revenue of \$120,000 (today's dollars), but it is expected to incur an additional annual operating cost of \$60,000 (today's dollars). It is projected that, due to inflation, sales prices will increase at an annual rate of 5%. (This implies that annual revenues will increase at an annual rate of 5%.) An annual increase of 4% for expenses and working-capital requirement is expected. The company has a marginal tax rate of 25%, and it uses a market interest rate of 15% for project evaluation during the inflationary period. The firm expects a general inflation of 8% during the project period.

(a) Compute the after-tax cash flows in actual dollars.

(b) What is the rate of return on this investment (real earnings)?

(c) Is the special subcontracting project profitable?

10.49 The Land Development Corporation is considering purchasing a bulldozer. The bulldozer will cost \$100,000 and will have an estimated salvage value of \$30,000 at the end of six years. The asset will generate annual before-tax revenues of \$80,000 over the next six years. The asset is classified as a five-year MACRS property. The marginal tax rate is 25%, and the firm's market interest rate is known to be 18%. All dollar figures represent constant dollars at time 0 and are responsive to the general inflation rate $\bar{f}$.

(a) With $\bar{f} = 6\%$, compute the after-tax cash flows in actual dollars.

(b) Determine the real rate of return of this project on an after-tax basis.

(c) Suppose that the initial cost of the project will be financed through a local bank at an interest rate of 12% with an annual payment of $24,323 over six years. With this additional condition, answer part (a) again.

(d) In part (a), determine the present-value loss due to inflation.

(e) In part (c), determine how much the project has to generate in additional before-tax annual revenue in actual dollars (equal amount) to make up the loss due to inflation.

Short Case Studies with Excel

10.50 USA Aluminum Company is considering making a major investment of $150 million ($5 million for land, $45 million for buildings, and $100 million for manufacturing equipment and facilities) to produce a stronger, lighter material, called aluminum lithium, that will make aircraft sturdier and more fuel efficient. Aluminum lithium has been sold commercially as an alternative to composite materials for only a few years. It will likely be the material of choice for the next generation of commercial and military aircraft because it is so much lighter than conventional aluminum alloys. Another advantage of aluminum lithium is that it is cheaper than composites. The firm predicts that aluminum lithium will account for about 5% of the structural weight of the average commercial aircraft within 5 years and 10% within 10 years. The proposed plant, which has an estimated service life of 12 years, would have a production capacity of about 10 million pounds of aluminum lithium, although domestic consumption of the material is expected to be only 3 million pounds during the first four years, five million for the next three years, and eight million for the remaining plant life. Aluminum lithium costs $15 a pound to produce, and the firm would expect to sell it at $28 a pound. The building, which will be placed in service on July 1 of the first year, will be depreciated according to the 39-year MACRS real-property class. All manufacturing equipment and facilities will be classified as seven-year MACRS property. At the end of project life, the land will be worth $8 million, the building $30 million, and the equipment $10 million. The firm's marginal tax rate is 25%, and its capital gains tax rate is 25%.

(a) Determine the net after-tax cash flows.

(b) Determine the IRR for this investment.

(c) Determine whether the project is acceptable if the firm's MARR is 15%.

10.51 The Pittsburgh division of Vermont Machinery, Inc., manufactures drill bits. One of the production processes for a drill bit requires tipping, whereby carbide tips are inserted into the bit to make it stronger and more durable. This tipping process usually requires four or five operators, depending on the weekly work load. The same operators are also assigned to the stamping operation, where the size of the drill bit and the company's logo are imprinted on the bit. Vermont is considering acquiring three automatic tipping machines to replace the manual tipping and stamping operations. If the tipping process is automated, the division's engineers will have to redesign the shapes of the carbide tips to be used in the machine. The new design requires less carbide, resulting in savings on materials. The following financial data have been compiled:

- Project life: six years
- Expected annual savings: reduced labor, $56,000; reduced material, $75,000; other benefits (reduced carpal tunnel syndrome and related problems), $28,000; reduced overhead, $15,000

- Expected annual O&M costs: $22,000
- Tipping machines and site preparation: equipment costs (for three machines), including delivery, $180,000; site preparation, $20,000
- Salvage value: $30,000 (total for the three machines) at the end of six years
- Depreciation method: seven-year MACRS
- Investment in working capital: $25,000 at the beginning of the project year, which will be fully recovered at the end of the project year
- Other accounting data: marginal tax rate of 25%; MARR of 18%

To raise $200,000, Vermont is considering the following financing options:

- Option 1: Finance the tipping machines by using retained earnings.
- Option 2: Secure a 12% term loan over six years (with six equal annual installments).
- Option 3: Lease the tipping machines. Vermont can obtain a six-year financial lease on the equipment (maintenance costs are taken care of by the lessor) for payments of $55,000 at the beginning of each year.

(a) Determine the net after-tax cash flows for each financing option.

(b) What is Vermont's PW cost of owning the equipment by borrowing?

(c) What is Vermont's PW cost of leasing the equipment?

(d) Recommend the best course of action for Vermont.

10.52 H-Robot Incorporated (HRI), a world leader in the robotics industry, produces a line of industrial robots and peripheral equipment, which perform many routine assembly-line tasks. The company enjoyed much success in the past when automobile manufacturers and other durable goods producers sought to cut costs by automating the production process. However, increased competition, particularly from Japanese firms, had caused HRI's management to be concerned about the company's growth potential. Therefore, HRI's research and development department has been applying industrial-robot technology to develop a line of household robots. The household robot is designed to function as a maid, mainly performing such tasks as vacuuming floors and carpets. This R&D effort has now reached the stage where a decision must be made on whether to go forward with production.

HRI's marketing department has plans to target sales of the robots to households with working mothers in the United States, and if it is successful there, then the robots could be marketed even to college students or households in other countries. Additional data follow.

- The marketing vice president believes that annual sales would be somewhere between 150,000 and 300,000 units (most likely, 200,000 units) if the robots were priced at $400 each.
- The engineering department has estimated that the firm would need a new manufacturing plant; this plant could be built and made ready for production in two years once the "go" decision is made. The plant would require a 35-acre site, and HRI currently has an option to purchase a suitable tract of land for $2.5 million. Building construction would begin in early 2018 and continue through 2019. The building, which would fall into the MACRS 39-year class, would cost an estimated $10.5 million. A $3.5-million payment would be due to the contractor on December 31, 2017, and another $7 million payable on December 31, 2019.

- The necessary manufacturing equipment would be installed late in 2019 and would be paid for on December 31, 2019. The equipment, which would fall into the MACRS seven-year class, would have a cost of $18.5 million, including transportation, plus another $500,000 for installation.
- To date, the company has spent $12 million on research and development associated with the household robot. The company has expenses of $4 million for the R&D costs; the remaining $8 million already has been capitalized and will be amortized over the life of the project. However, if HRI decides not to go forward with the project, the capitalized R&D expenditures could be written off on December 31, 2017.
- The project would also require an initial investment in net working capital equal to 12% of the estimated sales in the first year. The initial working capital investment would be made on December 31, 2019. On December 31 of each following year, net working capital would be increased by an amount equal to 12% of any sales increase expected during the coming year.
- The project's estimated economic life is eight years (not counting the construction period). At the end of that time, the land is expected to have a market value of $4.5 million, the building a value of $3 million, and the equipment a value of $3.5 million.
- The production department has estimated that variable manufacturing costs would total 65% of dollar sales, and that fixed overhead costs, excluding depreciation, would be $8.5 million for the first year of operations. Sales prices and fixed overhead costs, other than depreciation and amortization, are projected to increase with inflation, which is estimated to average 5% per year over the eight-year life of the project. (Note that the first year's sales would be $\$400 \times 200{,}000$ units $= \$80$ million. The second year's sales would be 5% higher than $80 million, and so forth.)
- HRI's marginal combined tax rate is 25%; its weighted average cost of capital is 15% (meaning that its minimum attractive rate of return is 15%); and the company's policy, for capital budgeting purposes, is to assume that cash flows occur at the end of each year.
- Since the plant would begin operations on January 1, 2020, the first operating cash flows would thus occur on December 31, 2020. Assume that the current decision point is December 31, 2017.
  (a) Develop the project cash flows, after taxes, over the life of the project. Use Excel to prepare the project cash flow worksheet.
  (b) Determine the equivalent net worth of the project at the time of commercialization.
  (c) Determine the equivalent annual worth of the project and the unit profit per production.
  (d) Determine the internal rate of return of the project.
  (e) Determine the break-even annual unit sales to justify the investment.
  (f) Suppose that the unit sale price could decline 3% annually over the previous year's price due to market competition. (But all other costs, other than depreciation and amortization, would increase at an annual rate of 5%.) What is your course of action?

10.53 A&H Chemical Corporation is a multinational manufacturer of industrial chemical products. A&H has made great progress in energy-cost reduction and has implemented several cogeneration projects in the United States and Puerto Rico, including the completion of a 35-megawatt (MW) unit in Chicago and a 29-MW unit in Baton Rouge. The division of A&H being considered for one of its more recent cogeneration projects is at a chemical plant located in Texas. The plant has a power usage of 80 million kilowatt-hours (kWh) annually. However, on average, it uses 85% of its 10-MW capacity, which would bring the average power usage to 68 million kWh annually. Texas Electric presently charges $0.09 per kWh of electric consumption for the A&H plant, a rate that is considered high throughout the industry. Because A&H's power consumption is so large, the purchase of a cogeneration unit is considered to be desirable. Installation of the cogeneration unit would allow A&H to generate its own power and to avoid the annual $6,120,000 expense to Texas Electric. The total initial investment cost would be $10,500,000. This would cover $10,000,000 for the purchase of the power unit itself—a gas-fired 10-MW Allison 571—and engineering, design, and site preparation. The remaining $500,000 would include the purchase of interconnection equipment, such as poles and distribution lines, that would be used to interface the cogenerator with the existing utility facilities.

As A&H's management has decided to raise the $10.5 million by selling bonds, the company's engineers have estimated the operating costs of the cogeneration project. The annual cash flow is composed of many factors: maintenance costs, overhaul costs, expenses for standby power, and other miscellaneous expenses. Maintenance costs are projected to be approximately $500,000 per year. The unit must be overhauled every three years, at a cost of $1.5 million per overhaul. Standby power is the service provided by the utility in the event of a cogeneration-unit trip or scheduled maintenance outage. Unscheduled outages are expected to occur four times annually with each outage averaging 2 hours in duration at an annual expense of $6,400. In addition, overhauling the unit takes approximately 100 hours and occurs every three years, requiring another triennial standby-power cost of $100,000. Miscellaneous expenses, such as additional personnel and insurance, are expected to total $1 million. Fuel (spot gas) will be consumed at a rate of 8,000 BTU per kWh, including the heat-recovery cycle. At $2.00 per million BTU, the annual fuel cost will reach $1,280,000. Due to obsolescence, the expected life of the cogeneration project will be 12 years, after which Allison will pay A&H $1 million for the salvage of all equipment.

Revenues will be incurred from the sale of excess electricity to the utility company at a negotiated rate. Since the chemical plant will consume, on average, 85% of the unit's 10-MW output, 15% of the output will be sold at $0.04 per kWh, bringing in an annual revenue of $480,000. A&H's marginal tax rate (combined federal and state) is 25%, and its minimum required rate of return for any cogeneration project is 27%. The anticipated costs and revenues are summarized as follows:

Initial Investment	
Cogeneration unit and engineering, design, and site preparation (15-year MACRS class)	$10,000,000
Interconnection equipment (five-year MACRS class)	$500,000
Salvage value after 12 years of use	$1,000,000
Annual Expenses	
Maintenance	$500,000
Miscellaneous (additional personnel and insurance)	$1,000,000
Standby power	$6,400
Fuel	$1,280,000
Other Operating Expenses	
Overhaul every three years	$1,500,000
Standby power during overhaul	$100,000
Revenues	
Sale of excess power to Texas Electric	$480,000

(a) If the cogeneration unit and other connecting equipment could be financed by issuing corporate bonds at an interest rate of 9%, compounded annually, determine the net cash flow from the cogeneration project.

(b) If the cogeneration unit can be leased, what would be the maximum annual lease amount that A&H should be willing to pay?

10.54 Wilson Machine Tools, Inc., a manufacturer of fabricated metal products, is considering the purchase of a high-tech computer-controlled milling machine at a cost of $95,000. The cost of installing the machine, preparing the site, wiring, and rearranging other equipment is expected to be $15,000. This installation cost will be added to the cost of the machine in order to determine the total cost basis for depreciation. Special jigs and tool dies for the particular product will also be required at a cost of $10,000. The milling machine is expected to last 10 years, but the jigs and dies for only five years. Therefore, another set of jigs and dies has to be purchased at the end of five years. The milling machine will have a $10,000 salvage value at the end of its life, and the special jigs and dies are worth only $300 as scrap metal at any time in their lives. The machine is classified as a seven-year MACRS property, and the special jigs and dies are classified as a three-year MACRS property. With the new milling machine, Wilson expects additional annual revenue of $80,000 from increased production. The additional annual production costs are estimated as follows: materials, $9,000; labor, $15,000; energy, $4,500; and miscellaneous O&M costs, $3,000. Wilson's marginal income-tax rate is expected to remain at 25% over the project life of 10 years. All dollar figures are in today's dollars. The firm's market interest rate is 18%, and the expected general inflation rate during the project period is estimated at 6%.

(a) Determine the project cash flows in the absence of inflation.

(b) Determine the internal rate of return for the project based on your answer to part (a).

(c) Suppose that Wilson expects the following price increases during the project period: materials at 4% per year, labor at 5% per year, and energy and other O&M costs at 3% per year. To compensate for these increases in prices, Wilson is planning to increase annual revenue at the rate of 7% per year by charging its customers a higher price. No changes in salvage value are expected for the machine, the jigs, and the dies. Determine the project cash flows in actual dollars.

(d) From your answer to part (c), determine the real (inflation-free) rate of return of the project.

(e) Determine the economic loss (or gain) in present worth caused by inflation.